INFORMATION NEEDS AND USE OF ONLINE VIDEO BY EDUCATORS: IMPLICATIONS FOR THE DESIGN OF WEB RESOURCES

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ABSTRACT

RON T. BROWN: Information Needs and Use of Online Video by Educators: Implications for the Design of Web Resources
(Under the direction of Professor Stephanie W. Haas)

A case study of the nasa.ibiblio.org Web site was undertaken to deepen the current understanding we have of how educators search for and use online video information in classroom settings. Three methods were used to conduct a user needs assessment: transaction log analysis, online survey, and cognitive walkthrough interviews. The findings support previous research which found educators used videos with difficult topics and they used them to help students visualize concepts. In the study, visual surrogates of video were evaluated and educators suggested a series of revisions which would make them more interactive. Some educators were able to compensate for the system's lack of educational standards metadata by applying their personal knowledge to the system.

The major contributions of this dissertation are the introduction of the Web of Criteria, the recommendations for educational digital libraries and implications for the design of storyboard and posterframe visual surrogates. Findings from the current study and from previous research suggested social interactions educators have are important and need to be facilitated in digital environments. Digital library providers might view the interface as the point where they can intervene and lessen the barriers educators have to retrieving educational information.

To my wife, parents, family and friends.

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CHAPTER I

INTRODUCTION

Since the introduction of the World Wide Web, educators and researchers have struggled with the question of how best to introduce Web based educational materials into the classroom. Educators attempting to use Web resources face a variety of problems when it comes to implementing those resources in the classroom, such as how to efficiently find information on the Web, lack of technology to fully use Web based resources in the classroom, and lack of time to align Web based resources to their course of study and/or develop related lesson plans. Although the previous list is not an exhaustive list of problems educators face when attempting to use Web materials, this list that suggests educators who do use these materials might have advantages which minimize some of these problems or these educators may see the benefit of using these materials as outweighing the problems related to their use. From the perspectives of information systems design and research on information seeking and use of Web materials, these "advantages" are the exact details which, if better understood, could lead to increased use of Web resources by educators.

In the field of Information and Library Science, previous educationally focused research has been composed of relatively few branches. In one branch researchers catalogue the resources educators use; in another, researchers evaluate the terms educators find useful in retrieving educational information. In other fields researchers have investigated how educators search for Web materials to use in the classroom, how disparities in technology and funding between schools affects student learning, and the importance of continuing education in sharpening educators’ classroom practices.

The previous branches generally emphasize access to resources and how access to more of those resources might influence the overall outcome of learning in the various institutions. For example, a common belief is that educators who have access to continuing education resources are generally more up-to-date in their field and better prepared to teach in the classroom. Although these types of research are important, they may not examine all of the variables related to how educators use the Web in relation to their teaching tasks. In particular, research could focus on how well current Web systems and Web resources satisfy the needs of educators. For this, more research needs to be done that evaluates educators’ information seeking and use of Web material.

To understand how the larger process operates as researchers we may need to understand which variables are most important and how these variables interact. More specifically we might need to evaluate how the Web material is advertised or made available to an educational audience, an educator's overall experience with use of the Web material, the role technology plays in educators' use of the Web material and how applicable the Web material is to their teaching tasks. In order to study this larger problem, this work focuses on evaluating educators’ information seeking in relation to the use of one specific type of Web material, Web based digital video.

Rationale

Web based or online video refers to video that has either been digitized by transforming analog video into some digital format or video that was captured with a device such as a digital camcorder and placed on the Web for distribution. The search for and widespread use of online video has recently increased at an exponential rate with the advent of sites such as youtube.com and google.video.com and their increased visibility and appeal in the past few years. Whereas youtube.com and google.video.com are Web based video repositories which focus on all genres of video created from the contributions of their users, educational Web based video repositories exist in a more library-type environment. In the library-type environment contributions are generally catalogued by information professionals and included in Web repositories based on some acquisition process. Despite the differences in how videos are contributed in educational and commercial Web based video repositories, both institutions know relatively little about the user behavior and information seeking habits of their respective populations. With that being said, the need for efficient Web based video retrieval systems and well designed interfaces will sharply increase as the number of users grows.

One important reason to investigate the use of these digital resources is the need to understand user behavior as it relates to Web based video repositories. In some respects the commercial sector will be less concerned with developing models of online video use because their primary efforts will be spent in developing ways to monetize and create economic models surrounding online video resources. This leaves the research sector to investigate why people use Web based video repositories and to explore how the use of the free online video resources might be improved.

Another important reason to investigate the use of these digital resources is related to the increasing trend in younger generations’ visual literacies. Roberts, Foehr, Rideout, and Brodie (1999) documented how media has changed in the average American home over the past 20 years; they argue that the children of today have access to more media with more channels and have more privacy when using these new media. As this trend continues educators may need to adapt to this evolving learning style of their students and proportionately increase their use of video and visual materials to stimulate the minds of their students. This adaptation will only increase the need for educators to find a variety of teaching materials in the most efficient manner possible, thus reiterating the importance of research to study how to improve access and dissemination of web video resources for use by educators.

Another motivation for the selection of online video over other educational materials is that Web based video has a distinct combination of textual, aural and visual components as compared to other Web resources. Web based video differs from text based resources because video description, search and retrieval are largely limited to the textual domain, with researchers still working on ways to leverage the audio and the video to improve performance of information systems. This more complex composition requires users to interact with Web based video differently. Until recently most Web based video required specialized players or additional plug-ins to be installed before the video could be displayed on users' computers. Not only is the viewing interaction of Web based video different compared to text based resources but so are the storage requirements. The higher the quality at which the video is stored, the more storage space is required. The more storage space required for the video, the more difficult it is to transmit the video files across the variety of bandwidths used by the general population. These characteristics distinguish Web based video from other Web based resources and suggest we need to study how these characteristics influence how users interact with and access these materials. Overall, the study of these materials will address the need to improve the description, search and retrieval of Web based video.

Additionally this topic deserves our attention because it can advance our understanding of pedagogies for, and preservation of, online educational materials. As suggested by Hatch, Bass , Iiyoshi, and Pointer (2004), instead of developing teaching materials for individual use, educators should make these materials available in the form of digital repositories to wider audiences. By publishing these materials in repositories, Hatch et al. suggest the scholarship of teaching would benefit from the feedback and use of the materials from the expanded global educational audience.

Given the unique problems presented to both the providers of online video resources as well as the users in the educational domain, more research is needed to propose solutions to the problem of how to best present, search for and retrieve Web based educational videos. We propose to evaluate a specific Web based educational video repository, nasa.ibiblio.org, in relation to educators' information seeking and use of online video in order to gain a deeper understanding of some of the issues involved.

A Study Of An Online Media Archive

Nasa.ibiblio.org is a digital library which provides Web based access to NASA educational videos (Figure 1.1). The current library is a collaboration of NASA's Educational Media Archive (formerly known as NASA's Center for Distance Learning), the Open Video project and ibiblio.org. In this relationship NASA's Educational Media Archive provides copies of their five educational programs: NASA's Kids News Science Network™, Noticiencias NASA™, NASA SCI Files™, NASA Connect™, and NASA's Destination Tomorrow™; Open Video provides the personnel which digitizes, segments and catalogs the video programs; and ibiblio provides the web space for the video archive to be stored. The target populations for the digitized video are mathematics, science, and technology educators in grades K-16, home schoolers, libraries, after-school clubs, and a variety of informal education outlets such as 4-H clubs, Boys and Girls Clubs, Boy Scouts, Girl Scouts, YMCA, science centers, and planetariums.

Figure 1.1 Screenshot of nasa.ibiblio.org index page.

Many questions exist about how to best design Web based video library systems for educators. The current research aims to explore the types of information educators require when searching for and retrieving online video. In particular this research will attempt to address the following broad research questions:

- How congruent is online video with educators' current work processes?
- Do the current ways in which online video is provided facilitate educator use of online video for instruction?
- How can the impact of these free resources be assessed?

The first step was to conduct a user needs assessment that focused on how educators would like to access and use video in their teaching. This research attempts to expand our understanding of educators' information seeking behavior and use of online video. With the knowledge of educators' needs we will be then able to improve our systems and empower educators to focus more on the task of teaching rather than technical issues of using video retrieval interfaces. Furthermore this user assessment provides further context for representing and identifying semantic relationships from raw video footage; this problem is commonly referred to as the semantic gap.

In the next chapter we discuss issues which have some bearing on how educational video materials are incorporated and used in the classroom. After describing the overarching model for this research, we present four sections: the teaching process, information seeking and use of online video by educators, relevance criteria for educational materials and online video, and digital library interface design. These sections serve as a starting point for understanding the larger problem and lead us to the fifth section in which we develop the research questions.

CHAPTER II

BACKGROUND

One Educator's Search For Online Video

Imagine an eighth grade algebra educator is looking for an online video to include in next week's class. The educator wants her lesson to reinforce the definitions of transversals, parallel lines, and alternate interior angles that the students learned the other day. The educator also wants the Web based video to have a good real life example of how to calculate the circumference of a circle. She begins to plan for next week's class at home by outlining the objectives, materials, prerequisites, and outcomes of the lesson plan that she would like to cover.

There are many things that we don't know about the current use of online video in K-12 classes including what motivates educators to search for online video to use in the classroom and where an educator's search for online video begins. After typing in "online video" and "Geometry" into her favorite search engine, the educator decides that there is just too much information out there that doesn't get her closer to finding what she wants. What she needs is an authentic and reliable source of online video. She calls one of her tech savvy friends and asks for help. Her friend gives her a link to a source he has had success with in the past, a Web based video library. A Web based video library is a collection of digitized videos whose authors have granted the appropriate copyright privileges for the video to be made available to the public, perhaps with certain restrictions on use. The Web based video library allows users to contribute, search, and retrieve digital video through the use of a digital library interface and a retrieval system. The digital library interface displays information to the user that allows him to interact with the digital library. The digital library retrieval system processes user queries by searching through records in the collection. Web based video libraries also establish a community of users focused on the research and use of online video materials in a variety of ways.

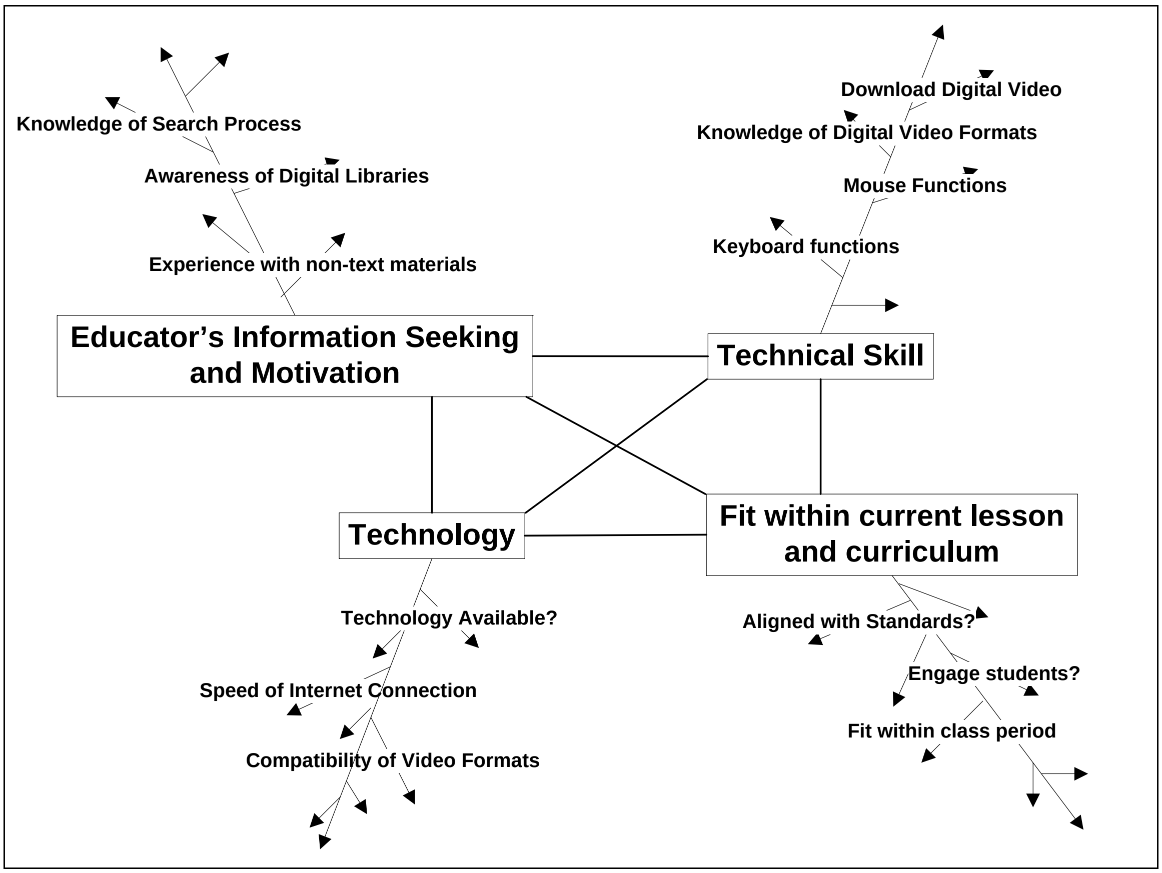
After going to the online video library and typing in “Interior Angles” the educator begins to search for online videos that might help her teach a lesson on parallel lines. Several questions become relevant to the interaction the educator has with the Web interface and the online video library retrieval system. How do educators phrase their search queries? What information do educators find useful for evaluating an online video’s content? What criteria do educators use to judge the appropriateness of the online video they find to the lesson they wish to teach? How user friendly is the online video library? These questions are important because everything from how online video is indexed, to how the interface for the online video library is designed, impacts the effectiveness of Web based video retrieval and the digital library.

The educator eventually finds several online videos on the subject of parallel lines, interior angles, and circumference. She chooses the video on Eratosthenes as a possibility. But because she wants to know if parts of the video will apply to tomorrow’s lesson, she must review the entire video – there’s no other way to know for certain.

As the educator prepares to review the online video, she notices there are several different digital video formats: MPEG-1, MPEG-2, MPEG-4, QuickTime, and Real Player. Because she does not understand the technical differences between the formats, she is not sure which formats will work at her home computer and which formats will work when she shows the video to the class. Another question the educator has is whether this site will even be available at school. The firewall prevents sites that have not had their content verified from being displayed on school computers. Randomly clicking on the MPEG-4 format she downloads the online video, the Real Player window opens up and a song begins to play. What an unexpected outcome! The educator guesses the song must be the last one she played with Real Player, and assumes that the attempt to play the video was unsuccessful. Trying again she clicks on MPEG-2 format. A progress window pops up and the video begins to download. After the download completes, a broken image of a film strip stares back at her on the computer screen indicating another unsuccessful attempt to play the online video. The educator is disappointed the Web based video library gives no indication of how long downloads will take or which videos are compatible with her computer. She decides to try one more time and clicks on the QuickTime link. The educator waits patiently as the progress window appears and the video downloads to her machine. After two unsuccessful attempts, the online video is downloaded to her machine and plays successfully. The educator reviews the video and decides it is appropriate for next week's class. However, based on her frustrating and unsatisfactory experience with using this particular resource she is certain she will not use it again.

This scenario outlines the problems that an educator might have trying to find and use online video for her classroom. According to Hanson and Carlson (2005), educators face a number of challenges when attempting to use digital library resources; these challenges are "variety and scope of digital collections, fragmentary nature of material, lack of educator guides, search engines not designed for the average end user; teacher's lack of experience using non-text resources; as well as challenges related to alignment of standards and the struggle between in-depth inquiry and curriculum breadth" (p. 1). These problems suggest there are criteria that must be met to successfully search, retrieve, and use online video in the classroom. Collectively these criteria will be referred to as “the Web model” or the “Web of Criteria” (see Figure 2.1).

Figure 2.1. The Web of Criteria: Factors which impact an educator's successful interaction with online video



The Web of Criteria is based on reflections on the research literature and from observations made during a focus group of educators conducted on January 11th, 2006 (Brown, 2006a; Brown, 2006b; Brown & Bowers, 2006). Overall this Web of Criteria represents the probability an educator will have a successful interaction with retrieval and use of online video. The model presented here is composed of four large subsections, which are not intended to be an exhaustive representation of the described phenomenon. The four subsections are each composed of one larger node and a constellation of smaller interconnected nodes. Nodes in the model represent different criteria related to the retrieval and use of Web based video; if any one criterion cannot be met then the web is weaker and the chance of an educator being successful in that particular interaction is diminished.

One node in the Web of Criteria represents an educator’s information seeking and motivation. In order for educators to retrieve online video they need knowledge of the search process. Knowledge of the search process implies educators have an awareness of the variety of digital libraries and search engines available along with a willingness to use them. If educators are not aware of the digital libraries or are not willing to use digital library content in the class then those resources are useless. Awareness of digital libraries and the collections each digital library contains will determine which resources are searched. Not only do educators need to be aware of digital library resources and collections, they also need to be aware of other services where online video can be accessed. Online video can also be accessed from on-demand and streaming services, however, the cost of these services might prohibit educators from continuous use of these resources. The focus of this research is on digital libraries which provide their online videos at no monetary cost to their user.

With regard to search engines, educators need to know which search engines can be used to find online video. Along with this knowledge educators will need the ability to formulate their own queries and the ability to determine how to refine searches in order to achieve better results both with standard search engines and with search facilities provided by digital libraries.

Another node in the web is technical skill: does the educator have the technical skill necessary to use a computer? This requires the educator to have a general knowledge of how to use a computer from basic skills such as how a keyboard and mouse function, to how to select between different digital video formats and download a digital video. Educators who have the technical skill needed to display digital video will be able to download and display video from a variety of Web resources and troubleshoot problems they encounter with Web based video use.

The next node in the web is technology: is the technology available to display online video in the classroom? To use online video in their classroom the minimum technology that educators need is an Internet connection and a computer. The computer allows the educator to search for, preview, display, and download or stream Web based video to use as part of a lesson. The speed of the Internet connection affects the length of the download time for the online video, as well as the interaction educators have with various components of the digital library, such as the interface and retrieval systems. Educators with slower connections will spend more time browsing and could possibly stop searching due to frustration developed from experience with previous web interactions. The display capabilities of educators in classroom are also an issue with technology. To effectively use online video the display size of the video needs to be large and educators need access to projections and / or large monitors.The issue of technology is also complicated by the variety of digital video formats available and the rapid changes that can occur with proprietary packages.

As educators evaluate the usefulness of the Web based video they must determine if the criterion for the last node is met: does the online video fit within the current lesson and the curriculum? Once found, educators must judge if the online video is relevant to the current lesson. Relevant videos will reinforce curriculum standards, engage students, and fit into class period time constraints. In general, educators might use a variety of sources to judge the usefulness of particular resources such as search engines, recommendations from other educators, or references from textbooks and other print materials. In addition to external sources for judging resource relevance, the digital library system must provide summaries or surrogates of their digital resources. Surrogates are the visual, textual, and aural representations of digital video in the digital library. These representations of the video must correspond to how the educator conceptualizes the digital video he needs in order to find a successful match between the system and user views of the information need. Otherwise educators will present queries to the digital video retrieval system that continue to return unsatisfactory results.

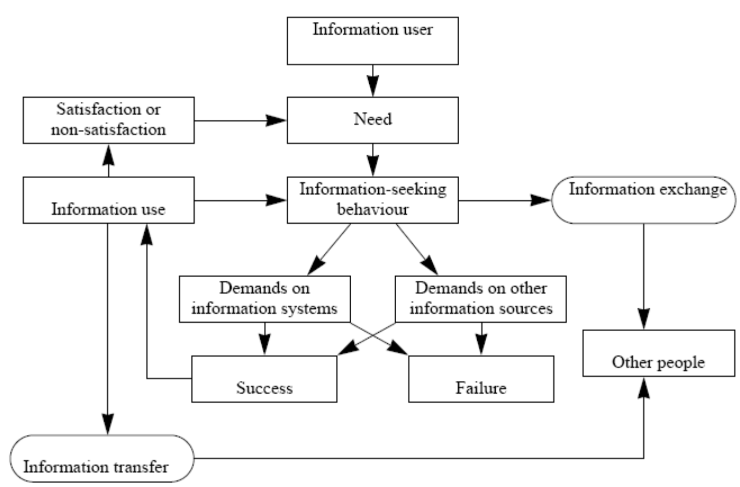
Online video surrogates can consist of the standard textual information used to identify books such as title, author, and date created. Online video surrogates might also consist of visual information that gives educators snapshots or overviews of the video. Visual surrogates are concise representations of online video meant to serve as brief summaries of their content. Various visual surrogates have been used to represent online video such as key frames, storyboards, fast forwards, and digital video excerpts. A key frame is a still shot taken from a video clip (O'Connor, 1985); key frames are usually selected to summarize the content of video segments or the entire video clip. Storyboards are a series of key frames used to give viewers a sense of action that has taken place over a video segment or clip (Yang et al., 2003). Fast forwards play the video content at a faster playback than normal, mimicking the fast forward function of a VCR (Yang et al., 2003; Wildemuth et al., 2003) Online video excerpts are very brief video segments that can represent video segments or clips and unlike key frames and storyboards, excerpts can contain audio (Marchionini et al., 2000).

Given the way in which the web was created, we need to confirm the descriptive power of the model by comparing it to more general models of information seeking behavior and by testing it with research. One model which is a good candidate to use for such purposes is Wilson’s model of information behavior. This model was chosen because of its popularity and its ability to describe a wide variety of information behaviors.

If we compare the Web of Criteria to Wilson's (1999) model of information behavior (Figure 2.2 & Figure 2.3) we can begin to see how an educator's successful interaction with Web based video fits into a more general information seeking process. The technical skill node in the Web of Criteria relates to the information user or the person-in-context in Wilson's (1999) model of information behavior. The information need which arises from the context of the user has the limitation that its form can only be expressed in the language of the user. In essence this expression of the need is based on the person-in-context's literacy which is a combination of criteria used to create technical skill. The educator's information seeking and motivation node resides in the information seeking behavior and activating mechanisms sections of Wilson's 1996 model. In the second activating mechanism portion of Wilson's (1999) model (Figure 2.3), self-efficacy and social learning theory are similar to an educator's experience with non-text resources, awareness of digital libraries and knowledge of the search process. These components of an educator’s search will have a direct influence on how effective educators feel in relation to completing their searches. This structure addresses how educators' online video searches are situated in the educational environment and how use of online video will have negative or positive reinforcement by educators' peers.

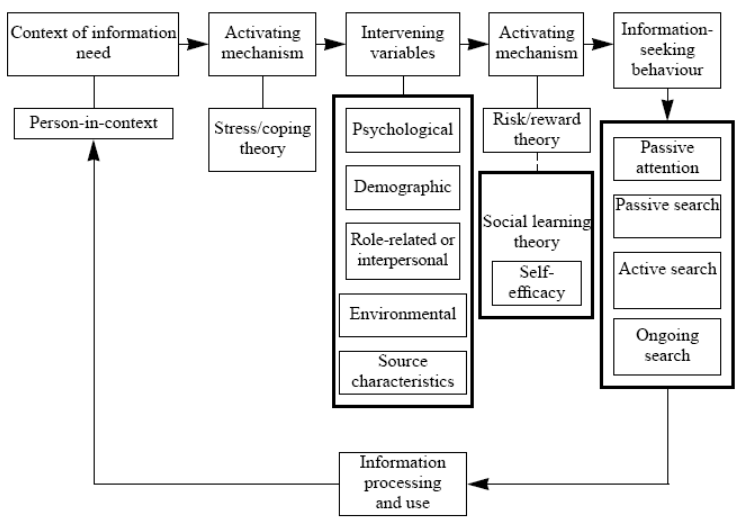
Wilson's model also suggests that an educator's self efficacy will be motivated by the risk and rewards associated with social learning theory variables. Wilson (1999) goes further than the Web of Criteria and categorizes each information behavior as passive attention, passive search, active search and ongoing search. The technology node of the Web of Criteria resides within the demands placed on the information systems section for the 1981 model (Figure 2.2) and the intervening variables section for the 1996 model (Figure 2.3). The technology node was placed in intervening variables section of the model because technology can be viewed as a barrier to the successful retrieval of information if the correct conditions are not present. The fit within current lesson node relates to the satisfaction and non-satisfaction sections of the 1981 model (Figure 2.2) and the information processing and use section of the 1996 model (Figure 2.3). In the last node users are judging the relevance of the retrieved document by processing it through a series of criteria, if the document meets the criteria the user is either satisfied or not satisfied with the overall result.

Figure 2.2. Wilson's 1981 model of information behavior



From this analysis of Wilson's (1999) model of information behavior we see that the initial stage of activating mechanisms present in the more recent 1996 Wilson model is missing from the Web of Criteria. This suggests the focus of the Web of Criteria is on the very specific experience a educator has searching for online video and not on the initial motivating factor for educators' to search for online video. Another difference between the Web of Criteria model and the 1996 Wilson model is that the Web of Criteria model does not include variables such as satisfaction or non-satisfaction with the result. This further highlights the focus of the Web of Criteria model on the continuum of criteria need for a successful interaction with Web based video, keeping in mind that as nodes in the Web of Criteria are not present the model weakens and the chance for success decreases. Given that Wilson's model describes the aspects of activating mechanisms and satisfaction with results in overall information behavior in more detail, his model will be accepted as the default description of how these aspects of information behavior are processed within users.

Figure 2.3. Wilson's 1996 model of information behavior



Given the models and broad research questions described above, we next review what current studies tell us about how educators search for, evaluate, select, and use online video for classroom instruction. Although there is much that is unknown related to the location and retrieval of online video by educators, I will focus on the following general question: in what ways can digital library collections better meet the needs of K-12 educators in their retrieval and use of online video material? The next section explores the impact educational philosophy may have on the use of online video.

Impact of Educational Philosophy

Educational philosophy is a field of research devoted to the study of teaching and learning. More specifically, educational philosophy can be thought of as the set of theories that motivate instruction, the tools used for instruction, and the beliefs educators have about student learning. The educational community is currently a mix of constructivist practices (open ended, process-based instruction) and instructivist practices (standards-based, content-centered instruction) (Fitzgerald, 2001).

Constructivist philosophies hold that "knowledge is emerging and not static, that the inevitable task of learning is to seek meaning within one's expanding frame of reference, and that a major part of the process of education is building knowledge and checking it against the concepts of others" (Joyce & Weil, 1996), whereas instructivist philosophies believe "reality exists independent of what we may think of it" and it is the job of educators to help students obtain this knowledge (Kozioff, LaNunziata, Cowardin, & Bessellieu, 2000). These two philosophies have different implications for educators, the instructional tools used, as well as how information should be designed for educator consumption.

Educators who accept a constructivist theory of learning will attempt to establish an environment centered on students as the catalyst for their own learning. This will involve methods in which students are encouraged to ask questions and learn based on their interactions with each other, as well as the surrounding environment. In this model educators may use Inquiry Based Learning (Crawford, 1999) or Problem Based Learning techniques (Capon & Kuhn, 2004) to guide and motivate student behavior. Practitioners of this approach believe that student learning works best in an environment where they discover rules, principles and theories, having minimal interaction with the instructor.

From the constructivist point of view video might be used as an instructional tool to motivate student inquiry. The NASA KSNN™, NASA Connect™, and NASA SCI Files™, educational videos have been developed within the constructivist paradigm. For example, the NASA Connect video The Path of Totality: Angular Distance© (http://www.knowitall.org/nasa/asx/angular_distance.asx) motivates student inquiry in one segment by asking the following questions: Why do eclipses occur? What is angular size? What is the path of totality? Why don't we see a solar eclipse every moon cycle? The purpose of these questions is to get students to think about the relationships among the sun, moon and Earth and their connection to eclipses. Similar guides for other videos have been prepared, highlighting the fact that videos whose philosophy are congruent to those of the educator should be easier to incorporate into the educator's work flow and actually reduce the amount of preparation needed.

On the other hand, educators who accept the instructivist theory of learning will focus on a model that is based more on educator centered instruction and focused on ensuring students master the main concepts of each unit. In the instructivist environment educators attempt to organize subject areas into logical chunks and to communicate those chunks to students in the most structured format possible. One example structure is the Model-Lead-Test-Delayed test format for delivering information (Kozioff, LaNunziata, Cowardin, & Bessellieu, 2000). In this structure educators show students the model for a specific concept, lead the students in use of the concept, test the students by providing structured and guided practice and finally follow up with subsequent tests to ensure that students have mastered the concept. Instructivist philosophies have developed based on Behaviorism (e.g. B.F. Skinner): in this philosophy educators may use Direct Instruction, Precision Teaching or applied behavior analysis techniques to guide instructional activities. Educators within the instructivist paradigm might use step-by-step guided instructions as a means of structuring their own knowledge and facilitating educator-student communication (Fitzgerald, 2001; Kozioff, LaNunziata, Cowardin, & Bessellieu, 2000).

Educators who accept the instructivist point of view may be less likely to accept video as a "substitute for teacher instruction" in the early stages of student learning; however, as students gain mastery of concepts educators with instructivist philosophies may use videos as introduction to tests or projects which cover using a variety of concepts and skills students have learned. On the other hand, educators with instructivist viewpoints may believe that video is a good instructional tool for reinforcing how concepts are used, such as showing students a brief video of acceleration before the educator leads the class in use of the force=mass*acceleration (f=m*a) equation. From the instructivist viewpoint, video use may have advantages over other ways of presenting classroom topics because it engages students' visual and auditory learning.

Although instructional tools such as video, or lesson plans may have been designed with one particular educational philosophy in mind, these resources have the potential to be used by educators regardless of the educational philosophy in which they believe. In some cases educators will have a personal aversion to using certain resources. For example, in year

2 of the Gateway to Educational Materials[1] (GEM) study, one subject found it ironic that GEM provided lesson plans. The subject suggested that educators seeking lesson plans were not congruent with the constructivist philosophy, educators who used lesson plans were less likely to achieve educational objectives, and lesson plans were not conducive to educator collaboration (Fitzgerald, 2001). Another consideration is the practical constraints that strongly affect teaching practices. Lack of time, access to resources, the need to teach to the curriculum standards and other constraints may take priority over organizing instruction according to one educational philosophy. If educators operate in this environment then what will be the determining factor for an educator's adoption and use of online video?

The answer to this question may depend on how educators approach learning digital library systems in the context of their own search, retrieval and processing of information related to the teaching task. Educators who believe in a constructivist theory of learning for their students may opt for a more instructivist learning pattern when it comes to acquiring new methods and materials for themselves because the constraints of time and cost may inhibit the flexibility educators have with acquiring and adapting class material. In this instructivist learning mode, educators might acquire new material by having other educators demonstrate how to use class materials rather than participating in unstructured, student-centered, open-ended discovery following the constructivist paradigm. In a stricter constructivist learning pattern, educators might use their own searches and retrieval of information to actively construct better mental models of how information systems operate and how to improve their interactions with information systems and content. This final point further stresses how educators' learning attitudes, attitudes toward technology, work roles, and tasks play a significant factor in how educators interact with digital library information

[1] http://www.thegateway.org/

systems. In this final question we see how richer knowledge of an educator tasks and mental models will enable us to better design systems that educators use in their everyday lives.

The previous review of educational philosophies acknowledges the importance of educational philosophy to the teaching task; however, including educational philosophy in the Web of Criteria will be left to future work and is not in the scope of this research. The next section will explore how the teaching process and the everyday information needs of educators are related to the search and use of online video.

<u>The Teaching Process</u>

For the purposes of this paper, the teaching process can be defined as the daily activities of teaching. The process involves decision making and the constraints of the teaching environment. During an average day educators have many concerns such as meeting instructional objectives, covering curriculum content, monitoring student progress, keeping students motivated, disciplining students, administrative tasks and managing time. Given the variety of tasks that educators must perform on any given day, their primary concern is not with the information seeking process itself but how their work gets accomplished. One model that takes into account the importance of work that must be done by professionals is the model of information seeking for professionals created by Leckie, Pettigrew, and Sylvain (1996).

Leckie, Pettigrew, and Sylvain (1996) analyzed and integrated the information seeking literature of engineers, health care professionals and lawyers into a general model of information seeking. Their work was aimed at discovering how the information seeking behavior of these different professionals was similar. The researchers found that information seeking was largely influenced by work roles, tasks, and setting, along with a variety of other factors.

The first major influences on the information seeking process were work roles and associated tasks. Work roles were a distinct group of job functions related to a specific profession. Associated tasks were the specific tasks required of each individual work role. For example, the researchers identified consulting as a work role of engineers. Tasks associated with the consulting role were presentations, interviews and client meetings. For this work role and task combination, engineers required information sources that were current and highly accurate. These requirements caused consultants to rely on market information from vendors. In the health care setting, an example of a work role often assumed by nurses was the role of patient care. The role of patient care was associated with administrative tasks of finding hospital equipment, and locating patient records. Patient care was also associated with the task of consultation with colleagues regarding the proper care for specific patients. Finally, in the legal setting an example of a work role of lawyers was counseling. In the work role of counseling lawyers performed the following tasks: client interviews, responding to telephone calls and client representation.

Given what we know of work roles and tasks from Leckie, Pettigrew, and Sylvain's (1996) model, we can extend the model to describe the teaching profession. With respect to the teaching profession, K-12 educators' work will largely be governed by administrative and teaching work roles. The administrative work role of the educator is characterized by processing paperwork related to student conduct, student progress, and need for various equipment. In the teaching role, educators perform tasks such as lesson preparation, and leading classroom activities on a day-to-day basis. All of these roles depend on how constrained educator time is. Educators in Hanson and Carlson's (2005) study described lack of time as: online resources that are not readily available and take too long to locate, resources that had long download times, or resources that took too long to adapt to their needs. Given educator work constraints, issues like time, covering curriculum material, resources used and relation to subject material are likely to be important factors that affect how educators search for information.

Leckie, Pettigrew, and Sylvain (1996) found a variety of other factors that determined either what information was sought or the format in which the information was desired. In the case of engineers' information use, the other factors that affected the information seeking process were accessibility, information system design, stage of research and stage of engineer's career. In the legal setting, the researchers found variables such as experience, highest level of education attained, information system design, and attitude toward research had a great influence on the information seeking process.

According to the Leckie, Pettigrew, and Sylvain (1996) model other factors will likely play a role in educators' information seeking and use of online video. These factors may include accessibility of online video, quality of online video, level of education, design of digital library information systems, experience teaching, attitudes toward video and perceived ease of digital library use.

Based on synthesis of the literature, Leckie, Pettigrew, and Sylvain (1996) proposed a general model of professionals' information seeking. Their model placed work roles and tasks at the center of the information seeking model rather than the individual, sources used, or the organizational context. The general model is composed of work roles and related tasks, characteristics of the information need, sources of information, awareness of information and outcomes. Also included in their model are feedback loops so that outcomes, sources of information, awareness of information and information seeking can occur at the same time and be influenced by other parts of the model. Now that we have discussed the overall model, the specific parts of the model will be discussed in detail.

The first part of the general model of professionals' information seeking was work roles and associated tasks. According to Leckie et al.'s (1996) model, professionals performed a discrete number of work roles, and associated with each work role were work tasks. Leckie, Pettigrew, and Sylvain, (1996) identified five basic roles that professionals perform: educator, service provider, administrator/manager, researcher, and student. The teaching process includes all five roles; however, the most relevant role to this literature review is the role of the educator. According to the researchers, the educator role has two main subroles of community outreach and teaching. The tasks associated with the educator role include planning and curriculum development. They described the service provider role as a creator and provider of a variety of services to the client. In the service provider role, professionals assessed client needs or handled various technical and nontechnical tasks. The administrator/manager role handled a variety of tasks related to meeting the specific requirements of business operations. For example, administrative and managerial work is usually associated with forms and paper work required for specific tasks such as, hiring a new employee or tracking specific data. Leckie et al. (1996) identified a distinction between the professional researcher and the academic researcher indicating that academic researchers may work closely with academic institutions and publish in scholarly journals but professional researchers' work may involve academic partnerships or arise solely from their professional responsibilities. The main distinction between the two types of researchers was the setting in which they work. The tasks of the researcher were writing publications, attending conferences, and finding research-related information. The last role was the role of the student. This role had an emphasis on staying current in the field and primarily was concerned with tasks of professional development.

The second part of the general model of information seeking for professionals was the factors that affected information seeking. Leckie, Pettigrew, and Sylvain (1996) describe three factors that influence information seeking.

The first factor that affected information seeking was the characteristics of the information need. This part of the model includes a variety of variables that interact with each other such as frequency of information need, or the complexity of information need.

The second factor that affected information seeking was the source of the information. Sources of information were characterized along four dimensions: formal/informal, internal/external, oral/written and personal (Leckie, Pettigrew, & Sylvain, 1996). Examples of formal sources of information were books, journals, and libraries. A conversation was an example of an informal source of information. The internal/external distinction clarifies the source of information's location with respect to the organization. Personal sources of information were characterized as sources of information belonging to the individual.

The third factor that affected the information seeking was overall awareness of information. Overall awareness of information was further defined by the following variables; familiarity with resource, trustworthiness, packaging, timeliness, cost, quality, and accessibility (Leckie, Pettigrew, & Sylvain, 1996). Packaging refers to the need to have the source of information in a particular medium or format.

The final part of the general model of information seeking for professionals was the outcomes of the information seeking process. Leckie et al. (1996) discussed two possibilities for the outcome of the information search process, either the information need is met and the task is completed, or the need is not met and more information seeking is necessary. If the search process begins again, ideally professionals will use the experience from previous searches to learn more about the information need, this is represented by feedback loops in the model.

The work of Leckie et al. (1996) suggests that when educators search for online video they may have certain tasks they are trying to perform. The educator in our opening scenario could be looking for online video in order to find class material that meets the variety of learning styles her students possess, or Web based video that illustrates a specific part of the curriculum. Of the variables that Leckie et al. (1996) discussed, attitude may be an important factor in an educator's interaction with online video. Educators will have to have high internal motivation to work through initial interactions with technology, such as learning the digital library retrieval system or navigating technical problems with their computer. Information system design may also influence the information seeking activity. Digital libraries that have poor design may lack important factors in web design such as authority and ease of use. Without these important characteristics educators may be less motivated to search for Web based videos because poor design has led to an unpleasant experience. Frequency of information need and familiarity with resources may also play a significant factor in use of online video. Educators who have previously used online videos should have enough experience to efficiently search for online videos and adapt them effectively for class presentations. However, educators who use online video infrequently may have no incentive to invest time into search or learning how different digital library interfaces function. Accessibility is also likely to be important to educators' use of Web based video due to limitations of technology access in the classroom. If Web based video is not accessible for presentation, storage and manipulation then it has no potential to be adopted in the classroom. Additionally, overall awareness of information may be an issue for how educators access digital libraries. In an online survey and interview study, Perrault (2006) found that educators cited three significant factors which influenced their online information seeking: lack of time, unsuccessful or frustrating information searches and challenges with managing resources (p.136). Perrault (2006) believes this is a problem because the majority of the educators studied did not take advantage of resources personalized to their needs such as online databases, and digital libraries, and because there is a lack of professional development devoted to these resources.

Perhaps the most significant factor on an educator's use of Web based video will be work setting, which has the potential to determine what class materials educators have available. Work environment may also play a role in establishing creative environments, or pressures to conform to some standard. Given these different pressures educators are likely to experience, educators will be more or less likely to try new things as opposed to using the same materials and formats as their colleagues.

Another study that investigates the work roles, tasks, and information needs of professionals is the work done by Hart (1998), who investigated university faculty at the State University of New York, College at Fredonia. Hart's (1998) study used a questionnaire to collect data on the information gathering of faculty. Information gathering was assessed along two dimensions and six categories; the first dimension, "formality" of the resource, was divided into informal sources of information, and formal sources of information. The second dimension, range, was divided into local sources, global sources, and personal sources. For example, the personal library is the formal/personal information source of faculty, the college library is the formal/local information source and other libraries are the formal/global information source. Departmental colleagues were the informal/personal information source, other campus colleagues were the informal/local information source and off-campus colleagues were the informal/global information source. Hart (1998) does not mention faculty use of web sources of information. This is probably due to the fact that the survey was administered in 1990 when Internet access was not as common as it is today.

Table 2.1 Range and Formality: Two dimensions of information gathering used by Hart

		Range		
		Personal	*Local*	*Global*
Formality	*Formal*	Personal Library	College Library	Other libraries
	Informal	On Campus Colleagues	Other Campus Colleagues	Off Campus Colleagues, Attendance to Scholarly Meetings

These categories are similar to the categories used to identify sources of information in Leckie et al. (1996). Informal and formal sources of information both refer to the dichotomy traditionally used in information seeking literature, however with the other categories Leckie et al. (1996) focuses more on classifying formats for sources of information and Hart (1998) focuses more on the location of the source of information.

The survey in Hart's study (1998) measured faculty's use of the following six sources of information: personal library, college library, departmental colleagues, other on-campus colleagues, off campus colleagues and attendance at scholarly meetings. Separate indexes were created from each source of information based on questions from the survey. The four independent variables were commitments to research, teaching, service and level of courses taught. Commitment was measured by gathering self reported levels of importance and number of hours spent each month on research, teaching and service. Level of courses taught was a measure of whether the faculty taught more undergraduate courses or graduate courses. Other variables such as age, possession of doctoral degree, and quality of graduate school were used in addition to the other independent variables to calculate a faculty's commitment to research.

Hart (1998) found faculty's information seeking and use of information sources varied by commitment to the three main roles: teaching, research and service. The majority of faculty in Hart's survey were committed to teaching. On average, faculty in the survey spent the majority of their time on these three tasks: preparing for class (54 hours), grading papers (28 hours), and advising students (16 hours). These findings were in line with the university's primary focus on teaching undergraduate students.

Hart's findings overall indicate that faculty use a variety of resources and have a variety of roles when searching for information. Contrary to Hart's (1998) hypothesis, the level of courses a professor taught (undergraduate, graduate) had no relationship with any of the information gathering measures. Although the roles of research and service are not likely to be as important for K-12 educators, the hypotheses relating information sources to teaching may be extremely relevant to the present study.

Hart (1998) initially hypothesized that commitment to teaching would be positively related to *personal* and *local* sources of information. Instead the researcher found that *local* and *global* resources were positively related to commitment to teaching. This could imply that educators with a strong commitment to teaching will use whatever sources of information that will help them to complete their task regardless of whether it is personal, local or global. If true it suggests it is not the *range* of the source used that is important to educator task but importance of the information source *in relation* to the teaching task. This might indicate that K-12 educators will use global and local sources of information as long as they are important enough to the teaching task. Based on use of college libraries and off campus libraries by faculty in Hart's study one might expect K-12 educators to rely on libraries and other formal school resources as significant sources of information. Future studies should add newer sources of information such as the Web and see how educator use of the Web varies according to educator work roles and tasks.

With respect to newer sources of information, several questions are raised such as, how should digital libraries and the Web be classified according to Hart's (1998) measures of information gathering? In terms of range, do digital libraries and other Web resources fall within the personal, local or global category? According to Hart, both the Web and digital libraries would probably fall within the personal or local range of information sources. Hart's range category is an informal distance between access to the information source and the user of the information source. Given this definition, resources like digital libraries and the Web can be classified in the personal range if educators access them from the home or office. This type of information use would be most similar to one's use of a personal library. On the other hand, if educators access these same resources from their local school or library then the range would be classified as local. How range is viewed might also depend on the speed of the user's Internet connection. Low speeds would increase the time needed to acquire materials and high speeds would reduce the time needed to acquire materials. In either scenario the time it takes to acquire resources might result in those resources being classified as personal, local, or global depending on the perspective of the user. This implies that range of sources of information will depend on the setting in which the resource is used and how close that setting is perceived to be to a person's place of work.

Another question that could be raised is: are digital libraries and other Web resources formal or informal sources of information? In the case of formality, how digital libraries and other Internet resources are classified will depend on the nature of the resource. Is the digital library associated with someone's blog or personal Web space? In this case the digital library might be considered informal. The same will be true for Web resources, how they are classified will depend on the type of communication it is, as well as if the source of information goes through some type of peer reviewed process.

Hart's (1998) research also does not address how teaching, research and service are interrelated activities. Hart (1998) views information gathering factors as predictive of teaching, research, and service commitment. This research question could be reversed so that the teaching, research and service behavior predict the information gathering. One study that does address this is the work of Borgman, Smart, Millwood, Finley, Champney, Gilliland and Leazer (2005). Borgman et al. (2005) investigated how the teaching and research of geography faculty was supported by their information seeking. Borgman et al. (2005) interviewed nine geography faculty and supplemented the interview data with interviews of four faculty conducted 2 years earlier. The researchers found geography faculty were better able to describe instances in which they had done research for grants or sought information for their research projects than they were able to describe instances in which they sought information for teaching. In the study, teaching and research were mutually reinforcing activities; geography faculty were able to identify useful research material while conducting information seeking for teaching and useful teaching material while conducting information seeking for research. Many geography faculty tried to maximize use of research data by also using it for teaching purposes. Borgman et al. (2005) recommended that a digital library of geography resources should contain teaching resources organized by teaching concepts and the digital library needed to provide resources and materials that could be used for both teaching and research.

Borgman et al.'s (2005) work suggests K-12 educators may also like content organized by factors most important to their teaching task. This would mean that digital libraries organized by facets such as teaching content, age of audience, state curricula addressed and duration of lesson / material will be more appealing to educators because it helps them to focus more on the task of preparation rather than the task of information seeking.

Whereas the previous studies of information seeking and use of teaching information focus on faculty information needs and use of material, there is a lack of studies that focus on the information needs of primary school educators, secondary school educators and informal educators such as those found in boys clubs and girls clubs. How generalizable are the information seeking habits of faculty to these other types of educators? The next few studies discuss what is known specifically about the information needs of primary school educators, secondary school educators and informal educators.

The work of Summers, Matheson, and Conry (1983) focused on the information needs of primary and secondary school educators. Summers, Matheson, and Conry (1983) surveyed the information needs and attitudes toward information of educators in British Columbia, Canada. The representative sample included the following positions: elementary educators, secondary educators, principals, vice-principals, support personnel and department heads. Respondents were asked to rate their frequency of use of 13 sources of information on a four point scale. Factor analysis of the 13 sources clustered into 3 orthogonal factors: close at hand traditional sources, less accessible print resources and organized intrapersonal resources. Examples of sources were conversations with colleagues, textbooks, and school libraries. Summers et al. (1983) found that position, dissemination and attitude were strong predictors of information use. Dissemination was a self-reported measure of how well the person transferred information from person to person. Attitude toward information was assessed using a 15 item measure of how people responded to information. The scale was based on Krathwohl, Bloom, and Masia’s Taxonmony of Educational Objectives: Affective Domain (Krathwohl, Bloom, & Masia, 1964).

Summers et al. (1983) suggest that educators mostly use traditional sources and resources that are in the “local” range. Although this research was conducted during a time with no Web resources and limited access to databases, this research supports findings from Hart’s study, which indicated faculty used the college library to support their teaching commitment. One reason for the similar conclusions between these different studies given how much resources have changed over time could be that the information needs of educators have changed relatively little with respect to their work tasks.

Summers et al. (1983) also support the findings of Leckie et al. (1996) that discuss the importance of attitude to the process of information seeking. If attitude is a strong predictor of information use, then perceptions of computer technology, design of the Web based video library interface and metadata for search will be important components that will affect educators' perceptions about the ease of use of Web based video library systems. Another factor that will likely play into educator's use of online video will be their experience with use of technology. Experience can come in the form of formal training while pursuing their degree, on the job training from a colleague or from being self-taught. Educators who have more successful experience with the use of the Web will feel more comfortable about monitoring student progress and behavior while conducting a lesson involving online video. Another important factor in the use of online video will be forms of support. Educators who have colleagues who also use Web based video will have a support system for integrating Web based videos into the classroom smoothly and informal contacts for discussing various uses of Web based video in the class. Educators who have technology support may be more inclined to take the risk of using computer technology in the classroom.

According to Morris (2002, p. 3) there are countless guidelines for integrating technology into the curriculum, however questions remain about how to most effectively achieve curriculum objectives and conduct relevant assessments of student performance. Without clear answers as to how to incorporate technology educators must develop their own systems based on the resources they have at hand. This creates a problem because resources vary from school to school and teaching expertise varies by individual. Implementing teaching methods such as the inclusion of online video may be largely left up to individual educators, and educators who are not comfortable with technology will be less likely to adopt newer practices unless forced to do so.

More recently than the Morris (2002) and the Summers et al. work, Normore (2005a; 2005b; 2005c; 2006) conducted a series of focus groups with educators and administrators from the K-12 setting. The focus groups were divided into two parts. During the first part of the focus group participants were asked to list types of information which they need to help them complete their work. After the list was complied, the participants were then asked to evaluate the importance of the items on the list and the top three information needs were identified. In the second part of the focus group, participants discussed ways to implement or fill the top three information needs.

In Normore's (2005a) first focus group, thirteen reading recovery educators from the National Conference of The Reading Recovery Council of North America discussed their information needs. Educator responses were divided into three content groupings: need for communication support, need to support specific instruction related skills, tools, and techniques and support for continued professional development.

The first content grouping, the need for communication support, consisted of needs in which educators expressed the desire to communicate or share their experiences with policy makers, administrators, parents, and other educators. Overall, reading recovery educators suggested they would benefit from communication tools such as discussion forums and wanted tools which would allow them to ask experts in the field questions (Normore, 2005a).

In the second content grouping, need to support specific instruction related skills, tools, and techniques, Normore (2005a) listed the support materials reading recovery educators desired. In particular reading recovery educators requested lesson plans, support for thematic units, enrichment activities, book recommendations, web site recommendations, and video clips. The need for recommendations was reiterated in the second focus group Normore (2005b) conducted. In the second focus group thirteen reading recovery educator leaders attending the 2005 North American Leadership Academy & Educator Leader Institute suggested that resources include recommendation information drawn from the broader educator and school community.

Of specific interest to this study are the ways in which reading recovery educators and other educators felt they might use video clips in their classroom settings. In the focus group conducted by Normore (2005a) educators suggested they might use video clips in three different ways. First, video clips of classroom activities might be used to help struggling students. Next, educators felt video clips could be used as resources for educators to view "master teachers" and improve their own classroom practices. Lastly, educators felt that videos might be able to convey to parents how the lessons were conducted. There was a trend in the need for video clips to be used in ways to improve educator classroom practices. This need was expressed in the focus group Normore (2005c) conducted with thirteen literacy coordinators and the focus group Normore (2006) conducted with three school principals. In the focus group with literacy coordinators, video clips were rated as the number one resource literacy coordinators needed to support their continuing education (Normore, 2005c). Similarly, principals in the fourth focus group suggested that video clips be used to provide guidance on specific problems such as finding ways to deal with the challenge of accommodating the differences in their student population or video clips should be used to provide specific details on presentation practices (Normore, 2006).

In the third content grouping, support for continued professional development, educators expressed their need to stay current with the field, and to support their own work. Specifically educators were concerned with finding information related to grants and also information which would help them in their own data collection, analysis and reporting activities (Normore, 2005a).

Normore's (2005a; 2005b; 2005c; 2006) focus group findings are important for two main reasons. It outlines some potential uses of Web based video repositories with respect to the teaching task. Educators in Normore's (2005a) study suggested additional uses of video beyond the traditional use of video to introduce classroom activities; in particular educators desired to use video as a continuing education tool and as a way to communicate classroom practices to parents. These varied needs with respect to video suggest that repositories find ways to somehow highlight segments which correspond to part or all of these documented uses. In addition to these documented uses of video there may be other uses which may also serve as broad views to online video collections.

The second important finding from Normore's (2005a; 2005b; 2005c; 2006) focus groups is educators' desires for some form of recommendation information with respect to support materials for the classroom. The need for recommendation information suggests that educators value and trust the experiences of their colleagues when searching for educational material. This finding may also be related to the need educators have for video clips which demonstrate good and bad teaching. In the case of video clips, educators may be using visual and auditory information to determine if the clip would be useful in their classroom setting, while concurrently evaluating the educator's mastery over the subject and presentation style.

In the case of textual recommendations educators may be attempting to elicit the same information from the description of how the support material was used by other educators.

Perhaps the most striking finding from Normore's (2005a; 2005b; 2005c; 2006) work is that each content group stresses the importance of the work roles and tasks educators must complete. The first content grouping, communication support, suggests that communication between educators is an important work task which had not been considered previously in Leckie et al.'s tasks. In the second content grouping Normore's (2005a; 2005b; 2005c; 2006) work goes further than the work of Leckie et al. to suggest educators need specific types of materials to help them during the planning and curriculum development phase of their work; these materials were lesson plans, enrichment activities and various recommendations from colleagues. The last content grouping, support for continued professional development, confirms that in order to complete their work educators must assume various roles which are beyond how Leckie et al. classified the work roles and tasks of educators. Specifically, the educators in Normore's focus groups suggest that professional development and conducting research are two roles which are highly important to the completion of their work. In the Leckie et al. work these roles were related to the student role and the professional researcher role respectively.

Overall, these findings suggest repositories need to consider a variety of ways to present video information to educators. For example video repositories should consider combining usage data with recommendation information to give users views of the repository which have the most used videos in the collection along side with how those videos were used by experienced educators. Video repositories might also consider dividing up videos by related roles and tasks. To implement these groupings video repositories might divide their video collections by the uses of video found in Normore's (2005a) focus groups such as videos which contain classroom activities, videos which contain professional development, and videos which demonstrate classroom practices to broader audiences like parents and policy makers. Additional research will need to be conducted to explore if there might be other uses of video than the ones listed by educators in Normore's (2005a) focus group and if video use varies by the subject matter of the educator searching for video. Video repositories may also need to seek out video with the categories of use in mind, if their current collections do not contain sufficient examples of videos from each category. More broadly, video repositories need to consider the importance educators place on communication and consider ways to design communication tools into their current structures. This research specifically suggests that video repositories might focus on developing ways in which educators can gain access to experts in their field.

Previous research on the information seeking and needs of professionals has shown work roles and tasks to be a significant influence on their information needs. Several studies have illuminated the work of faculty and the roles they assume in their everyday work but the roles and tasks of primary, secondary and informal educators are not the same and therefore need to be studied more extensively. To summarize, Hart's (1998) work suggests that how close educators perceive the information to be to their setting and the perceived authority of the information could possibly make some information resources more useful than others. Other research implies the resources available in the work setting and the culture of the work environment can determine how useful educational materials are. The work of Leckie et al. suggests that educators might benefit from systems which complement their work roles and tasks and experience are likely to be large factors in how those systems are used. Also, consideration must be given to other variables such as attitude toward information, attitude toward technology, accessibility, and familiarity with the resource because these variables are likely to play a significant part in the information search process of informal and formal educators as well.

Information Seeking and Use of Online Video by Educators

Information seeking and use studies can be broadly divided into studies that focus on the materials and sources used and studies that focus on specific populations of users.

Studies that focus on materials and sources generally divide information gathering categories into the two dimensions of formal sources and informal sources. Formal sources of information are books, journals, and encyclopedias while informal sources of information are colleagues and scholarly meetings (Hart 1998).

There are a number of information seeking and use studies that focus on specific populations. Much of the current information seeking literature focuses on the information seeking process of students (Sandvig & Bajwa, 2004; Kerins et al., 2004; Orme 2004; Weiler, 2005; Hoffman et al., 2003; Lumpe & Butler, 2002; Kulthau, 1997; Kulthau, 1991) or focuses on how expertise influences the search process by comparing experts and non-experts (Kulthau, 1999; Kulthau, 2001; Holscher & Strube, 2000; Marchionini et al., 1993; Detlefsen, 1998; Brown, 1999). Several studies have investigated medical students, nurses, and other health care professionals (Wildemuth, et al., 2000; O'Keefe et al., 1999; Pelzer et al., 1998) in an effort to understand how they interact with specific retrieval systems, formulate queries and develop their domain knowledge. With an emphasis on these populations the information needs of educators and the research problems related to their information seeking and use have not been extensively documented.

It is important to study the information seeking of educators because understanding how educators view the process of information seeking and frame their information needs will help information professionals design more effective retrieval systems more effectively. These tailored systems will more accurately address educators' specific needs. There are numerous research projects and studies designed to help educators with access to educational content, e.g., GEM, Apple Learning Interchange[2], and National Science Digital Library[3]. The focus of these projects is on bringing together materials and creating environments in which educators can collaborate. Although these projects make digital materials available, the majority provide materials in print or image format and do not provide online video materials. Some progress has been made with use of non-textual indexing and materials to represent online video for search and retrieval (Marchionini & Giesler 2002; Watclar, Christel, Gong & Hauptmann, 1999) however, we have far more experience with the use of text in representing digital objects. With respect to video we still have the following questions: what part of the online video can best summarize the video as a whole? What criteria should we use for indexing given the high cost of indexing every word or every camera shot? Should indexing take into account the broadest user group possible or focus specifically on one particular user group? Should indexing focus on identifying the exact content or focus on providing a summary? and how can indexing of online video be automated given current technology works best on processing text not digital media files?

Before Web based video is finally incorporated into the classroom, educators must go through a process of finding the video and preparing the lesson plan for the class. As illustrated in the opening scenario, the usual steps in this process are: recognition of

[2] http://ali.apple.com/ali/resources.shtml
[3] http://nsdl.org/

information need, formulation of search strategy, search, retrieval of the video, evaluation of the online video's appropriateness, customization of the online video to the specific lesson, and lastly, presentation of the online video in class. During the process of evaluation educators must take into consideration factors such as student attention, student motivation, and assessing how well the video conveys the material.

Although there is no literature that specifically focuses on the retrieving of online video by educators there are several studies that highlight related areas. This section will review the following topics: educators' use of online learning materials, instruction of education students on the methods of search, information needs of K-12 educators, and access to technology.

Recker, Dorward, and Nelson (2004) assessed the use of the Instructional Architect tool by conducting a case study with eight middle and high school science and mathematics educators from the state of Utah. The purpose of the study was to assess how educators search for online learning resources. As suggested by Normore's focus groups, the educators studied in Recker, Dorward, and Nelson (2004) also desired recommendations and filtering tools which were generated by other educators. Additionally educators suggested that items be available in a common format, where common format was defined as a format compatible with available word processors and other technology. Perhaps most importantly Recker, Dorward, and Nelson (2004) found that educators stressed finding content which was age appropriate, current, accurate, aligned with topic and also relevant to the curriculum standards.

In general the educators in the study used broad search strategies, which were characterized by multiple resources and searches refined through iteration and specific search strategies, in which educators used facets like age level and topic to refine their search (Recker, Dorward, & Nelson, 2004). The importance of Recker, Dorward and Nelson's (2004) work is that it supports other research on the specific features educators' desire of online resources. This work also lays the groundwork for discussing educators search strategies and search processes in relation to online resources. In order to examine these strategies more closely the next research will compare what pre-service educators are taught to current information seeking models and processes.

Gratch et al. (1992) created a guide for instructional librarians to teach education students the skills of searching. The importance of this work lies in the fact that it very concisely summarizes how education students should ideally structure their information seeking and information retrieval tasks. The work of Gratch et al., (1992) could potentially be used to classify the search process of education students and current educators into identifiable steps. The report is divided into learning goals and objectives for education students followed by a glossary of terms and example applications. The example lesson plan gives the following sequence for the information seeking process of education students. 1. Select a specific topic around which to develop a search strategy. 2. Identify a variety of information retrieval tools that will be useful for locating different types and formats of resources. 3. Formulate a strategy for locating information in each of the tools identified. 4. Use the information retrieval tools to locate citations to background or curriculum materials on the topic for each tool (Gratch et al. 1992). Step 2 of the example lesson plan is very important to the search process for online video. At this stage educators use a variety of search engines, web pages and other resources to evaluate the content and utility of digital library resources they encounter. At the locating stage they also identify which formats of digital video are best given their particular storage capacity and Internet connections.

In contrast with more general models of information seeking, Gratch et al.'s process is closely tied with information retrieval tools. General methods of information seeking (Ellis, 1989; Marchionini, 1995; Bates, 1989; Dervin, 1983; and Kuhlthau, 1991) allow searchers to rely on other sources of information such as colleagues and are more general than the process presented in the lesson plan by Gratch et al. (1992). In order to fully describe the overall information behavior of educators both process models as well as general models are needed. In addition to these models, a catalog of the resources educators use will provide the most complete picture of the information seeking task. The work of Small, Sutton, Eisenberg, Miwa and Urfels (1998) provides such a catalog.

Small, Sutton, Eisenberg, Miwa and Urfels (1998) conducted an in-depth information needs assessment of K-12 educators. The purpose of the assessment was to find out what information was available on the Web for educators, what information educators preferred to use and how they used that information. The results of the study were used to design GEM. Small et al. (1998) used content analysis of Web based resources, a content analysis of questions submitted to AskERIC (http://www.eduref.org/Eric/) and an electronic questionnaire to collect data. AskERIC was the first Web interface to the Education Resource Information Center. They found that lesson plans were the most common type of instructional material available on the web and of all the instructional materials available activities were the most common element. Content analysis of questions submitted to AskEric confirmed that the most requested type of instructional information was the lesson plan (Small et al., 1998). This finding was supported by a survey conducted by Hanson and

Carlson (2005) who found lesson plans and activity ideas were requested as one of the top three instructional tools educators desired to find on the Web. Hanson and Carlson (2005) further found that audio and video files ranked 7th of the most top 3 desired instructional tools.

When it came to search, Small et al. (1998) found educators generally phrased their questions in the context of broad subject area, grade range, and/or topic. Examples of queries related to broad subject areas might be,” find video containing physics content” or “what lesson plans are available for mathematics?” Queries related to more specific topics within those subject areas might be: "find material that illustrates the concept of velocity" (physics), or "find online video that illustrates the concept of a number line" (mathematics). These findings were supported by Hanson and Carlson (2005) who found specific content and topic area drove approximately 85% (n=88) of educators' web searches.

Educators most commonly used print resources followed by workshops and electronic resources for instructional design (Small et al., 1998). The majority of educators used a variety of sources when looking for information to design their lesson plans; according to Small et al. (1998), this style of information seeking is similar to the berrypicking method described by Bates (1989). Educators were also noted as adapting the lesson plans that they found or only using parts of the lesson plans for their own classes, rather than adopting them unchanged. (Small et al., 1998).

Small et al. (1998) also described how educators might phrase queries for Web based video collections. Their findings indicated that Web based video libraries should have the potential for educators to search by grade range, broad subject and specific topics within the subject. This conclusion is similar to the conclusion drawn by Borgman et al. (2005) that educators would like digital library content organized by teaching content. This would allow educators to quickly narrow their search to a set of documents that are relevant to their work, since educators generally teach classes of a specific grade and in a specific subject area. For example, educators who are interested in mathematical concepts could eliminate browsing through Biology online videos if digital library content is organized according to broad subject areas.

The work of Small et al., (1998) and Hanson and Carlson (2005) highlighted the types of sources that educators request. That lesson plans were the number one resource requested indicates that educators are looking for resources and materials that fit into “teachable units.” The fact that educators are searching for lessons may indicate that digital libraries containing only online video may be less appealing than digital libraries that contain both online video and related instructional content such as lesson plans, activities, handouts or simulations. Although the Small et al., (1998) study does not specifically address the use of video or online video, similarities may be found between educators' use of non-video sources of information and educators' use of video.

One study that described in-depth the use of video by educators was the 1997 Study of School Uses of Television and Video. This study analyzed how video, television and computer technology were used in the classroom. This study specifically focused on key measures of video use and how the Web and computers influenced classroom practice. One thousand fifty-nine principals and 1,285 educators completed questionnaires about the accessibility, use and classroom support of television, video and computer technology (Corporation for Public Broadcasting, 1997). As part of a follow-up study 127 educators were contacted by telephone for in-depth interviews.

Ninety-two percent of educators felt that TV and video improved their classroom effectiveness. Educators also felt that use of TV and video did not divert students from important tasks. Educators remarked that TV and video “reinforces lectures and readings, provides a common base of knowledge, and shows things that students would not otherwise experience.” Educators found that use of TV and video in the classroom increased discussion, motivation, enthusiasm, and students learning (Corporation for Public Broadcasting, 1997).

Educators learned about videos from colleagues, home viewing, TV listings, newspapers, and magazines. The most common way for educators to learn about video was through a colleague. According to the Corporation for Public Broadcasting (1997) study, educators used TV or video for an average of 88 minutes of class time in one week, with public television being the largest source of programming used for the classroom. When educators were asked which programs they considered best for classroom purposes, they listed over 1,500 different titles. Nine of the top ten titles were programs from public television (Corporation for Public Broadcasting, 1997).

Schools in the study had access to public television programming; however educators had difficulty finding the “appropriate” programming. Educators in the study defined appropriate programming as programming at “just the right level of complexity for the age group they teach.” Other problems noted with locating appropriate programming included finding video related to subject areas such as science or English, and finding programming that could be used in a single class period.

The study found that educators who had access to both computers and TV and video continued to use TV and video for instruction. Sixty-eight percent of the educators in the study report that they use the Web and TV and video as separate technologies (Corporation for Public Broadcasting, 1997, p.26). When used in combination the Web was used to locate TV programs or to find information that will further explain the TV programming used in class. Very rarely were the capabilities of the two technologies merged, i.e., editing video images on the computer and later displaying them with the TV, using digitized videos in multimedia presentations, or having students use online guides while viewing TV programs, (Corporation for Public Broadcasting, 1997, p.26).

It should be noted that the results of the Corporation for Public Broadcasting (1997) study could be affected by the report's relationship with the organization that published it, the Corporation for Public Broadcasting (CPB). The CPB has a vested interest in how its programming is used and the results of the School Report clearly favor CPB programming over alternatives. Despite this potential influence, the stratified sampling, large sample size and the repeated studies lend some evidence to the impartiality and veracity of this report.

The Corporation for Public Broadcasting (1997) study reaffirmed the conclusions drawn in Small et al. 1998; and Borgman et al. 2005 that educators generally phrase their searches in terms of subject area or prefer to have collections organized teaching concept. The Corporation for Public Broadcasting (1997) study also suggested educators had problems locating the appropriate programming. This finding suggests digital libraries should examine how educators desire age level and subject area represented for online video within the digital library. How educators interacted with technology may be an important factor in educators' perception of video and Web based use. In 1997, according to the study, educators were just beginning to incorporate the use of the computer into their instructional practices along with the use of TV and video. Given the time period in which this research was conducted, a new study might determine if educators continue to see use of TV and video and use of the computer as separate activities. One question that could be asked is whether use of the computer, and TV and video has changed since then. The work of Morris (2002) offers a perspective of how technology use by educators may have changed.

Morris (2002) studied educators' access to and use of technology in the classroom. The researcher defined ease of access to technology as an overall infrastructure that would (1) provide students with a low hardware to student ratio, (2) give students access to software that is closely related to the curriculum, (3) give students access to high-speed Internet, and (4) allow students access to computers in the classroom at higher frequencies than once a week. This definition of technology focuses mainly on the availability of computers to students and how educators used computers to enhance classroom lessons. Morris (2002) interviewed 28 elementary and middle school education graduates and conducted classroom visits. The researcher found that educators had varying access to technology. This variable access to technology led to limited computer lab time for students and increased challenges for educators trying to integrate technology into the classroom. Despite the lack of technology, educators were eager to integrate different techniques for computer use into their teaching practices. According to Morris (2002), educators of grade levels 2-6 used more complex methods than educators in kindergarten and first grade to integrate computer technology into the classroom for student use. Educators in grade levels 2-6 used the Web to find resources related to the lesson objectives or to find computer games, while educators in kindergarten and first grade used computer assisted software or videos in their lesson plans instead of the Web. Computer assisted software was software which offered younger students interactive learning environments based around specific topics. The researcher classified educator Web use into the following categories: information, teaching ideas, lesson plans, supplemental activities, on-line games, sites that have activities that meet state standards and book orders. In interviews, educators said that the Web was more stimulating than traditional technology for engaging students in a variety of educational activities (Morris 2002). Several educators also discussed the amount of time it takes to locate quality resources and wanted a "reliable resource for relevant and appropriate sites" to support their teaching activities (Morris p. 8, 2002). In terms of factors affecting technology use, educators made the decision to incorporate technology into the classroom based on ease of use, user friendliness, low stress and accessibility factors (Morris, 2002). As a final recommendation, this study indicated that educators needed workshops that focused on integration strategies, efficient and effective ways to distribute concepts that promote student learning and ways to communicate how integration of technology succeed in their classroom to their fellow educators. Along a similar vein, Hanson and Carlson, (2005) found that educators had trouble identifying the term "digital library" and this lack of recognition for the resources digital libraries make available to educators presents a problem for the community of developers.

Morris’s study has several limitations. The sample in this study was not representative of the population of educators because all the subjects in the study were drawn from the geographic region of Pittsburgh. The sample was also limited in that all of the educators interviewed came from the same University and had graduated fewer than five years before the study. Morris’s study sample did not include educators who hadn't had courses on how to integrate technology into the classroom; such educators may have different problems than the educators interviewed in Morris’s study. Despite these limitations, this study is supported by findings from other studies. Morris (2002) reiterates the finding from Small et al. (1998) that educators want information related to lesson plans and objectives. Educators in the Corporation for Public Broadcasting (1997) study discussed earlier also had positive attitudes toward technology despite the challenges related to integration and accessibility.

Morris's (2002) work has several implications for the present study. First, it suggests that educators are finding different ways to use the computer than they did in Corporation for Public Broadcasting (1997) study. Secondly it implies that educators are likely to be highly motivated to use online video based on their willingness to adopt different technologies into their teaching practices. Morris's (2002) work divided educators into different groups based on which materials they used. This implies that online video will be more appropriate for educators within a range of grade levels.

What is not clear from the conclusions of this study is the access schools have to technology. In the Corporation for Public Broadcasting (1997) researchers found that schools were technology rich, whereas Morris (2002) found that educator access to technology was variable. The findings from Morris (2002) could be due to their smaller sample size, however educator access to technology and technology support are likely to be a determining factors in use of video and online video. What is also not clear from this study is which educators will be more likely to adopt online video; those that currently use analog video in their classroom, those that currently use the Web, or neither?

Perhaps the most important finding of the Morris (2002) study are the factors that educators use to make decisions on whether they should incorporate technology into the classroom. Online video should be accessible to educators in terms of the technology being compatible with the technology of the schools and easy for students to use, this finding was supported by the research of Recker, Dorward, and Nelson (2004). If Web based video collections can be designed as reliable and useful resources, educators will find the process of incorporating online video into their classrooms easier.

The previous research on the information seeking and use of online video by educators suggests that educators search based on subject area, grade range, and topic. This implies that digital library collections should be organized by these facets and content should have these descriptors in their metadata, this is another recommendation supported by Recker, Dorward, and Nelson (2004). In terms of the resources that educators searched for, the lesson plan was determined to be the most searched for resource. This fact suggests that online video collections that include lesson plans along with their online video will be more appealing to educators for several reasons. First, the lesson plans will give educators some indication as to how the use the video in their classroom, second the lesson plans will contain activities and curriculum standards that can be adapted to suit the educator's individual needs and lastly the lesson plan will help to reduce the amount of preparation time educators need for the class. Based on educator perceptions about other resources, online video and video are likely to be highly appealing to educators because of its highly interactive visual nature and its ability to engage students in different learning modalities. Although this resource is likely to be appealing, the largest barriers to its use will probably be the ability to find video related to subject area, access to technology and technology support. Because of these barriers Web based video collections and other digital library curators should consider how to develop workshops that illustrate how to search for and incorporate online video into the classroom. They should also consider ways in which to involve educators who have used video in the process of metadata creation so that educators can search by terms highly relevant to the teaching task, or provide recommendation information on how to use available materials. Next we will examine how metadata relates to educators' online video information seeking and needs and how digital objects are currently being described with metadata standards.

Relevance Criteria For Educational Materials And Online Video

This section will first revisit the scenario of the educator searching for Web based video, then it will explore how metadata standards have been used to describe educational and online video materials. It will examine past studies of how educators make relevance assessments with respect to their overall teaching task and finally, it will discuss what should be done to help the problem. Due to the scarcity of literature on educators' use of online video, studies that highlight the use of video will be taken into consideration.

When an information retrieval system displays the results of a query, a decision must be made; educators must decide what information is most relevant to their task. This decision point is known as a relevance assessment; it is at this time that educators narrow down the larger result set of a query to a few documents. Educators base their assessments on relevance criteria. In the scenario, the eighth grade algebra educator used the terms "online video" and "Geometry" to define her search. These terms essentially map to the relevance criteria attributes of resource format and subject area. Relevance criteria generally are the criteria that are most important to the task of information seeking and use of digital material. Educators and other users of information retrieval systems apply relevance criteria to define relevance.

Relevance traditionally has been defined in the literature from a system oriented view, where recall is a ratio of number of relevant records to the total number of records in the database and precision is a ratio of the number of relevant records retrieved to the total number of irrelevant records (Borlund, 2003). The system oriented view of relevance has come under question due to its neglect of how the user interacts with the retrieval system (Schamber, Eisenberg & Nilan, 1990), and has subsequently been revised to include more input from the user (Borlund & Ingwersen, 1998; Järvelin & Kekäläinen, 2000). Relevance can be defined with respect to the teaching process as identifying documents or objects that help to complete some teaching related task. This view of relevance is from a user's (in this case the educator's) point of view. Definitions of relevance that are user-oriented consider how the educator's needs are related to the retrieved information. Once the eighth grade educator in the example found the relevant online video, she planned to use it in her class so that students could see how to calculate the circumference of a circle.

Users often base relevance assessments on the available metadata. Metadata is commonly defined as data about data. Gilliland-Swetland (1998) distinguished 5 types of metadata: administrative, descriptive, preservation, technical and use. Educators generally interact with descriptive metadata as they solve their information seeking problems. Descriptive metadata describe the resource objects. It allows users of the information retrieval system to locate the material they wish to retrieve, this process is also known as resource discovery. Whether it is descriptive metadata or one of the other types of metadata, this information is used to summarize the digital objects in an attempt to provide all the associated stakeholders with the information needed to make relevance judgments.

Current metadata standards such as the IEEE Learning Technology Standards Committee Learning Object Metadata (LTSC-LOM) 2002 standard[4,5], GEM or Dublin Core[6] (DC) can be used to describe educational materials. The Gateway to Educational Materials

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[4] http://www.imsglobal.org/metadata/mdv1p3pd/imsmd_bestv1p3pd.html
[5] http://dlib.anu.edu.au/dlib/september03/lightle/09lightle.html
[6] http://dublincore.org/

(GEM) project extended the basic DC element set with 8 additional elements in order to better describe educational material (Sutton 1999). In their extension they added elements that were tightly coupled with the teaching task such as education level, pedagogy, and duration (length of class time). A comparison of these three metadata standards demonstrates that each standard has its specific strength (Table 2.2).

Table 2.2 Comparison of Educational Metadata Elements

LOM	**DC**	**GEM**
		Essential Resources
		Pedagogy
		Quality Assessments
		Academic Standards
Language		
Description		
Typical Learning Time		Duration
Difficulty		
Typical Age Range		Education Level
Context		
Intended End User Role	Audience	Audience
Semantic Density		
Interactivity Level	Interactivity Level	
Learning Resource Type		
Interactivity Type	Interactivity Type	

Although not apparent from the table, the strength of DC is its flexibility. Over time the DC element set has been changed to address different weaknesses discovered in the metadata standard. The LOM's strength is that it attempts to address the time needed to implement the resource in the classroom and also describes the difficultly of the resource for the intended age range. GEM's strength is that it includes categories related to educational aspects like academic standards, and essential resources. GEM also tries to define a pedagogy that matches the resource and includes a field to assess the overall quality of the resource. Each of the standards overall convey a sense of educational context; this context strives to summarize the important elements related to the teaching task.

What is not clear from the educational metadata standards is how well online video and video materials will be described using their elements. Most educational material is in the form of text with associated textual metadata, whereas online video combines visual, aural and textual elements and can have surrogates that are combinations of each modality. Not only are the modalities different between video and standard educational materials but the tasks educators need to complete once those materials are found may also be different. Educational metadata standards may capture the educational context but educational context alone may not make the task of downloading and retrieving specific segments of video easier. Educators searching for online video may need visual and audio surrogates to review online video content, or to search for specific characters. In the NASA Connect™ educational videos produced by the NASA Educational Media Archive, educators may want to search for segments containing the host, Jennifer Pulley, or they may want to search for segments with Norbert, a computer animated character. Educators who are familiar with these videos will know that when the host appears she discusses what the next video segment will cover and what the students should have learned from the previous segment. Likewise, Norbert's presence in a segment indicates some scientific fact or problem is about to be demonstrated.

When searching for video educators also need information that describes the situational context; who the characters and objects in this segment are; what the locations of this particular scene are, and lastly what the subtext or underlying meaning of the content is. This type of information will not be readily available in most current educational metadata standards. These complexities make describing what an online video is about much different than describing what traditional educational materials are about. Think of the old adage "a picture is worth a thousand words." If a picture is worth a thousand words then one hour of video is worth 108 million words (this is assuming a rather conservative estimate of 1 picture per frame).

Not only is description of online video different from description of traditional textual objects, so is storage and retrieval. Video objects take up more space than textual objects. Educators must decide if they would like to stream online video or if they would like to download online video. Streaming online video means that educators will choose to play the video from the remote site or on the server side. Streaming video negates any issues that might arise related to storage of video on the local machine (client side) but quality of playback will determined by the speed of the Internet connection.

To address the need to better describe online video the Open Video project[7] extended the DC element set. An examination of the database schema for Open Video outlines some of the metadata elements used to describe video content (Table 2.3). Open Video added elements closely tied to the content of a video such as a video's duration (total length of

[7] http://www.open-video.org/

video), amount of motion, color, and sound. Open Video also uses a series of visual surrogates (poster frames, storyboards, fast forwards and 7 second excerpts) to further describe video content. These additions to DC provide an excellent base for describing video’s situational context, but something is still missing. According to Shabajee (2002), even with extensions metadata standards still could not describe the infinite contexts in which resources could be used or describe the content in the multiple ways necessary for the diverse user groups of the web. Given that metadata standards alone will not solve the problem of how to deliver digital content to users we will explore what is currently known about educator's relevance criteria.

Table 2.3 Some metadata elements used by Open Video to describe online video.

Digitizing
Organization
Metadata Cataloger
Frame Dimension
Contributing
Organization
Segmentation
Edited
Genre
Color?
Sound?
Framerate
Duration
Posterframe
Timestamp
Number of Frames
StatsText
Amount of Motion
Digitization Date

Yang (2005) investigated how professors, video librarians and video editors/producers made relevance judgments when they searched for video. Of the user groups that Yang (2005) investigated, the most relevant to this study were the professors. Yang interviewed 10 professors to investigate how they used video to support their teaching. Three professors taught courses in foreign literature, three professors taught courses in film analysis and production and the remaining professors taught courses in medieval English literature, English, nutrition and library and information science. Professors used videos in class for the following reasons: students were more attentive to video than to text, students were usually able to learn better from videos than from text, and videos helped students to visualize concepts. Professors in Yang's (2005) study generally used videos in class to illustrate concepts related to the current class topic. For example, a professor of film analysis reported he showed students video to allow them to see the different types of camera shots. The film analysis professor did this so that students could compare the film to their mental visualizations of the readings on different camera shots. Other examples of illustrating concepts were a professor who showed his literature students a video about life in the 19th century so students could compare it to a reading they had done for class, and a professor who taught a nutrition course and used a video that illustrated communication between a patient and health care provider. This type of video use supplements and/or reinforces the material professors are teaching. Since all of the professors used video to illustrate class concepts, Yang termed them the "illustration task" group.

Yang (2005) derived 30 relevance criteria from interviews with the professors and created the following three categories: textual relevance criteria, audiovisual criteria, and implicit criteria. Textual relevance criteria referred to professors’ use of standard textual metadata such as title, author, and genre to judge a particular video's usefulness in the class. Textual relevance criteria were the most frequently mentioned criteria with topicality, author date/recency, genre and recommendations being the most frequently mentioned.

The results from Yang's study imply that although video has aural and visual components, the way professors searched for and described videos was mostly textual. These findings support previous research which indicates faculty and educators desire information organized by topic. The research also suggests video use by professors can broadly be categorized into illustration tasks. Finally, like previous research, Yang also found that professors participated in informal "word-of-mouth" information seeking with their colleagues.

In a similar study, Lawley, Soergel and Huang (2005) investigated relevance criteria used by educators planning lessons and searching a video archive of Holocaust survivor testimonies. They also found educators searched for video material that would illustrate class points. The researchers observed that educators used video as a means to connect to students. Educators connected to students by asking them to relate the video used in class to their personal experiences or by asking students to relate the video to pop culture. Some educators in the study remarked they would rather browse than use descriptors. Educators in the study sometimes searched for video based on scenarios, that integrated the concepts the educator wanted to convey to students with general knowledge about the video collection. The educators used many criteria to assess whether they would use testimony passages, including several relevance criteria that had not been documented in the literature previous to their research: vocabulary, positive message for students, role of interviewee in Holocaust events and students identification with interviewee (Lawley, Soergel &Huang, 2005). These relevance criteria were specific to the task of lesson planning. The criteria further stress that educators want their students to connect to the characters within the video, whether this connection be through identifying with the characters from the situations they are involved in, or from understanding the environment the character acts in by witnessing firsthand accounts.

Overall, the metadata standards and the relevance criteria educators use indicate that there are apparent gaps between what the standards address and how educators search. This gap is apparent from analysis of the different strengths inherent in each standard and from the lack components necessary to describe online video. In order to build effective search systems of online video for educators, metadata that describes educational content will need to be combined with metadata that describes video content. The studies of educator relevance criteria indicate that educators prefer browsing to keyword search. Another theme was that educators used video to illustrate or "reinforce" lesson objectives, giving students a visual way to learn the material. These findings suggest indexers trying to describe video for educational audiences should summarize the concepts or topics the video illustrates. To address the gaps of the metadata standards more user need assessments should be performed in order to capture the different contexts in which online video might be retrieved. Although the problem of resource description has been described as intractable by Shabajee (2002), understanding user contexts will aid in the design of more efficient digital library retrieval systems, more user friendly digital library interfaces and ultimately, better metadata.

Digital Library Interface Design

A digital library interface that is designed to support the information seeking of educators must take into account their information needs, work roles and tasks. Well designed interfaces will take into account educators' need to search by subject area, grade range and topic. However, few systems have tried to address the problem of describing online video collections from an educational view point. What kinds of interactions should the user interface support to effectively allow educators to determine the appropriateness of online video and what are the tasks educators want to complete with respect to online video? This section will examine the roles digital libraries have traditionally addressed with respect to education and some of the assumptions digital libraries make in regard to the educational setting.

In order to support interactions with users, digital libraries must give consideration to roles that the digital library assumes with respect to its setting. Masullo and Mack (1996) defined three roles that digital libraries can play in education: a resource for teaching, an environment for student learning, and a publication and authoring tool. In the first role, that of providing a resource to educators, educators might review other educators' recommendations for lesson plans in the digital library, examine assessment techniques other educators reported using with objects in the digital library or see how educators have annotated digital objects according to curriculum objectives. Although Masullo and Mack (1996) mentioned using digital libraries as resources for learning, they did not give examples of how students might use digital libraries as a resource. Student use of digital libraries might have the following interactions: download supplemental material to the lesson, review rubrics that describe the points and the concepts covered by the lesson, access definitions, and access external related links.

Next, Masullo and Mack (1996) described how digital libraries might be used to create learning environments for students. In this second role Masullo and Mack (1996) envisioned students using interactive multimedia to experience learning in a digital form. In this role students might replicate experiments completely in a digital environment, follow learning modules through a series of concepts, or see how students in other cultures learn.

The final role of digital libraries in education suggested by Masullo and Mack (1996) was the role of publishing in supporting the student learning experience. Although they suggested this role was distinct from the previous roles, they did not further elaborate how publishing might enhance the digital learning process. In this role students might share data collected from experiments, create journals of experiences to share with other students answering inquiry based questions, or allow students to share art and poetry with other students around the world. Also not explicitly mentioned in Masullo and Mack's (1996) discussion of publishing was how educators could contribute to the publishing role in various ways. Educators might contribute to the publishing role by making available class notes, lesson plans, how assessment was conducted, which curriculum requirements were addressed by the lesson, notes about any problems they encountered with delivery of the lesson and also thoughts on how the lesson might be improved.

In comparison to the roles of the digital library for education, Marchionini and Maurer (1995) discussed three roles of physical libraries: 1) Libraries play a practical role in allowing the sharing of expensive resources; 2) Libraries play a cultural role in preserving and organizing artifacts and ideas; and 3) Libraries play social and intellectual roles by bringing together people and ideas. The researchers stated the difference between physical libraries and their digital counterparts were that digital libraries combined "technology and information resources to allow remote access" (Marchionini & Maurer 1995).

The summary of roles provided by these researchers for digital libraries and physical libraries are essentially the same. One should note that Masullo and Mack's (1996) roles for digital libraries focus primarily on the interaction between students and the digital library. One question that could be asked is what other roles can be envisioned for educators and other members of the educational community? When digital libraries are used as a resource for teaching, they are allowing educators to share expensive resources. Digital libraries are also used for organizing and preserving teaching ideas and artifacts. Both digital and physical libraries can establish learning environments by bringing together people and ideas. What separates digital libraries from their physical counterparts is how their users are able to interact with them; more specifically, digital libraries have a long way to go in recreating the social spaces and interactions possible in physical libraries.

For digital libraries the interface is the gateway to user interaction. The digital library interface should enable users to browse, search and retrieve video. Several projects have developed digital library interfaces with these intended functionalities: GEM, NASA Ibiblio[8], NSDL, Open-Video, Informedia[9], and VISION. This literature review will examine each of these projects and evaluate the contributions they have made to online video and educational material retrieval.

The GEM[1] project's focus is to provide educators with quick and easy access to educational materials. The majority of educational materials in the collection are text based lesson plans and web resources. The GEM interface allows educators to browse by subject, resource type, educational level, keywords, and a variety of other elements. Educators also have the option to perform keyword searches to retrieve digital objects from the GEM

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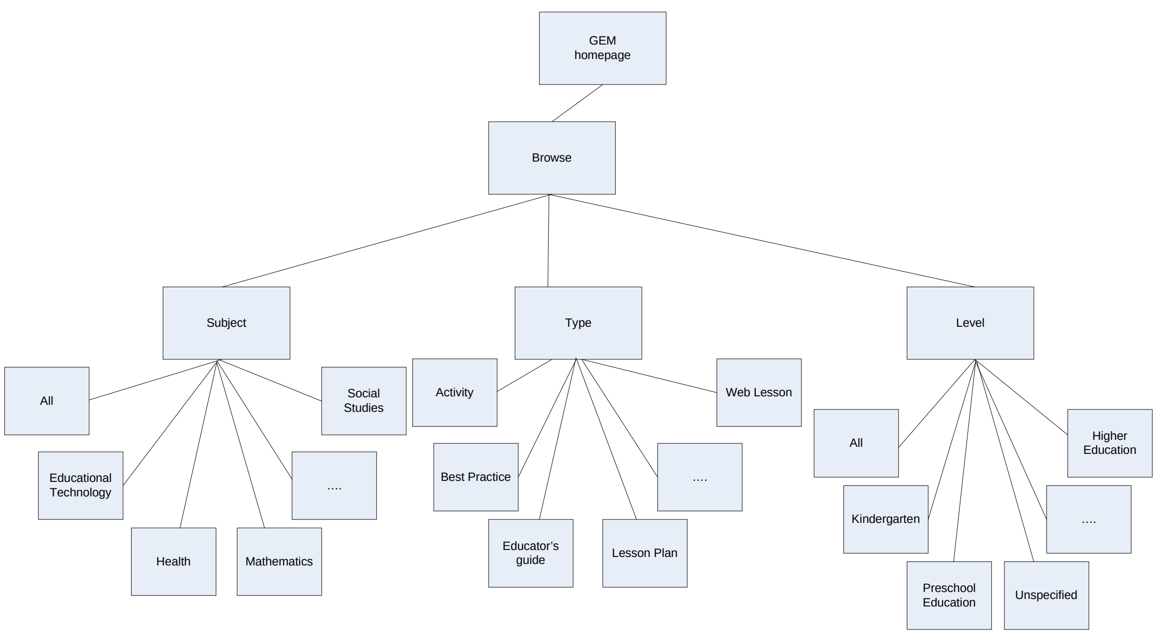
[8] http://nasa.ibiblio.org
[9] http://www.informedia.cs.cmu.edu/

catalog. Once a search has been performed on the catalog, educators are given the option to further refine their search using the elements of the GEM catalog. (Clicking on the final level of the facet reveals a list of educational resources with its associated metadata.) The strength of the GEM catalog lies in the GEM element set on which it is based; this element set has been widely adopted as the standard for educational metadata. The GEM element set was created as an extension to the Dublin Core element set and includes the following educational elements: audience, duration, essential resources, educational level, and pedagogy (Sutton 1999).

Figure 2.4 Selected faceted categories from the Gateway to Educational Materials.



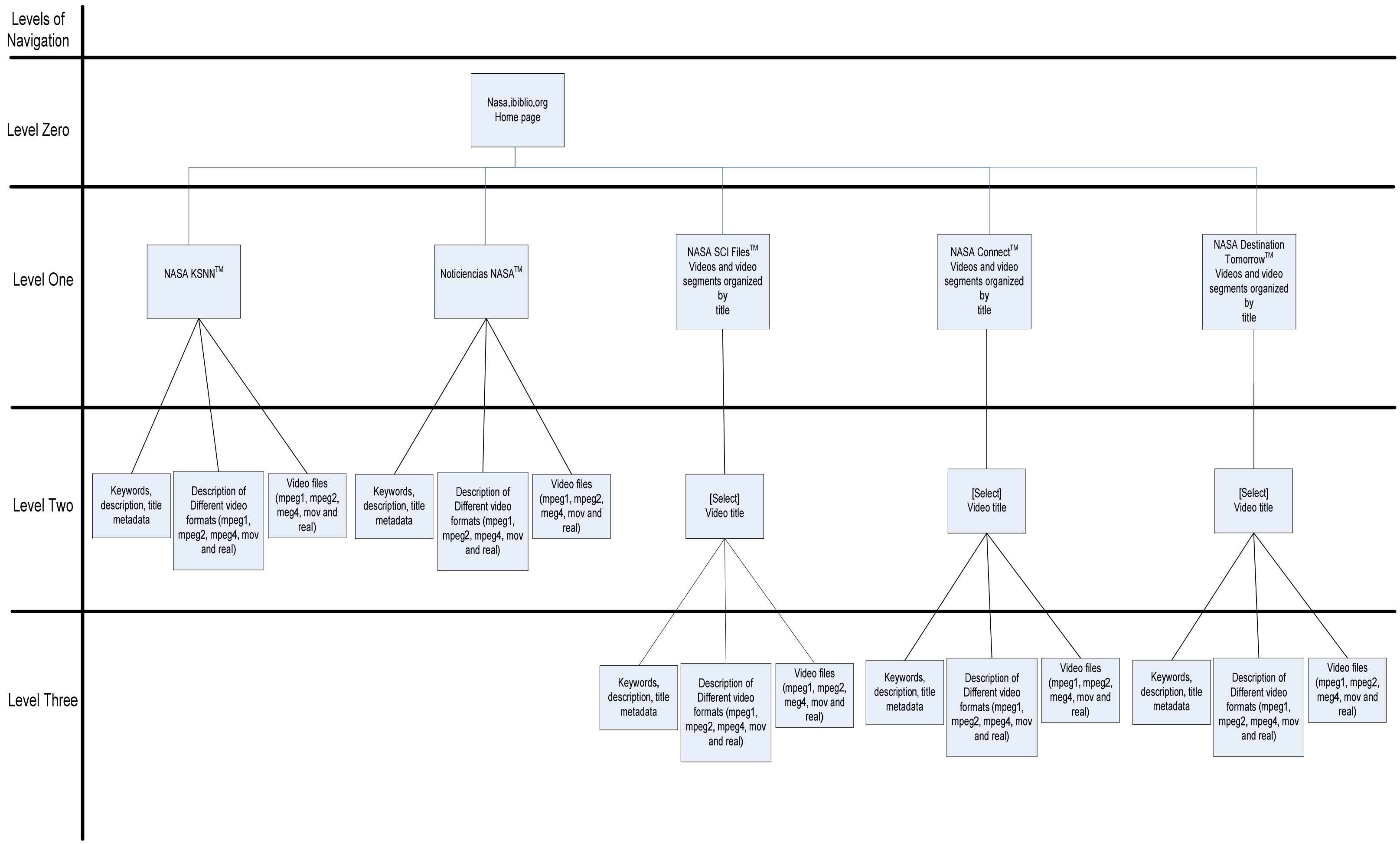
These elements are important to the task of identifying educational resources, and are based on a paradigm of faceted search. Faceted search is search based on a number of categories that are descriptive of the underlying collection but also highly relevant to the task of the user. While faceted search may be the dominate paradigm for describing textual documents, research on video suggests that users desire concise previews of video content.

Future research should determine what type of browsing and search educators prefer when searching digital collections that combine textual and video content.

An alternative to faceted browsing is to present users with a hierarchal series of links for browsing. The NASA Educational Media Archive is a digital library based on a hierarchal structure. The NASA Educational Media Archive digital library is a collection of educational online videos which have been donated by NASA's Educational Media Archive to ibiblio for digitization. Each video is manually digitized and indexed with metadata based on the video content. The NASA Educational Media Archive produces 5 different programs; NASA Kids Science News Network™ (KSNN™), which has an audience of Kindergarten through fifth grade; Noticiencieas NASA, which is the Spanish version of NASA KSNN™; NASA Sci Files™, which has an audience of third grade to fifth grade; NASA CONNECT™, which is aimed at a sixth through eighth grade audience and NASA's Destination Tomorrow™, which has a 9th grade to adult audience. The NASA Educational Media Archive digital library hierarchy contains either two or three levels for users to navigate through from the index page depending on which program users select. From the index page (level zero in Figure 2.5), users select the NASA program they are interested in to drill down to the level one, the individual program pages. At level one, users who have selected the NASA KSNN™ or Noticiencias NASA™ programs can see a list of video titles. They can then click on links for a title to download an episode, or view a description for an episode (level two). The NASA KSNN™ or Noticiencias NASA™ videos contain one less level of navigation because videos from these two programs are approximately one minute in duration and they have not been segmented further. Users who selected one of the NASA CONNECT™, NASA Sci Files™, or NASA's Destination Tomorrow™ programs can see a list of video titles for that program (level one). Clicking on a title takes them to page for that title (level two), this page displays information about videos and their segments. They can then click on links for a title or a segment to download or view its description (level three).

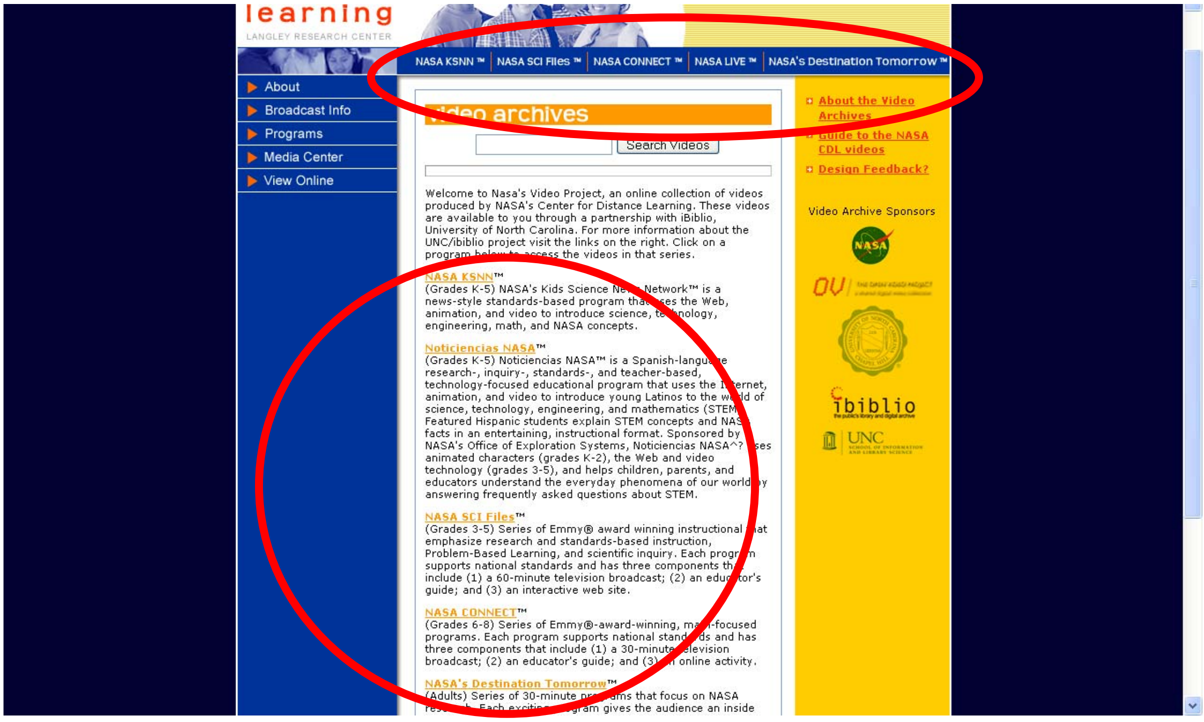
Users may also perform keyword text searches on title and description information. The hierarchal organizational structure is useful for users who have previous knowledge of the video collection and titles, but is less useful for educators who desire the ability to search by curriculum objectives and subject area. In essence, NASA Educational Media Archive provides access to online video content but does not organize the collection with a focus on educational use.

Figure 2.5 Navigation paths for nasa.ibiblio.org



In addition to the navigational structure shown in Figure 2.5, the nasa.ibiblio.org digital library provides links to the home pages associated with each of the programs and to information about the Educational Media Archive itself. These links were implemented in the beginning of the digital library's creation because nasa.ibiblio.org adopted the "look and feel" of its parent organization. Doing so introduced problems into the design because the links to browse videos in the collection were given the same name as the links to the home pages associated with each of the programs. In effect there were two links with the same name which produced different results depending on which one the educators chose (see Figure 2.6). Another issue with adopting the look and feel of the NASA Educational Media Archive was a disconnect between updating content at the parent organization and the portal. Essentially, after creating the digital library, no communication or protocols were established for updating matching nasa.ibiblio.org content. This could negatively affect how users interact with the system by portraying the content on the nasa.ibiblio.org web site as not being the most up-to-date. These inconsistencies and others emerged in a focus group study in which users were asked to respond to the nasa.ibiblio.org web site before prototype changes developed as part of this research were implemented (Brown, 2006a).

Figure 2.6 Screenshot of duplicate link structure for nasa.ibiblio.org



In a focus group study of educators' information seeking and use of online video, I confirmed that educators desired digital collections organized by curriculum objectives and subject area. Collections organized by units and objectives allowed educators to quickly narrow search results (Brown 2006a). Educators in the focus group also stressed the "word-of-mouth" nature of their information seeking and their reliance on technical support to use instructional materials they were unfamiliar with such as online video (Brown & Bowers, 2006). These findings further support the literature on information seeking that asserts that educators use colleagues to identify quality instructional materials. More importantly, these findings suggest that in order for digital collections such as NASA Educational Media Archive to be widely used by the educational community, the NASA Educational Media Archive developers must find economical ways of implementing interface and metadata changes that better reflect the information needs of educators.

The NSDL supports access to instructional materials and tools. It is intended for use at all levels of education. The NSDL is a collection of digital library resources that can be found on the Web (http://nsdl.org/). Most of its materials are a combination of text and images. The NSDL supports a variety of browsing options: users can perform faceted browsing by topic, they can browse an alphabetical list of collections, or they can view the subjects in the collection in a graphical fish eye viewer[10]. The fish eye view shows subjects that are closer to the center as larger and topics closer to the edge of the view as being far away. The center of the view is composed of NSDL Collections by Subject, Science, Mathematics, Health, Education (General), Technology and Social Studies.

In an evaluation of the NSDL, Recker et al. (2005) investigated how integrating educator development and use of a digital library would affect resource use. Educators reported high value of learning from digital library resources and positive impacts for the educational community, however the researchers found educators seldom used systems to create instructional projects online (Recker et al. 2005). There were several reasons educators did not adopt the new system: lack of time, little or no access to associated technology needed to use the system, mismatch between language of the system and language of the users, inability to incorporate non-digital library resources, resources not organized according to grade, and resources not organized according to U.S. state and federal teaching standards (Recker et al. 2005). These findings further reiterate the problems educators have with incorporating digital resources and the need for systems to better support teaching practices (Brown & Bowers, 2006; Small et al., 1998; Hanson & Carlson, 2005; Borgman et al., 2005).

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[10] Since the initial study was done the fish eye view was removed from the system and the Web site was changed. See http://web.archive.org/web/20060101160057/nsdl.org/browse/ for a list of options this analysis refers to.

Aside from the problems associated with trying to add value to educational materials, there is also the problem of how to best represent Web based video collections. The Open-Video project has focused on providing an interface that will facilitate the browsing and extended use of online video in a variety of communities. Open Video has collected a number of Web based video collections (http://www.open-video.org); the system uses a combination of automatically generated metadata and human indexed metadata to describe material in the collection. The human generated metadata describes the video objects in the standard textual categories such as title, keywords, and description. The automatically generated metadata gives users the ability to preview video content prior to downloading an entire video in a variety of ways. Poster frames present one key frame to users used to represent the video much like a movie poster. Storyboards are a series of keyframes presented to give users a sense of action over the entire length of a particular video. Fast forwards present a small preview of the video to the users at an increased rate of viewing. Seven second excerpts present the user with a very brief video excerpt that is intended to give users a gist of what the video is about (Yang et al., 2003). These descriptions of the video provide different types of visual information for users to preview before they make a selection. In addition to these attributes, the Open-Video project allows users to browse a number of textual video attributes: genre, color, sound or duration. Users can browse at the collection level and through the traditional title, keyword and description information.

Another project that has researched different ways of representing online video is the Informedia Video Digital Library. The focus of the Informedia Video Digital Library is to apply automatic indexing techniques to the problems of video information retrieval. The online video in the Informedia library consists of news video from the Cable News Network and documentary video from the a variety of sources, including the British Open University, QED communications, Discovery Channel, NASA, the National Park Service and the US Geological Survey (Watclar, H. D. et al., 1999). The Informedia Digital Video Library uses speech recognition and image processing to create metadata for online video for retrieval.

The speech recognition software provides Informedia with transcripts that allow users to the search audio content. Despite errors in transcripts created with the speech recognition software, they found that information retrieval was still effective at high rates (Watclar, H. D. et al., 1999).

The Informedia Digital Video Library uses image processing to automatically produce key frames to represent sections of video. The image processing is weighted to detect key frames with faces and key frames with text superimposed over the video layer (Watclar, H. D. et al., 1999), on the assumption that these types of keyframes are more important than the other video content.

The Informedia Digital Video Library continues to make advances in areas of content based video retrieval. The Informedia project has designed interfaces which allow users to play videos from the point of thumbnail key frames, initiate search using images, or perform content based search based on specific visual features, such as "find videos that contain the color red" (Christel & Moraveji, 2004).

Given what the literature says about educator information seeking however, the following question arises: how well does content based retrieval capture the subject area and curriculum metadata desired by educators? The actual content contained in the video that is the basis for both Open Video and Informedia metadata may be good for improving some searches educators perform on online video, such as search based on finding specific subject areas, or topics. However, video text transcripts may not contain the curriculum and subject area information necessary for educators to perform precise searches within the digital library system. Similarly, search based on other information dimensions may elude both of these techniques. These dimensions include what grade range is a suitable audience for this video or what curriculum objectives the video covers.

Content based video retrieval may be good for the task of reviewing online video content. Gauch, Li and Gauch (1997) argued that valuable time is wasted when educators have to manually scan video to locate portions most related to the educational content they wish to teach. This introduces a new task that educators may have in terms of online video information seeking: finding specific video segments in a video for which they have some prior knowledge. In these tasks, content based video retrieval or systems which provide visual metadata will probably be more efficient at pinpointing specific video segments than retrieval that relies on keywords and title information. However these methods need to be mixed with the faceted browsing and search that has proven successful with other digital library projects such as NSDL, and GEM. In the long term, Web based video libraries aimed at making search more efficient must provide a variety of methods for educators to review online video content. Iyer and Lewis (2007) suggested using storyboard surrogates to implement a tiered model for representing keyframes. In their tiered model, the first layer of storyboards is presented along with thematic information, in the second level keyframes are presented with background information and in the third and final layer keyframes are presented with location, period, and attribute information. These recommendations suggest the context of the video can be lost when selecting keyframes for the storyboard format when thematic, background and location information does not accompany storyboard keyframes

(Iyer & Lewis, 2007). Another concern for online video users is how this image-rich retrieval will perform over network traffic and for users with lower bandwidth.

The Video Indexing for Searching Over Networks (VISION) project uses content based techniques similar to the Informedia digital library to provide multimedia curriculum materials to educators. Gauch and Gauch (1997) developed the VISION Web based video library prototype to evaluate how content based search and video retrieval would perform across networks with a wide range of bandwidths. To address the problem of users having a variety of connection speeds, the VISION library provided online video at three different levels, high, intermediate and low quality. At each quality level videos are provided with different compression ratios and playback sizes. The VISION system sends the appropriate video to the client based on the network bandwidth between the client and the server.

Other projects which have attempted to address the problem of network bandwidth are the Open Video and the NASA Ibibio projects. Their approach has been to provide users with videos and video segments in the following formats for download: MPEG1, MPEG2, MPEG4, and QuickTime. Disadvantages of this approach are that educators may not be aware of their network connections and how long downloads will take based on file sizes or even which formats are compatible with their workstations.

The VISION search system allows users to search the full text transcript using a Boolean full text query. This differs from the Informedia system, which translated users' queries using natural language processing techniques (Gauch, Li & Gauch, 1997).

As the previous review emphasizes, there are many resources available to educators and this places pressure on providers to clarify the content of the digital library and match how teachers frame their information needs when searching repositories. Consequently, digital library interface design should give consideration to roles and setting so that user interactions can be fully supported. In the education setting, important interactions for successful digital libraries will involve the reuse of digital materials, collaborations among user groups, remote access to digital materials, consideration of network limitations and the creation of virtual environments for user groups. Digital libraries of the future will address the roles envisioned by previous research (Masullo & Mack, 1996; and Marchionini & Maurer, 1995) and they will also assume expanded roles. Examples of expanded roles for digital libraries are enabling user communication through digital channels, providing help to the user, allowing users to perform work within the digital library setting, and finally enabling finer grained relevance judgments of digital library content by adding metadata more aligned with user needs. Currently, educational Web based video collections do not combine content based searching and browsing of digital video with faceted categories that allow videos to be organized by subject area, grade range and topic. Current educational digital collections also do not fully link online video to related educational materials. Educators using online video may desire simultaneous access to related lesson plans, web sites, simulations of teaching concepts, recommendations developed by fellow educators and class activities. Although previous studies have attempted to build systems that allow educators to create instructional content, those efforts have been met with social and institutional resistance. Developers of digital library interface systems must realize that in order for the system to be widely used it must be simple, intuitive and not require excessive amounts of time to learn. Developers must also realize that educators will be reluctant to change their current work practices and are unlikely to exchange a digital work flow for their current paper based work flow. This will require new systems to be compatible with the work flow and technologies currently available to educators. The research presented in this dissertation is framed by this broad imperative for digital library interface design.

Research Questions

The overarching research question this research seeks to answer is: in what ways can digital library collections better meet the needs of K-12 educators in their retrieval and use of online video material? Given the current state of the literature, this research question is appropriate because it is exploratory and aims to address some of the gaps in our knowledge of their needs. This dissertation addresses the following specific questions in the context of the NASA Educational Media Archive Web based video collection.

Question 1. Who uses these digital collections? Are educators making use of the digital collections that are available? This type of information will be important when attempting to draw comparisons to the larger teaching populations and discussing which populations of educators need to be studied in future research.

Question 2. What are the information seeking processes of educators looking for online video? This research question gathers information on K-12 educators. In the previous research literature the focus of research has been on students' information seeking or on the information seeking of university faculty. This important addition to the information seeking research will help us to better understand how changes in context, setting, work roles and task influence the overall information seeking process.

Question 3. How well do the current retrieval systems meet their information needs? There are currently a variety of educational retrieval systems available for educators to use; however, these systems may have or may not have been built with feedback from educators. This research question specifically focuses on telling us if the current system is good enough or where the current system fails to meet educators' needs. With answers to this question we can determine the best ways to develop retrieval systems in the future for educators, as well as work on improving our current systems.

Question 4. Are there practical ways in which the current systems can be improved to better meet the needs of educators? For example, what interface changes or additional metadata will be needed to better address the information needs of educators searching for online video? This research question is an extension of Question 3 and specifies how our current retrieval system might be improved.

Based on what we learned from the review of the literature and the specific research questions chosen for this particular study, we will now explore which research methods were best suited to address these concerns.

CHAPTER III

METHODS

There are many reasons for evaluating digital libraries: to improve design, to conduct research on how a particular collection is used, to investigate user characteristics or to streamline workflow processes. The method one selects should complement the purpose of the evaluation as well as support the collection of reliable and valid data for analysis. As stated earlier, the purpose of this investigation was to examine the ways digital library collections can better meet the needs of K-12 educators in their retrieval and use of Web based video material. To begin to answer this question requires many different types of data. Understanding how educators use current systems along with information about the characteristics educators' desire in new systems will help ensure a new system can be built which combines these different requirements. Since these general stages closely resemble the process of design, the stages of the traditional waterfall model will be used to discuss the methods for evaluating digital library systems and to justify the final methods chosen for this study.

The waterfall model originally proposed by Royce (1970) depicts software development as a series of cascading phases much like the levels of a waterfall. Although Royce (1970) remarked that the waterfall model was "risky and invites failure", the model is an excellent method of discretely representing different phases of the design process. The original model had 7 phases: system requirements, software requirements, analysis, program design, coding, testing and operations. These phases can be further collapsed into five basic stages of development: requirements, design, implementation, verification and maintenance. In practice, software designers use the model for project planning; during actual development, the phases of the model can blend together with different parts of the project occurring simultaneously or different parts of the project coming to completion at different speeds. First we will use these five phases to discuss the advantages and disadvantages of different research methods for digital libraries and then we will describe the specific methods selected for this study.

The first phase of development is the requirements phase. During this phase, system designers are concerned with collecting the system requirements from the administrators of information systems, as well as collecting information from the general users of the system. Data can be collected at this stage using interviews, focus groups, and surveys. The goal of this phase is to understand the context of the work, and the environment of the workplace and users; this information will help system designers to create a system that meets the needs of the users.

According to Babbie, (2001) interview methods have several distinct advantages: they generally produce fewer incomplete responses than surveys, have higher completion rates, and interviewers can make important face-to-face observations not possible with other methods (p. 267). Contextual inquiry is another method which uses the interview process. In contextual inquiry, developers observe end users in the context of their work environment; these interviews may be semi-structured or structured (Beyer & Holtzblatt, 1998). In this manner, developers gain more of a firsthand view of the users' tasks and goals. Interview and observation methods have the disadvantages that getting access to representative users may be difficult, both methods are time intensive, and they have the potential for interviewer and interviewee bias. Observations also have the added limitation that without a current system or workflow there is nothing to observe until a prototype exists.

In contrast, focus groups offer the following advantages: they provide the ability to collect large amounts of data, researchers can quickly assess how users feel about a certain topic, design or product, and group responses may reveal aspects of the topic that individual interviews can miss (Bruseberg & McDonagh, 2003, Babbie, 2001). Surveys have advantages in that they can be conducted with low cost, and are often more effective dealing with sensitive issues (Babbie, 2001). One disadvantage of surveys is the response rate; in a focus group and survey conducted by Brown (2006) educators remarked they were constantly asked to participate in studies through email, and given their time constraints, rarely viewed participation in studies as being beneficial to them. Despite this difficultly in achieving high response rates, others have achieved sufficient rates (65%, CPB, 1997) or used convenience sample methods to achieve a large enough response for data analysis (n=197, Hanson & Carlson, 2005). The CPB study achieved the high response rate through use of notification letters, reminder cards, two reminder mailings, and follow-up phone contact. The Hanson and Carlson study achieved a large amount of participation by advertising the study on list servs, posting links on websites and announcing the study on bulletin boards. Another advantage of surveys is that they can be administered online or in the traditional paper based format. Online surveys can be deployed from the online system under study to measure how satisfied users are with the system, and gather user feedback on new functionality of the system. Online surveys have the majority of strengths and weaknesses of the other survey methods including the ease of collecting responses from people who already use the system. However, with online surveys it is difficult to make certain the respondents to the online survey are representative of the target user population, especially in including non-users of the system (Babbie, 2001; Harley & Henke 2007). This can potentially introduce bias into the survey methods and the resulting requirements phase of the research.

Hanson and Carlson (2005) studied how educators used digital web resources using online surveys, focus groups and telephone interviews. Using an online commercial survey tool, the researchers asked a convenience sample of educators about attitudes and use of current web resources. A total of 236 participants responded to the survey, however, after filtering out educators who did not meet the criteria only 197 educators remained. Hanson and Carlson (2005) asked educators which educational resources they relied on the most for curriculum planning, which source they relied on most for instruction, how educators find out about new educational resources and how often they collaborate with colleagues to share educational information. The researchers also probed use of web resources with 3 questions.

- What are the top three challenges when seeking and using web resources?
- On average, what percentage of instructional time with learners incorporates web resources?
- How often do you use the following web resources in instruction?

In a study of TV and video use in the classroom the Corporation for Public Broadcasting (1997) explored educator attitudes and availability of technology using a traditional paper based survey. The survey was sent to a stratified random sample of educators with a total of 1,285 educators responding to the survey (65% response rate).

The CPB (1997) study asked educators about their difficulties in using TV and video, their information sources for TV and video programming, the viewing arrangements educators used, the subject areas the video covered, and how computer use relates to use of TV and video programs.

The second phase in the waterfall model is design. Design in general focuses on creating technology to support the work tasks of the users. If the system does not support the work tasks and does not adhere to the business practices of the users then it is unlikely the system will be used. Data collected from the first phase can be developed into functional requirements. Also at this time use cases, scenarios and various models such as physical, cultural, or sequence models can be developed. In the early stages of design it is important that models reflect needs of the user. When developing models developers must remember that great time and effort are necessary to build models which accurately represent work flow. After design models and prototypes have been built, designers can gather feedback from users to ensure that functional requirements meet their needs; these meetings can be in the form of interviews. Other methods used at this stage are prototyping, brainstorming, interviews, and focus groups. Design will continue to iterate through a cycle of collecting requirements from users, building models and prototypes from requirements and getting feedback on prototypes from the users. The number of iterations designers go through, however, will be limited by constraints such as manpower, time and funding for a project.

The third phase is the implementation. Implementation is the phase where coding takes place, in essence, this is when the system is developed. The designers take the functional requirements and translate them into working prototypes. Working prototypes can be released to the users so the system can be tested in the context of the users' work before release of the final design.

The fourth phase is verification. At this stage systems are further tested to make sure they meet the minimum user requirements. Usability testing can be conducted to gather data on user errors, time to completion on common tasks and satisfaction measures of system design. For example, usability testing can also measure the number of links the user must travel to find wanted information and improve interface design by reducing the links (Nielsen 1993; Norlin and Winters 2002). One drawback to usability testing and other experimental methods is that usability testing generally occurs in a "laboratory setting" rather than the natural setting of the user. The risk is that user behavior could be different when observed in a laboratory setting than when users are not being observed. For example, in an experiment studying use of web search engines users may modify their queries to exclude sexual content because of the social pressures of being observed. Laboratory settings and experiments have the added of advantage of being able to control the experimental variable, as well the ability to repeat experiments several times (Babbie, 2001). Experiments that occur in naturalistic settings have issues that must be addressed in order for results to be valid, including the difficulty of assigning people to experimental and control groups and the fact that they must study phenomenon as they occur and are "not repeatable". However experiments that occur in a naturalistic setting do not have the weakness of being artificial (Babbie, 2004).

Another method which can be used at this stage is the cognitive walkthrough method. Cognitive walkthroughs have an advantage over traditional interviews in that instead of asking what a subject would do in a specific set of hypothetical circumstances, the researcher can observe subject's interactions with a real artifact for a set of defined tasks. Traditional walkthroughs are conducted by Human Computer Interaction (HCI) experts in a controlled setting. According to Wharton, Rieman, Lewis and Polson (1994) one tradeoff with the cognitive walkthrough method is that it focuses on one attribute of usability, ease of learning, and thus has a narrow scope (p. 107). The fact that the walkthrough method is focused on ease of learning might be a stronger limitation for this research if we were concerned with a system that was designed only for experts, but since this system is being designed for new or highly intermittent users, it is not as severe a limitation. Other limitations identified by the authors were the importance of task selection to the final outcome of the evaluation and severity of the problems that are identified by the method. These limitations entail that care must be taken that the tasks to be performed during the walkthrough are realistic. and the researcher must encourage subjects to do more than just identify surface level problems. To address overall issues with the method the researchers have revised it to address some of its criticisms. Whartaon et al. stress that the value of this method lies in its ability to identify problems with design early on and its ability to identify problems which may require more specific user testing (p.139).

The fifth phase is maintenance. In this phase system designers focus on improving workflow and further understanding the use of systems. Methods which can be used at this stage are transaction log analysis, content analysis and online surveys. For fully designed digital library systems, transaction log analysis can provide overviews of how collections are accessed and generic user profiles. Transaction log analysis (TLA) is defined by Davis (2004) as a "non-intrusive method for collecting data from a large number of individuals for the purpose of understanding online-user behavior" (p. 327). In TLA, records of visits to web pages are collected as well as search terms used within the web site. Davis (2004) studied Uniform Resource Locator (URL) referral data by analyzing the transaction logs of the American Chemical Society (ACS). The purpose of the study was to understand how chemists learned about journal articles. Davis defined a referral URL as a "web address that directs (or refers) a browser to another address" (p.327). Defined more simply, referral URLs are the web addresses users visit prior to coming to the site of which is being studied with TLA. In Davis's (2004) study each referral was categorized by referral type (article link, bibliographic database electronic journal list, etc.) and referral domain. Davis used this information to explore underlying patterns to the paths that chemists take to journal articles. He found that individuals were referred to the ACS website infrequently and 70% of users' search originated from one domain.

Wang, Berry and Yang (2003) used TLA to analyze longitudinal query data from an academic website in order to identify problems of web users and to better understand users' query behavior. They reported data on the average query length, distribution of words, frequency of terms and co-occurrence preference for terms. Co-occurrence preference was determined used the following mutual information statistic:

$$I(w_1, w_2) = \ln \frac{P(w_1, w_2)}{P(w_1)\, P(w_2)}$$

where $P(w_1, w_2)$ is the relative frequency of the word pair, and $P(w_1)$, $P(w_2)$ are probabilities estimated by the relative frequency of the two words. The researchers found that misspellings occurred in 26% of the queries and the terms could be organized based on 8 categories. The researchers argued these categories could be used to reorganize the academic website for improved user searching.

Transaction logs use generally use IP address information to identify users. This makes it difficult to identify individual users from groups of users, because some IP addresses are not static and other IP addresses belong to public computers which can be used by multiple people. Transaction logs are limited because they cannot capture actions on the client side and miss other elements of the searching process (Wolfram, Jansen, Rieh, Spink, & Wang, 2005). These issues with TLA have been documented by Harley and Henke (2007) and others. Despite these drawbacks, Jansen and Pooch (2001) argue, "... if one knows and accepts the limitations of TLA, it can be beneficial for understanding the system itself and the user interactions during the search process" (p. 236).

Another method that can be used in the maintenance phase is content analysis of web pages to insure that systems meet standards of usability and design. Areas of inquiry can include whether the Web site provides adequate navigation, whether it provides alternate means of viewing web content for disabled persons, whether it has flexible or static page formatting (Nielsen, 2005).

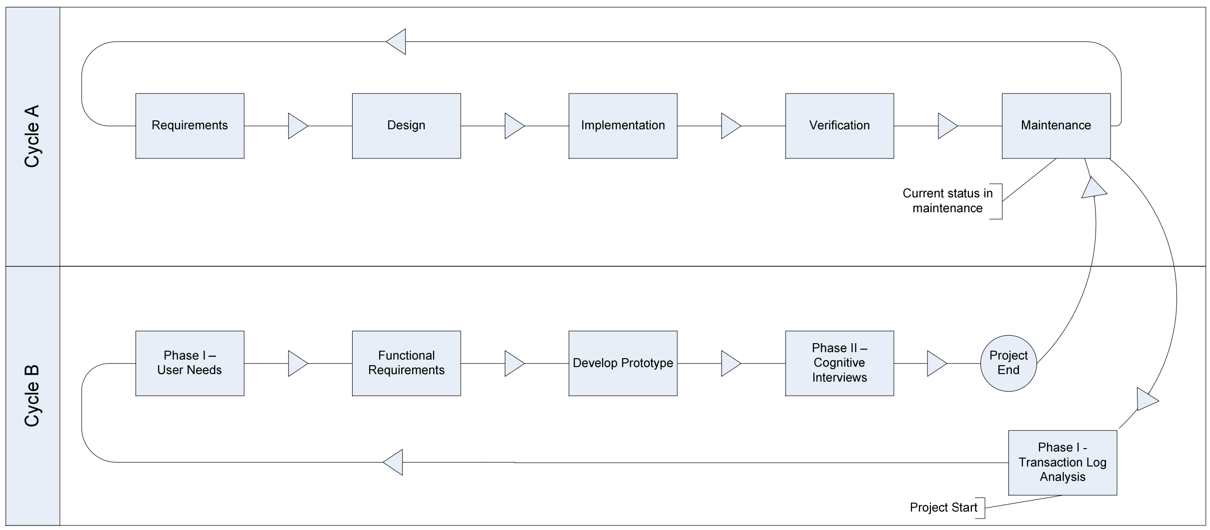
In addition to the previous methods mentioned a combination of methods can be used to evaluate effectiveness of current systems. The Gateway to Educational Materials (GEM) has done a series of evaluations to assess the effectiveness of their digital library for educators. In the first year evaluation, the developers wanted to determine how easy the digital library was to use, if educators were spending their time efficiently during their visits, and if the website was usable by educators who were inexperienced with the

Web (Fitzgerald, Branch, Williams, & Lovin, 2000). In the second year evaluation, the developers wanted to further investigate aspects of the system that might need improvement (Fitzgerald, 2001). They employed a series of methods to discover the answers to these questions including usability testing with novice and expert users, interviews, surveys, focus groups, online surveys, and content analysis. In another example of multi-methods, Yee, Swearingen, Li, and Hearst (2003) investigated whether users preferred a faceted category interface to a standard interface for image searching in the Thinker collection of the Fine Arts Museum of San Francisco.

Following the models provided by these studies I used a multi-method approach to investigate the research question, "in what ways can digital library collections better meet the needs of K-12 educators in their retrieval and use of Web based video material". In particular, since an online video repository currently exists at nasa.ibiblio.org, this research focused on iterating through a cycle of collecting requirements, building a prototype from the requirements and gathering feedback on the prototype from users. Focus on this cycle suggests using methods aligned with the maintenance, requirements, design, and verification stages of the waterfall model (Figure 3.1, Cycle A). The research for this study was divided into two phases (Figure 3.1, Cycle B). The first phase of the research corresponds to the maintenance stage of the waterfall model and used TLA to determine how the current system was being used and if there were any specific lessons which could be learned from how users interacted with the system. Also in the first phase of research an online survey was conducted to assess the specific features educators desired from Web based video library systems. This step matched with both the maintenance phase and the requirements phase of the systems development life cycle. In an intermediate step, which matched the design and implementation phases of the waterfall model, the survey and TLA results were used to develop a set of functional requirements and inform the redesign of the nasa.ibiblio.org interface. The second phase of the research represented the verification stage of the waterfall model; it used a combination of interview and cognitive walkthrough methods to assess how educators interacted with the prototype system and determined if there were any additional requirements not revealed by the first phase of research. The purpose of the second phase of research was to get feedback on prototypes from users in preparation for the maintenance phase and the next iteration of the cycle.

In phase one of this research it was important to understand the requirements educators have for Web based video library systems, the mental models educators have of search and a deeper understanding of how online video fits into their current work practices. This stage applied TLA to understand how online video was currently being searched and retrieved by educators in the nasa.ibiblio.org Web based video collection. Data gathered from an online survey was used to understand some of the features educators desired from their Web systems.

Figure 3.1 Comparison of systems development life cycle to NASA ibiblio research project Cycle A. Normal NASA Educational Media Archive systems development life cycle, current status in maintenance. Cycle B. This research project starts with understanding current use of the system. At the end of the project the status returns to the maintenance phase.



Educators can enter the Web site through direct links, search engines and through the provided Web site navigation. With both direct links and search engines users can begin their exploration of the site from any page. Direct links and search engines may also allow users to download videos without interacting with nasa.ibiblio.org Web pages at all. In the case of Web site navigation users are provided with directed paths and must navigate through the hierarchy presented earlier in figure 2.5. Previously the digital library provided limited browsing access to the collections (refer to Figure 2.6). Educators who came to the web site needed some prior knowledge of the video they were searching for because videos on the index page were organized by NASA program and not by topics which might be closer to the teaching task. Similarly, the view within a NASA program provided limited browsing access giving users only broad program descriptions and title information for users to select (Figure 3.2). The previous design of the system forced users to go at least two levels deep to get keyword and description information for each video (Figure 3.3). To retrieve videos in this design, users must wade through a morass of textual information to determine what is relevant to their search. (The navigational structure of the previous Web site was described in the Digital Library Interface Design section).

TLA was chosen for use in the first phase of research because of its non-intrusive nature, its relatively low cost, its ability to collect a large amount of data and for the way it complements some of the weaknesses of the other methods used in the study. This study modeled its data collection on the work of Davis (2004) and Wang, Berry and Yang (2003). TLA data of user interactions with nasa.ibiblio.org were collected from July 1, 2006 until May 31, 2007. Two different methods were devised for collecting TLA data.

The first method relied on using preset Urchin[11] software to collect referral URL information. In this preset configuration Urchin presents a user interface for interacting with transaction logs which have been collected in the combined log format. The combined log format collects information on:

- the host which made the request
- identity of the client program making the request (if known)
- identity of the user making the request (if known)
- a date for the request including a time stamp
- the request method (HTTP GET or HTTP POST)
- the item requested, the status code of the request
- number of bytes in the request
- the URL which referred the user to the site and
- the Web browser or platform used to access the site.

[11] http://www.google.com/analytics/urchin_software.html

Figure 3.2 Screenshot of NASA SCI Files™ listing

Figure 3.3 Screenshot of video keyword and description information

This allows us to count the number of referrals from other Web sites. Referral URLs for online video in the nasa.ibiblio.org collection were analyzed to understand the different paths educators take to retrieve online video. Referral URLs provided data on the primary domains educators' searches originated from and were classified by type of domain (search engine, higher education, K-12 education, digital library, government agency, etc). In addition to using Urchin, TLA information was collected directly from nasa.ibiblio.org by modifying the Web pages to record user clicks, IP addresses and search terms.

In the second TLA method, pages were modified to contain a combination of PHP: Hypertext Preprocessor (PHP) scripting, a common language for developing Web pages, and a MySQL® database to record user information. This additional method of collecting TLA data was necessary because Urchin data included downloads from the open-video.org Web site and also did not separate out robot activity but the focus of this study was just on the nasa.ibiblio.org Web site. PHP variables were created on the various Web pages and when a user clicked on a specific page those variables were submitted to the database by adding the values for each variable to the address string. For example if a user requested to download the video "Ahead Above the Clouds", first the user's IP address would be captured in PHP variables then using the redirect function the location URL for the video, the video ID and the format of the video would be passed to next page. A truncated example URL follows: "…redirect.php?locationURL=…NASAConnectAheadAboveTheClouds.mpg&videoid=6000&format=MPEG-1". At the next page the user's IP address, the video ID and the format of the video would be inserted into the database along with the action "downloaded a video". The second method for collecting TLA was used to count the number of video downloads, the number of NASA program index page views, the number of video title views, the number of video metadata views, and to document the users searches of the Web site.

Analysis of query terms from the nasa.ibiblio.org collection was performed to investigate questions similar to those explored by Wang, Berry, and Yang (2003). In particular an analysis was undertaken to investigate the frequency of misspellings in search terms, the ratio of English search terms to Spanish search terms and to establish if any broad topic categories could be developed from the of queries entered by users. Combining these two sources of data was designed to provide a fuller picture of activity on the Web site.

To augment the TLA in phase one, an online survey was conducted to explore the features educators desire from Web sites which provide Web based educational materials. Of the methods available to use, the survey method was chosen because of the relatively low cost of the research method, the ease of collecting information from the targeted populations of the study and the way this method complements some of the weaknesses of the other methods used in this study. Despite some of the concerns raised by Harley and Henke (2007) about the potential bias of online surveys, we thought that any sample bias could be accounted for if the results were triangulated with a variety of data sources. We therefore compared the results of the survey to previous research, the TLA results and the findings from phase 2. We adopted the survey questions developed by Hanson and Carlson (2005) and CPB (1997) which were relevant to this study. The purpose of the survey was to explore educator use of online video, determine the related resources useful in conjunction with online video and collect information on the design features educators desired from Web based resources (see Appendix A: Online survey). The survey collected basic demographic information on the participants, the types of Web resources educators used for planning and instruction, the frequency of using various educational resources, and some of the features which make educational Web sites useful to educators.

We were also interested in the challenges educators face when incorporating Web resources and determining some of the features educators' desired of their retrieval systems so features could be implemented into a prototype system for further testing. After developing the online survey in the commercial survey software SurveyMonkey.com, links to the survey were placed on the open-video.org and nasa.ibiblio.org web sites (see Appendix B: Web page introduction to survey). The original recruitment procedures for the online survey were aimed at recruiting users of the nasa.ibiblio.org collection; after not having much success in recruiting educators through that method the procedures were revised to include other populations. Emails explaining the purpose of the survey and a link to the survey were sent to the following groups: contacts from the Brown and Bowers (2006) focus group who agreed to participate in the follow-up study, field representatives of NCwiseowl.org, NC educators from NASA’s Educational Media Archive listserv, UNC Chapel Hill students in the School of Information and Library Science, UNC Chapel Hill students in the School of Education, school librarians in the NC community and library media specialists in the NC community (see Appendix C: Email introduction to the survey). The emails were meant to target interested educators from each of the groups included in the expanded efforts.

The NCwiseowl field representatives were chosen because the TLA had revealed the NCwiseowl.org web site to be a digital library designed for educators to use to access the nasa.ibiblio.org content. UNC Chapel Hill students in the School of Information and Library Science and UNC Chapel Hill students in the School of Education were targeted in an effort to recruit educators who were pursuing additional degrees or who were taking continuing education classes. School librarians and library media specialists across the state of NC were targeted because school librarians and library media specialist often teach in the classroom and have firsthand knowledge of a variety of video information needs. Lastly NC educators from the NASA Educational Media Archive were contacted; these educators were either members of NASA explorer schools or educators who had participated in previous NASA workshops describing NASA’s educational videos and materials. Overall the expanded sampling techniques strived to recruit educators who had experience with NASA educational materials and educators from the NC community. The purpose of these recruitment efforts was to retain the participants in the second phase of the research and to interview these educators face-to-face.

In the intermediate step, the results from the TLA and online survey were analyzed. During this step, functional requirements for the system were developed by compiling the findings from previous research, the focus group, TLA and the survey data. After the findings were compiled a series of design decisions were developed to meet educators' needs. These design decisions were the specifications for the changes which would be implemented in the prototype system. The design decisions were ranked in terms of importance and feasibility of developing given the limited resources and time available. Highly ranked design decisions were implemented into the prototype system.

Once the changes had been implemented into a working prototype, the system was tested to identify surface problems which need to be corrected. First, I conducted a variety of commonly performed tasks which were meant to uncover any bugs in the performance. After correcting them, the system was pilot tested with 3 users. The second round of testing served not only to find any remaining problems with the system but also as a means to refine the tasks for the second phase of the study.

After the prototype was developed and pilot tested, the second phase of research was conducted to explore users' reactions to the changes and collect any additional requirements. In particular, we wanted to observe educators' use of the prototype tools and affordances and how they used them in searching and browsing tasks. Subjects were recruited to participate in the second phase of the research using two forms. (See Appendices D: Letter To Previous Participants, E: Introductory Email Letter to Recruit New Subjects, F: New letter to recruit educators from South Carolina, and G: New letter to recruit educators from Durham Public Schools). Because participants from phase one elected not to participate in phase two I had to expand the pool from which participants were recruited.

The second phase used a combination of interview and cognitive walkthrough methods. The two methods were combined because together they provide the opportunity to ask specific questions about the interface, give subjects a chance to gain hands-on experience, and allowed me to observe how subjects used the interface. The combined method also had the advantage in that it did not restrict user comments to asking them to recall past interactions. Instead it provided the opportunity for subjects to provide immediate feedback on features which they found to be helpful or unhelpful. Tasks for the second phase of research were designed to collect data on each of the design decisions implemented in the prototype (see Appendix I: Phase two script and interview questions). Variation in tasks came about from participant preferences, all the tasks were described to the participants and they were allowed to the select the initial and subsequent tasks they desired to perform. If the participant did not select a task I provided one for them by following the interview script. Additionally, care was taken when developing probes for the interview and cognitive walkthrough stage to make sure the language in the probes was free from bias. During the second phase demographic data was collected using the same demographic questions from phase I for subjects who hadn't participated in the survey. During each session a laptop was used to display the prototype Web pages. An office headset and Camtasia software were used to record participant comments and on-screen actions. During the sessions, any problems educators had were noted, and comments and suggestions were elicited. Qualitative data analysis was done on each of the cognitive walkthroughs using Nvivo. In the analysis, each interview went through a process of open coding and themes were developed from the comments of all the subjects. The phase 1 survey and phase 2 walkthrough study were approved by the University of North Carolina at Chapel Hill Institutional Review Board.

Research Bias and Validity

Overall the breadth and variety of methods chosen were in an effort to minimize research bias and maximize the validity of this research study. For qualitative studies 4 criteria are used to evaluate trustworthiness: credibility, transferability, dependability, and confirmability (Lincoln & Guba, 1985). Next each criterion is used to frame the discussion of strategies applied in this study to ensure it was of high quality.

Credibility

Lincoln and Guba (1985) describe the implementation of credibility as follows: first, the methods for conducting the inquiry should increase the “probability” that the study is found “to be credible” and secondly, the “constructors of the multiple realities being studied” should “demonstrate the credibility of the findings” (p. 285). Merriam (2002) stated credibility can also be determined by the rigor with which the study was conducted.

For this study its rigor was insured by adopting an interview protocol (see Appendix I: Phase two script and interview questions). Each question in the protocol was designed to be neutral and informative about the specific task. The protocol adopted a regular procedure for the cognitive walkthroughs and was designed to gather the same information from the participants while allowing other topics to emerge through the semi-structured format. Rigor was infused in the process also through data collection and data analysis. In the collection phase, Camtasia studio was used to record on screen actions and interview participant comments. In the analysis phase, interviews were transcribed verbatim for further analysis.

According to Lincoln and Guba (1985), triangulation is another way to increase the credibility of a study. Using three methods, this study investigated how educators search for and use online video in the classroom. A large part of the results for each of these methods was in agreement with each other and with the literature, suggesting that the study is credible.

Another issue which affects the credibility of the study is sample size. The rules for sample sizes differ between probabilistic sampling and purposeful sampling. The purpose of probabilistic sampling is to guarantee the results up to the limits of the confidence measure, whereas with purposeful sampling the object is to describe the richness of the content. According to Patton (1990), "*there are no rules for sample size in qualitative inquiry*" and "…*validity meaningfulness, and insights generated from qualitative inquiry have more to do with information- richness of the cases selected and the observational/analytical capabilities of the researcher than with sample size*" (p. 184, emphasis in the original; p.185, emphasis in the original). Given that the number required for sample size is open to interpretation, this study opted for a sample size that was diverse in population and was feasible in terms of effort required in data analysis.

In the cognitive walkthrough portion, 12 participants were selected to participate in the interviews. The selection criteria were that the participants had to have some experience teaching and incorporating Web materials into their classroom. The University of South Carolina at Columbia and the leader of a NASA workshop designed to introduce educators to NASA educational materials served as liaisons for contacting participants of this study. The participants represented good candidates to participate in the study because they met the selection criteria and were from a variety of states and schools across the country. However, the teachers present at the workshop are also likely to be more knowledgeable and motivated than the general population of educators. Availability and willingness also played a role in the sample size. At the workshop only 9 out of the 30 participants agreed to participate in the study. In the case of the University of South Carolina, the number of people invited to participate in the cognitive walkthrough portion of the study cannot be determined because the liaison used a variety of listservs to contact potential candidates. The final number of participants from South

Carolina was 3. The sample size, although small, still provided an information-rich dataset and was in line with the purposes of this study.

Transferability

This criterion refers to the ability to apply findings to different situations, groups and/or to different settings. Lincoln and Guba (1985) argued that researchers themselves can only provide the “thick description” and that it is up to the researchers who follow to evaluate if the transfer is possible given their situation. This study implemented “thick descriptions” in the discussion section by providing detailed quotations from the participants. By providing participant demographic information and the rich detail of the participant responses, this study attempted to, as Holloway stated, “[provide] a clear picture of the individuals and groups in the context of their culture and the setting in which they live” (p. 154). Ponterotto (2006) goes further with the concept of thick description saying, “thick description leads to thick interpretation, which in turn leads to thick meaning ” (p. 543). Essentially this means that a densely described research study lends itself to the interpretation of the researcher which is densely described, and to a meaning for readers which is fully engaged and understanding of the overall context of the study.

Dependability

Lincoln and Guba (1985) define dependability as “means for taking into account both factors of instability *and* factors of phenomenal or design induced change” (p.299, emphasis in the original). This criterion relates to the study results being replicated and consistent. There is much debate about the ability of qualitative studies to be repeated and to be consistent; it is widely known that in qualitative research the same data may have multiple interpretations (Merriam, 2002).

Dependability in this study was assessed through the external audit method. With this method the researcher leaves an “audit trail” which makes the records of the study (field notes, transcripts, and other materials from the data analysis process) available for examination. For this study, TLA data, online survey data, and Camtasia recordings have been archived by the researcher. In this case the dissertation committee checks both the “process” and the “product” of the study (p. 318, Lincoln & Guba, 1985). This system serves as a check to make sure the research meets the standards of the University, and the profession at large.

Confirmability

Confirmability also depends on the “audit trail”, or the record of raw data left by the researcher. The confirmability criterion suggests that the study should attempt to minimize research bias. Eisner (1991) defines structural corroboration as, “a means through which multiple types of data are related to each other to support or contradict the interpretation and evaluation of a state of affairs” (p. 110). Structural corroboration introduces the idea that not only does richness of content matter but data should be confirmed by “recurrent behaviors or actions” (p. 110) This research study attempted to meet the confirmability criterion by leaving an audit trail of the raw data which consists of a record of the process of collecting data and the product of those efforts. Triangulation of methods used in the study also enhances confirmability because the different pieces of information collected from each method must relate to each other, forming a coherent whole. Lastly this study relied on actions which were reoccurring between participants to produce the themes reported in this research. Using this method to produce the themes lessens the likelihood that these themes are outliers to the question of how educators search for and use online video.

Conclusion

The previous criteria describe how this research study attempted to minimize the effects of bias, and maximize the validity by adopting a series of rigorous protocols for each stage of the research. Based on four criteria (credibility, transferability, dependability, confirmability), this discussion was meant to describe how the validity and trustworthiness of the study was maintained. In the next chapter, we present the findings from the TLA, from the online survey, the functional requirements and design decisions which were developed, and the findings from the combined interviews and cognitive walkthroughs.

CHAPTER IV

RESULTS

The results chapter is divided into five sections. The first two sections analyze the Web logs and the online survey, the third section presents the design decisions and functional requirements which were created from the findings of the first phase of the research, the fourth section covers a qualitative analysis of the interviews and cognitive walkthroughs and the fifth section summarizes the overall findings from the entire study.

Transaction Log Analysis

Transaction Log Analysis (TLA) data was collected from nasa.ibiblio.org from July 1, 2006 until May 31, 2007. September 2006 is missing data from September 9, 2006 until September 18, 2006 due to a change in the way PHP variables were implemented by the Web host, this missing data is present in all the tables which relied on the Web pages modified by the PHP scripting[23]. “Adjusted data” represents Web log data for which IP address information of local workstations and known computer robots were removed. To identify computer robots first the number of downloads were counted and grouped by computer IP addresses. From this list of downloads, IP addresses were identified which had a over a hundred downloads for the period in question. Next, IP addresses were input into the http://www.arin.net/whois/ IPLookup system (ARIN is the American Registry For Internet Numbers). For registered robots the system would indicate the IP address in question was a computer robot by the

[23] This missing data affects Figures 4.1, 4.2, 4.3, 4.4, 4.5, 4.6 and 4.7. Figure 4.8 is not affected because it was collected through the preset Urchin software. The missing data also affects Tables 4.1, 4.2, 4.3, 4.4, 4.5, and 4.6.

keyword including the "bot"; additionally, IP address ranges were compared to IP addresses on a maintained list of computer robots (http://iplists.com). If questions still existed about the data (i.e. a large number of downloads and no searches performed) the IP address was also classified as a computer robot. Many of the tables and figures present both adjusted and unadjusted data. As shown in figure 4.1, adjusted video downloads for the nasa.ibiblio.org Web site varied between 1500 and 2000 downloads per month. The mean, median, and standard deviation for the monthly adjusted download data were 1506, 1577, and 784.65 respectively. There was enormous fluctuation especially in the robot activity; analysis of this fluctuation is beyond the scope of this project. Data for Figure 4.1 was collected using the Web pages modified by PHP scripting.

Figure 4.1 Video downloads for nasa.ibiblio.org from July 2006 – May 2007

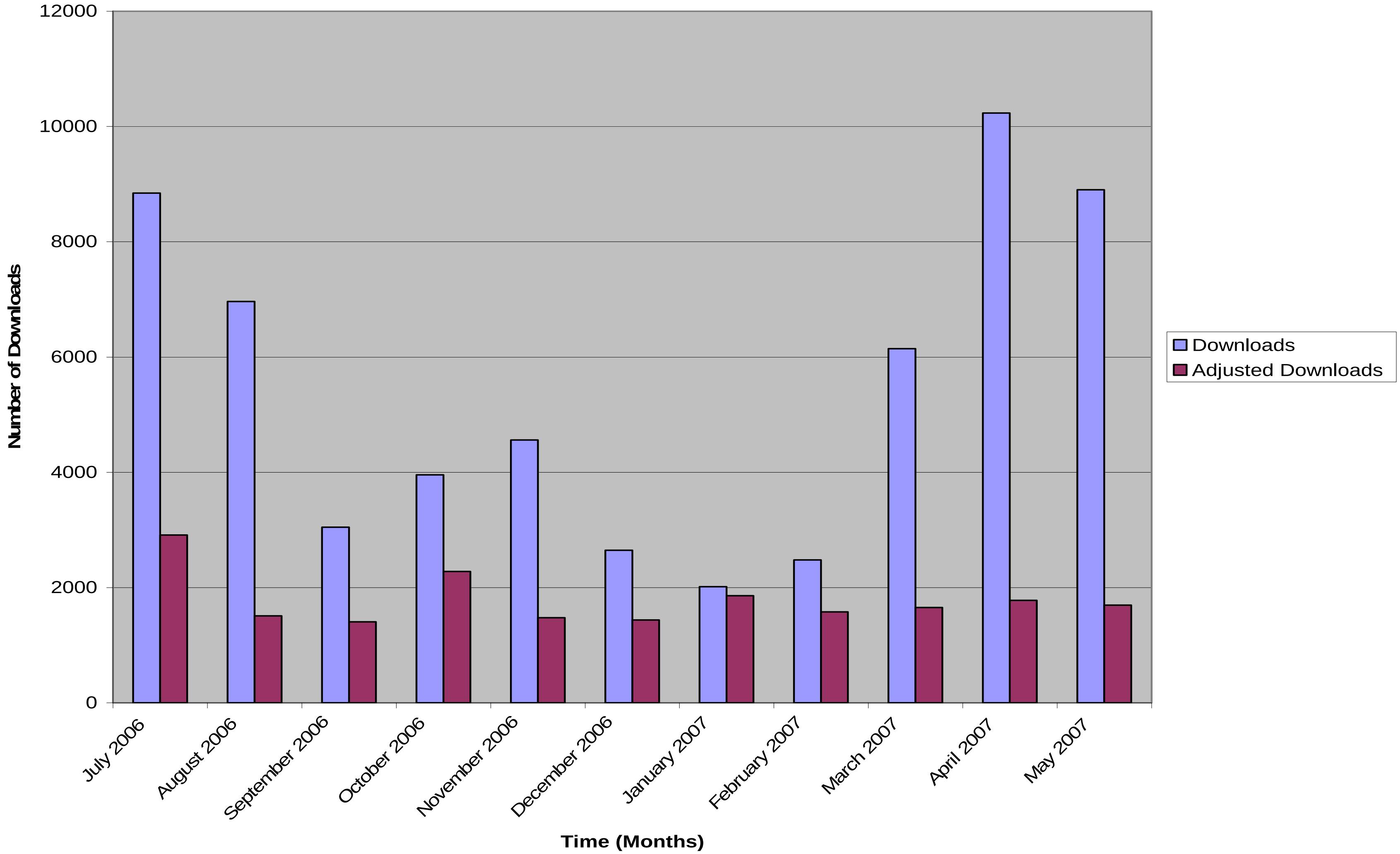


Figure 4.2 highlights the most frequently downloaded video formats. The median monthly adjusted downloads for QuickTime was 439 and for MPEG-1 was 438. Data for Figure 4.2 was collected using the Web pages modified by PHP scripting. Note that some extraneous data points are represented in the data set like MPEG-3, and QuickTime-. This is because the data in this figure represent “requests” for videos and some users requested video formats which were not available in the system. In addition to a small number of extraneous data points there were also some video downloads for which no format was recorded, these are represented by the “blank” category. These extraneous data points are both examples of people modifying variables in the URL.

Figure 4.2 Adjusted downloads by video format for nasa.ibiblio.org from July 2006 – May 2007

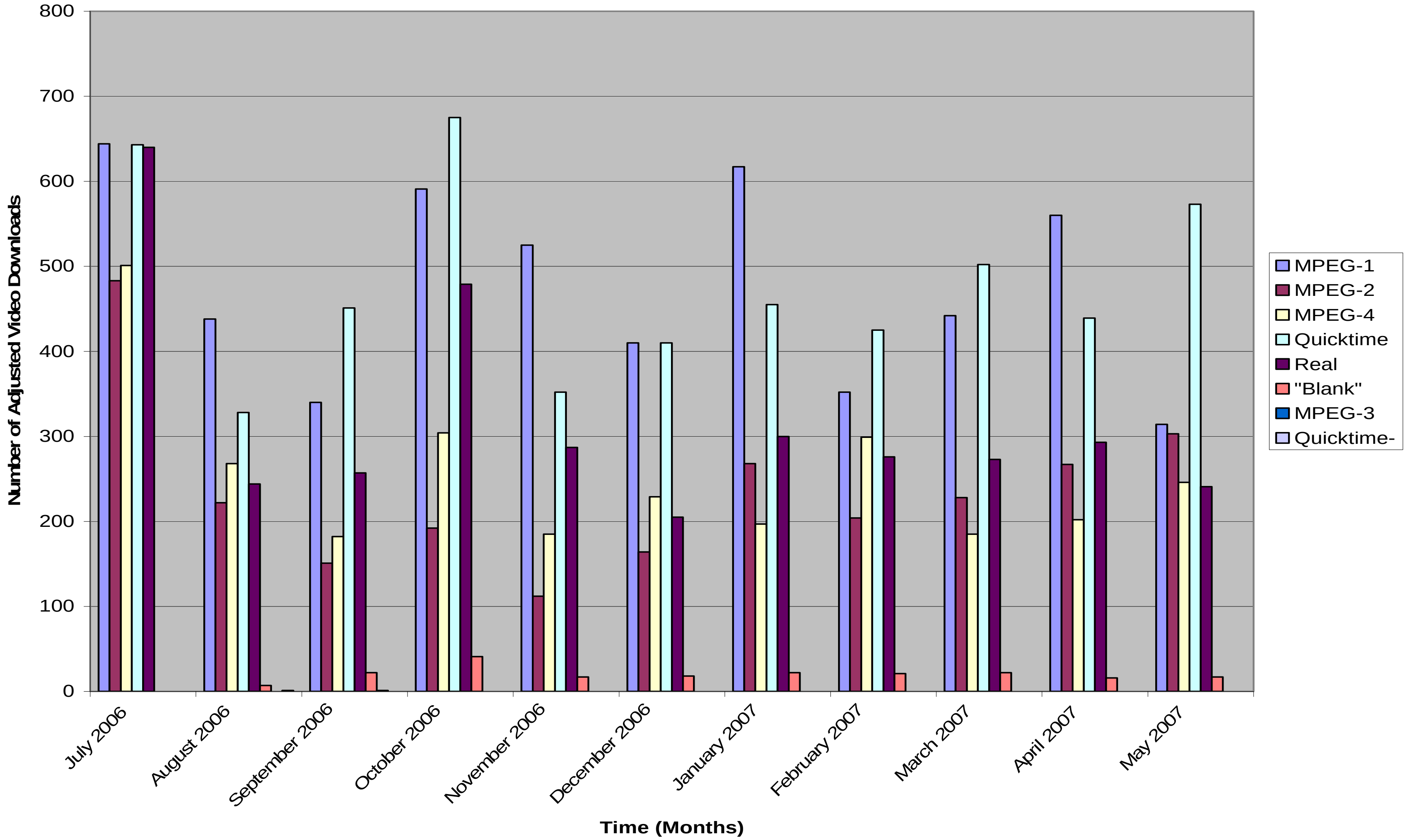


Table 4.1 contains the top ten downloaded video titles organized by NASA program for the period of analysis. Videos from the NASA Sci Files™ and the NASA Connect™ programs were downloaded the most. Data for Table 4.1 was collected using the Web pages modified by PHP scripting.

Table 4.1 Top downloaded video titles by NASA program

NASA Program	Rank	Download Frequency	Video Title
Noticiencias NASA™	1	361	Aurora Boreales
	2	208	El Nanotecnología
	3	161	El Sonido
	4	102	El Ruido de los Aviones
	5	97	Agua en Marte
	6	95	Los Rayos Eléctricos
	7	90	El Electro-Imán
	8	84	El Cielo Azul
	9	81	El Metro
	10	81	El Popcorn
Kids News Science Network™	1	448	Blue Sky
	2	152	Bubbles
	3	125	Nanotechnology
	4	98	Magnetism
	5	81	Lightning
	6	74	Why Airplanes Fly
	7	72	Calcium And Bones 1
	8	71	Northern Lights
	9	70	Floating In Space
	10	66	Wright Brothers
NASA Sci Files™	1	569	The Case of the Barking Dogs
	2	421	The Case of the Electrical Mystery
	3	375	Hurricane Energy And Coriolis Effect
	4	290	The Case of the Shaky Quake
	5	198	The Case of the Powerful Pulleys
	6	181	The Case of The Great Space Exploration
	7	170	The Case of the Mysterious Red Light
	8	170	The Case of The Zany Animal Antics
	9	164	The Case of the Unknown Stink
	10	153	The Case of The Ocean Odyssey
NASA Connect™	1	537	AATC - Hurricane Hunters
	2	430	Ahead Above The Clouds
	3	282	Geometry and Algebra - Glow With the Flow
	4	159	Dancing In The Night Sky
	5	155	Virtual Earth
	6	154	Ancient Observatories: Timeless Knowledge
	7	148	The Right Ratio of Rest: Proportional Reasoning
	8	130	Better Health From Space To Earth
	9	112	Rocket to The Stars
	10	111	Shapes of Flight

NASA Destination Tomorrow™	1	539	Episode 2
	2	109	Episode 20
	3	97	Episode 3
	4	78	Episode 10
	5	67	DT2 - Icing Research Tunnel
	6	66	Episode 17
	7	63	Episode 12
	8	62	Episode 4
	9	51	Episode 5
	10	51	Episode 6

Figure 4.3 provides data on how many times the index pages of the five individual NASA programs were viewed for each month. This data serves as another measure to gauge the activity related to each individual collection by showing how many times users viewed collections at the NASA program level. At this level users can see information about the NASA program, the audience the NASA program is geared to, and a list of video titles in the specific NASA program. The index page for each NASA program serves as a gateway for viewing individual video titles for that particular program. The most viewed collections were the NASA Sci Files™ (grades 3-5) and NASA Connect™ (grades 6-8). The views of the NASA Sci Files™ index page had a monthly adjusted median value of 548. The views of the NASA Connect™ index page had a monthly adjusted median value of 403. Data for Figure 4.3 was collected using the Web pages modified by PHP scripting.

Figure 4.3 Adjusted views of NASA program index pages on nasa.ibiblio.org from July 2006 – May 2007

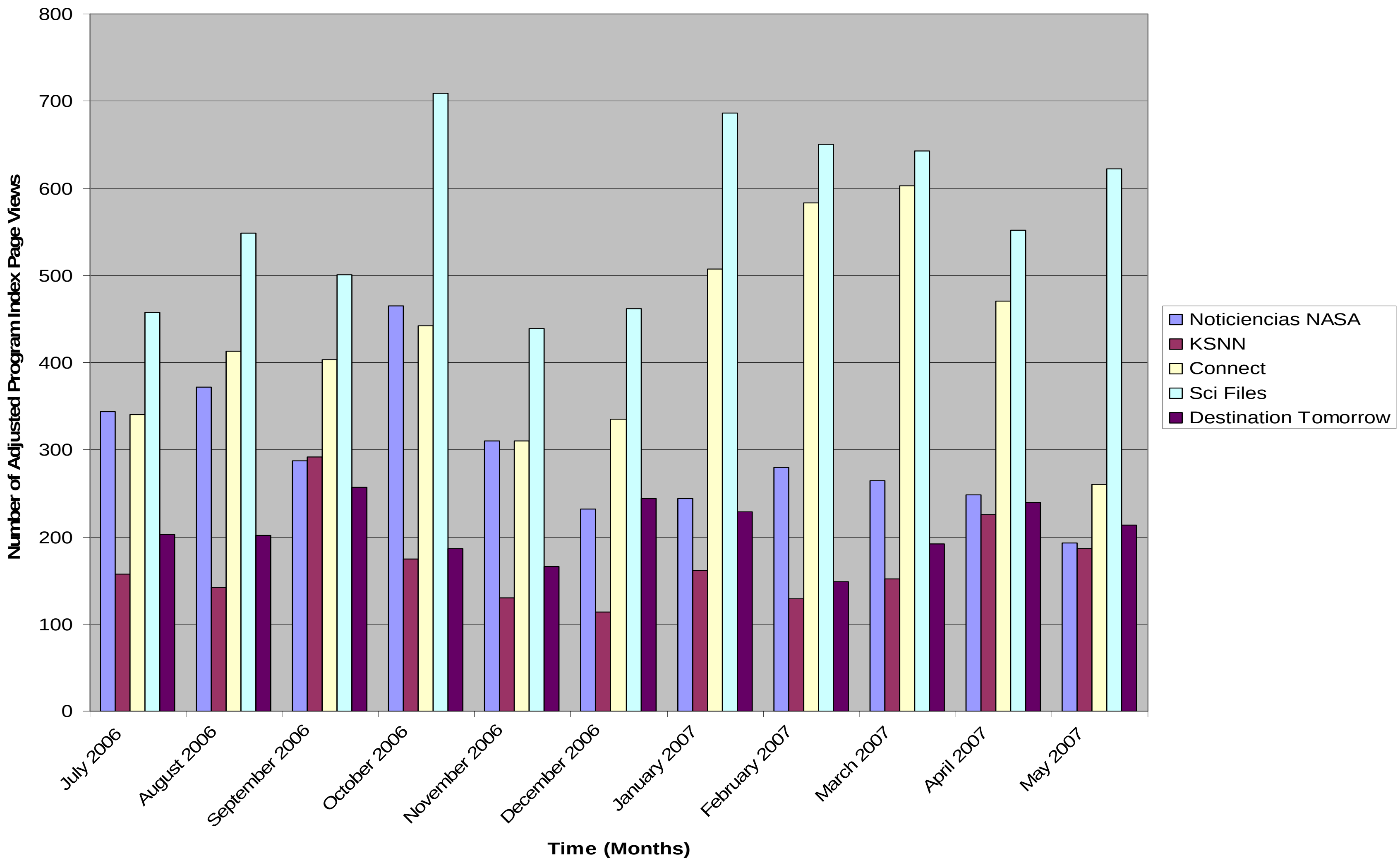


Figure 4.4 provides data on how many times users viewed individual video titles for the nasa.ibiblio.org Web site. A view of the individual video title is different from a download in the sense that this data reflects the number of times users visited the video title pages. From the video title pages users can follow links to video metadata or the links for downloading the video titles. This data appeared less spread out than the data for downloads, with the data for adjusted video title views having a standard deviation of 493.95. The monthly adjusted video title views mean and median were 1007.77 and 1068 respectively. These lower values indicate that there is generally more downloading activity than views of information about the video titles in a given month. As mentioned previously, in the methods section users have a variety of means for accessing Website content including direct links, search engines in addition to the Web site navigation. Data for Figure 4.4 was collected using the Web pages modified by PHP scripting.

Figure 4.4 Video title views for nasa.ibiblio.org from July 2006 – May 2007

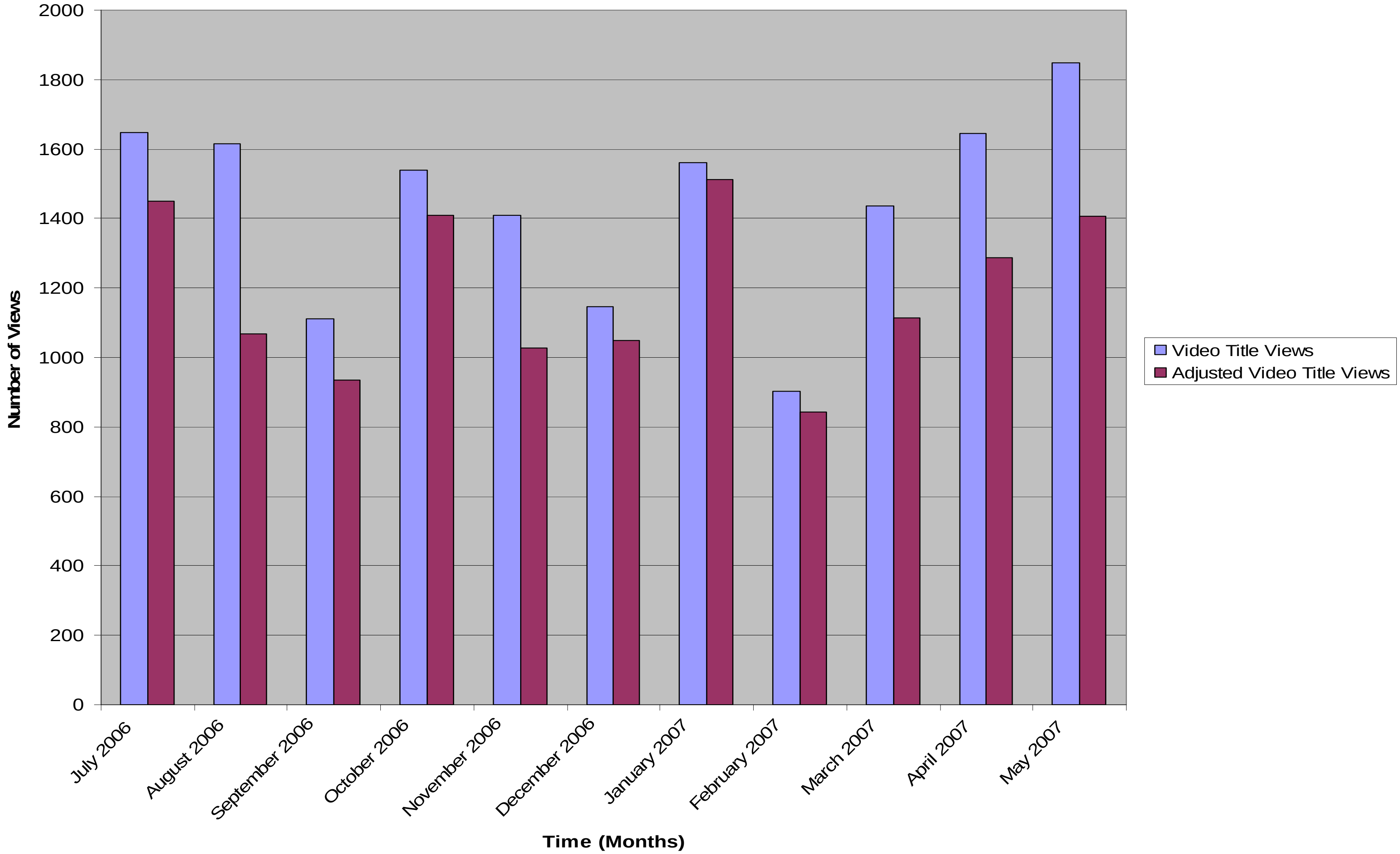


Table 4.2 provides data on the most frequently viewed index pages for video titles. The viewing activity associated with the Noticiencias NASA™ and the KSNN™ video series is not shown in the table. This is because, with the Noticiencias NASA™ and the KSNN™ programs, the title keyword and metadata information is available immediately with all the video titles residing on the main program page (See figure 2.5). As a result, the activity recorded for these pages was the result of robot crawls and not human activity. The data for these specific pages were the only ones affected by the difference in web structure described earlier. In Table 4.2 NASA Connect™ and NASA Sci Files™ had the most frequently downloaded top ten video titles. Data for Table 4.2 was collected using the Web pages modified by PHP scripting.

Table 4.2 Top viewed video title pages by NASA program

NASA Program	Rank	View Frequency	Video Title
NASA Sci Files™	1	680	The Case of the Barking Dogs
	2	426	The Case of the Electrical Mystery
	3	384	The Case of The Great Space Exploration
	4	252	The Case of the Shaky Quake
	5	228	The Case of the Mysterious Red Light
	6	228	The Case of the Galactic Vacation
	7	227	The Case of The Zany Animal Antics
	8	217	The Case of the Powerful Pulleys
	9	203	The Case of the Biological Biosphere
	10	198	The Case of the Inhabitable Habitat
NASA Connect™	1	530	Ahead Above The Clouds
	2	319	Geometry and Algebra – Glow With the Flow
	3	266	Dancing In The Night Sky
	4	257	Ancient Observatories: Timeless Knowledge
	5	249	Virtual Earth
	6	224	Better Health From Space To Earth
	7	217	The Future of Flight Equation
	8	206	Rocket to The Stars
	9	205	World Space Congress
	10	200	The Right Ratio of Rest: Proportional Reasoning
NASA Destination Tomorrow™	1	712	Episode 2
	2	309	Episode 20
	3	200	Episode 3
	4	169	Episode 17
	5	168	Episode 4
	6	164	Episode 18
	7	155	Episode 15
	8	151	Episode 16
	9	140	Episode 12
	10	134	Episode 5

Figure 4.5 provides data on the number of times users requested additional video metadata. This graph tracks the number of times users asked to see title, keyword, description and duration information from the Web site. The mean, median, and standard deviation of the monthly adjusted metadata views were 1103.92, 1090, and 746.11 respectively. These numbers are slightly higher than the monthly adjusted statistics of the video title views, suggesting users navigate to video metadata more frequently than they do to video title pages. Data for Figure 4.5 was collected using the Web pages modified by PHP scripting.

Figure 4.5 Views of video metadata for nasa.ibiblio.org from July 2006 – May 2007

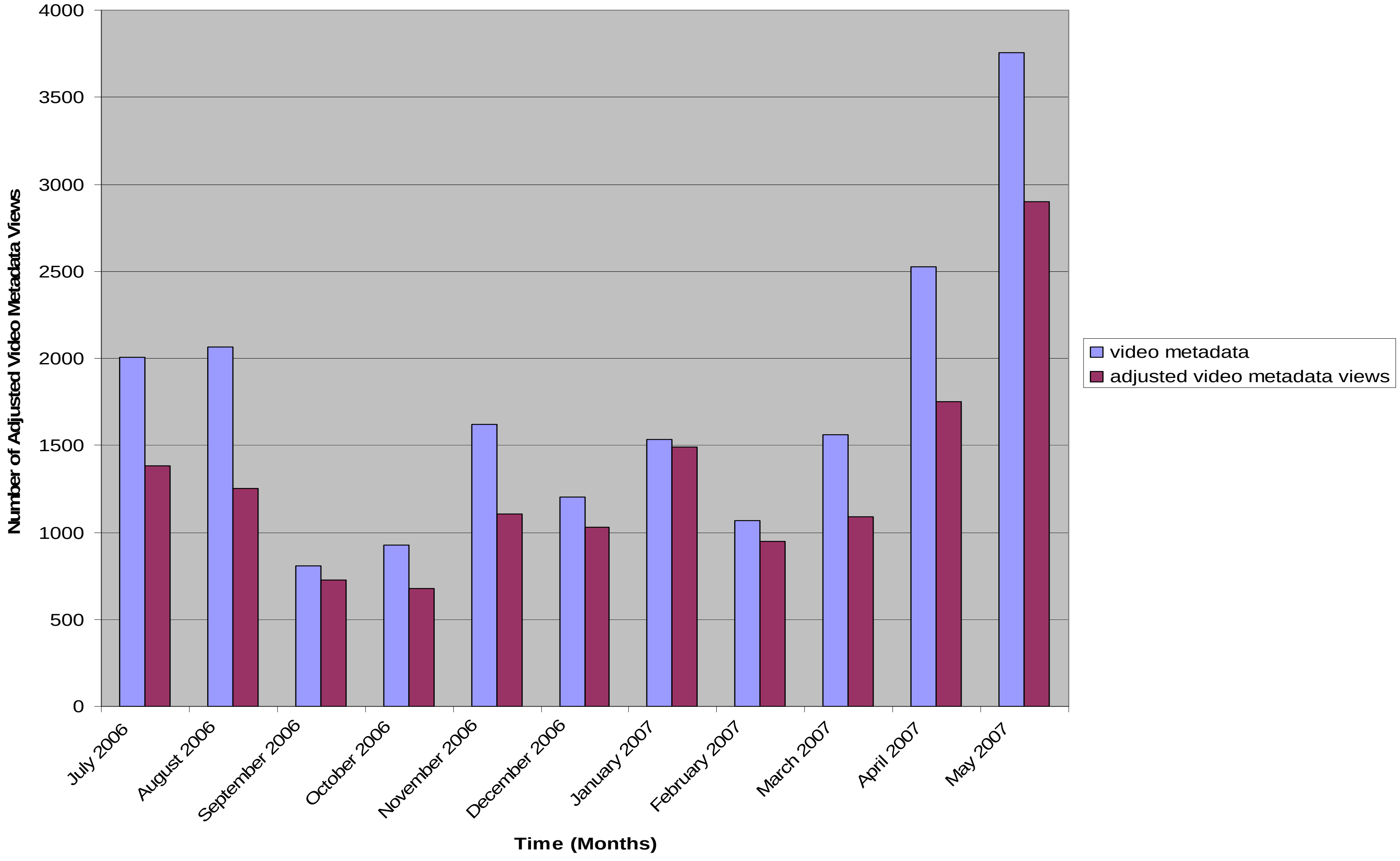


Table 4.3 provides data on the video whose metadata was viewed the most frequently organized by NASA program and video title. Data for Table 4.3 was collected using the Web pages modified by PHP scripting. The Noticiencias NASA™ and KSNN™ programs had the video titles with the most viewed metadata. One reason the Noticiencias NASA™ and the KSNN™ video metadata may have been viewed more is because these programs have one less layer of navigation. The added layer of navigation could have impacted the way users behaved in relation to the different NASA video programs (See Figure 2.5). This finding suggests that flattening the navigation structure might increase overall use of the Web site and make it easier for educators to use the site.

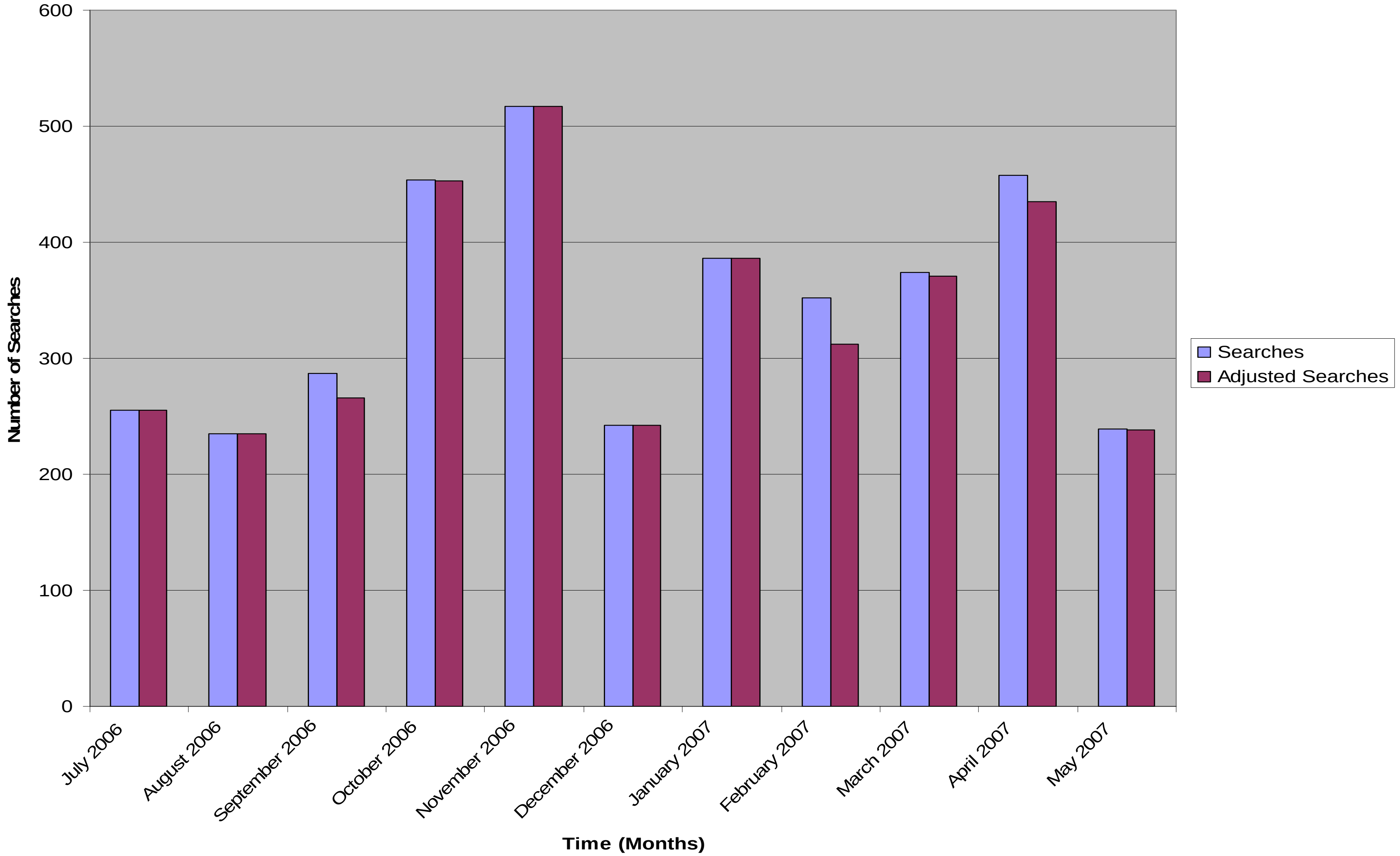
Table 4.3 Top viewed video metadata by NASA program and video title

NASA Program	Rank	Frequency	Video Title
Noticiencias NASA™	1	651	El Internet
	2	513	Las Fracciones
	3	217	Los Rayos Eléctricos
	4	202	Los Números Negativos
	5	200	El Nanotecnología
	6	172	La Ebullición en el Espacio
	7	131	Aurora Boreales
	8	87	El Cielo Azul
	9	83	Un Auto de Control Remoto en Marte
	10	81	Virus de Computadora
Kids News Science Network™	1	323	Atomic Clocks
	2	303	Negative Numbers
	3	205	Popcorn
	4	124	Blue Sky
	5	112	Nanotechnology
	6	92	Bubbles
	7	91	The Internet
	8	84	How Do Space Shuttles Blast Off
	9	80	Aircraft Noise
	10	79	Magnetism
NASA Sci Files™	1	326	Hurricane Energy And Coriolis Effect
	2	63	The Case of the Barking Dogs
	3	34	The Case of the Technical Knockout
	4	34	The Case of The Great Space Exploration
	5	31	The Case of The Zany Animal Antics
	6	30	The Case of the Galactic Vacation
	7	29	The Case of the Biological Biosphere
	8	27	The Case of the Electrical Mystery
	9	26	The Case of the Inhabitable Habitat
	10	26	The Case of the Mysterious Red Light
NASA Connect™	1	157	World Space Congress
	2	88	Ancient Observatories: Timeless Knowledge
	3	76	Ahead Above The Clouds
	4	46	Virtual Earth
	5	44	Geometry and Algebra - Glow With the Flow
	6	43	Better Health From Space To Earth
	7	30	The Venus Transit
	8	29	Dancing In The Night Sky
	9	29	Rocket to The Stars
	10	27	Hidden Treasures: Landscape Archeology

NASA Destination Tomorrow™	1	72	Episode 2
	2	39	Episode 17
	3	38	Episode 3
	4	34	Episode 15
	5	31	Episode 16
	6	31	DT16 - Food Preservation
	7	30	DT16 - Space Food Processing
	8	29	DT15 – Aerobraking
	9	27	DT17 - Eating In Space
	10	27	DT16 - Space Food Preparation

Figure 4.6 highlights searches users performed on the nasa.ibiblio.org Web site. The mean, median and standard deviation for user queries per month were 285.38, 266, and 156.30 respectively. These statistics represent the average monthly use from July 2006 to May 2007. Data for Figure 4.6 was collected using the Web pages modified by PHP scripting. Compared to downloads, video title views and video metadata views, the number of searches performed is relatively small. This significant drop off in numbers could indicate several possibilities. One possibility is users prefer browsing to search; other possibilities are that users don't find the search functionality useful or users know exactly where the resources they need are. In addition to those possibilities other factors which are not known could be contributing to the observed user behavior as it relates to search. Using the manual method of pruning IP addresses led to some searches being removed subsequently making the adjusted and unadjusted numbers unequal. These IP addresses most likely belong to the local workstations using the nasa.ibiblio.org Web site and also computer robots tailored specifically to the website to perform repeat searches.

Figure 4.6 User searches on nasa.ibiblio.org from July 2006 – May 2007



Tables 4.4, 4.5 and 4.6 summarize the download, view of video titles, view of video metadata, and search information from the previous figures and tables.

Table 4.4 Adjusted activities by NASA program from July 2006 to May 2007

		Activity		
		Downloads	View of Video Titles	View of Video Metadata
NASA Program	Noticiencias NASA™	2959	-	4417
	KSNN™	3076	-	4369
	NASA Sci Files™	5973	4200	1813
	NASA Connect™	5521	6064	2594
	NASA Destination Tomorrow™	2038	2806	1158

Table 4.5 Adjusted activities by month from July 2006 to May 2007

		Activity			
		Downloads	View of Video Titles	View of Video Metadata	Searches
Month	July 2006	2911	1449	1383	255
	August 2006	1508	1068	1253	235
	September 2006	1404	936	725	266
	October 2006	2282	1410	678	453
	November 2006	1478	1027	1106	517
	December 2006	1436	1048	1029	242
	January 2007	1859	1513	1492	386
	February 2007	1577	844	948	312
	March 2007	1652	1114	1090	371
	April 2007	1777	1286	1748	435
	May 2007	1694	1406	2899	238

Table 4.6 Monthly summary statistics for each activity

		Activity			
		Downloads	View of Video Titles	View of Video Metadata	Searches
Statistics	mean	1506	1007.77	1103.92	285.38
	median	1577	1068	1090	266
	standard deviation	784.75	493.95	746.11	156.30

Figure 4.7 shows the different types of queries users performed on the nasa.ibiblio.org website from July 2006 to May 2007. A large proportion was searches for specific video titles (9%) and scientific, technological, engineering and mathematical (STEM) concepts (22%). Surprisingly, there was a small portion of searches for the 5 NASA programs (3%). The NASA program searches were duplicating the paths users can take while browsing. This behavior suggests that there may be inefficiency with the way browsing in the Web site is structured, users may not have invested the minimal time to learn the browsing paths, users may prefer searching to browsing or some undetermined behavior is occurring in relation to the search. As expected, there were a considerable number of queries which didn’t fit into the broad categories which eventually served as a focus for the revision of the Web site. For example some of the queries were for celebrities: Jennifer Lopez, Paton Manning (s.p.), and Hillary Duff. These searches were not considered relevant to the Web site. Overall, the rest of the terms in the "other" category did not occur with enough frequency to justify placing them in separate categories.

Figure 4.7 Categories of queries performed on nasa.ibiblio.org from July 2006 – May 2007

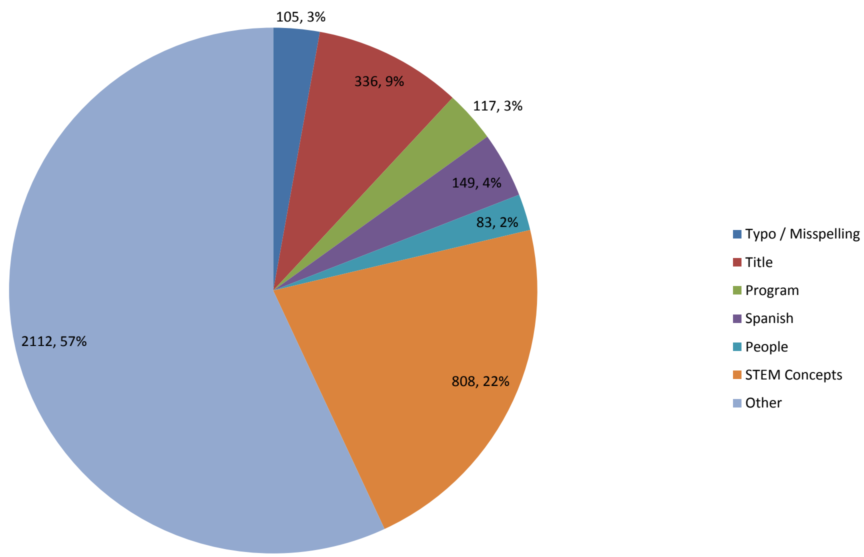


Figure 4.8 shows the domains from which requests were made to the nasa.ibiblio.org Web site from July 1, 2006 to April 30, 2007 were made. Data for Figure 4.8 was collected using the Urchin preset software. The data in Figure 4.8 total 25,586 sessions which did have a referral. This is less than the total number of sessions which did not have a referral (34,841 sessions, these sessions are not shown in the Figure 4.8). As expected, Open Video was one of the top sites which refer users to the nasa.ibiblio.org domain; this is because Open Video serves the nasa.ibiblio.org content as a collection in their digital library and refers users to nasa.ibiblio.org to download the online videos. Other domains which played a large role in referral traffic include Yahoo, NASA, NCWiseOwl and Google. Yahoo, AltaVista and Google accounted for another significant portion of Web log traffic (14%) for the Web site. Referrers 36-780 account for the long tail of referrers who only visited the site one each.

Figure 4.8 Top Referrers to nasa.ibiblio.org from July 2006 to April 2007

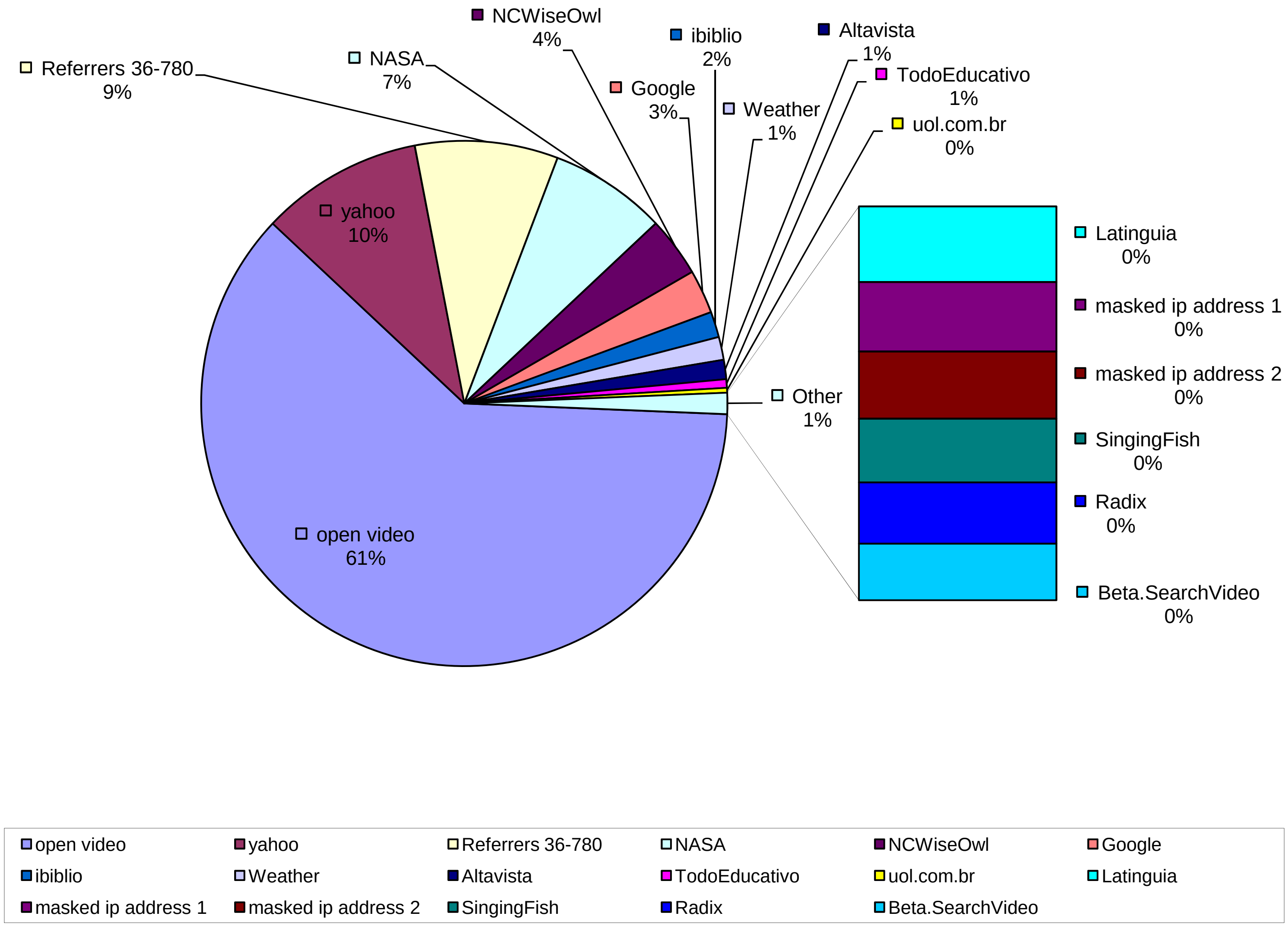


Table 4.7 shows an analysis of all the traffic to the Web site including the traffic for which there were no referrals. The table highlights that non referrals were the largest percentage of sessions (57.66%). Of note are the specific IP addresses which had a large enough count to appear individually and the overseas and Spanish Web sites which used the online videos as well. The individual IP addresses might be explained by computer robot crawls but the more interesting overseas and traffic from Spanish Web sites suggests nasa.ibiblio.org content has some value in countries abroad.

Table 4.7 Classification of Referrer traffic into broad categories

Broad Classification	Percentage of overall traffic
No referral	57.66%
Digital Library	28.21%
Search Engine	6.03%
Long Tail	3.72%
NASA	3.05%
Commercial Web site	0.68%
Overseas and Spanish Web sites	0.45%
Individual IP addresses	0.19%
Total	**100.00%**

The TLA provided several important findings. A variety of digital libraries and search engines were the top referrers to the nasa.ibiblio.org Web site. The most downloaded online video formats were QuickTime and Mpeg-1, while the NASA programs with the most activity were NASA Connect™ and NASA SCI Files™. The only category in which NASA SCI Files™ and NASA Connect™ weren't the top programs accessed was the view of video metadata. In this category NASA Connect™ and NASA SCI Files™ were third and fourth respectively. This category was led by the

Noticiencias NASA™ and KSNN™ programs. Additionally, video metadata views were slightly greater than views of video titles suggesting that users may be entering the Web site from points other than the standards path provided by the Web site.

Online Survey

A total of 43 respondents answered the survey: 3 people did not consent to being in the study; 12 people filled out the survey only partially; 11 people who had not instructed students in the past 3 years and 17 educators who had instructed students in the past 3 years. This analysis focuses on the 17 educators who had instructed students in the past 3 years. For the purposes of this study, the group who had not instructed students in the past 3 years were categorized as participants who had never instructed students. The 11 people who fit into this category will be referred to as "non-educators" and the 17 respondents who had instructed students in the past 3 years will be referred to as "educators".

Demographic Information

Demographic data was collected for all 17 educators and for 10 of the 11 non-educators. Demographic information was not collected for 1 respondent because that person elected not to complete that part of the survey; however the rest of the survey information was complete. The majority of the non-educator group did not meet the criteria for the study. Nine out of 10 non-educators indicated they were students. This group was interested in online video for its entertainment and news purposes. The full results for the non-educator group are beyond the scope of this dissertation (but see Appendix J. "Survey results for non-educator group"). The educator group, on the other hand, was of special interest since their feedback could provide first-hand information about how to improve sites which provide online video for educational purposes. The age distribution of the educator group was evenly distributed between the 18-29 age group (29.41%), the 40-49 age group (29.41%) and the 50-59 age group (29.41%). Ten of the educators were female and 7 of the educators were male. Three of the educators were also in the process of pursuing degrees, with one respondent pursuing a PhD and two pursuing Bachelors degrees. The two educators who were pursuing Bachelors degrees had one year or less experience in the classroom, while the educator pursuing the PhD had 4-6 years experience. The years of experience for the entire educator group was evenly distributed between educators who had 4-6 years experience (23.53%), educators with 11-20 years experience (23.53%) and educators with 21 years or more (23.53%).

Fifteen educators reported they were of Caucasian or white race/ethnicity. Eleven educators indicated the majority of their students were white. Fourteen of the educators taught their courses in North Carolina. The other 3 educators taught in Virginia, Pennsylvania and the United Kingdom. Sixteen out of 17 educators taught in a formal classroom. A formal setting was defined as a school classroom whereas an informal setting was defined as places like boys clubs, girl clubs, schooling in the home, or at planetariums. Five out of 17 educators surveyed had taught multiple grade levels. The most frequently taught grade range was sixth through eighth grades.

Twelve of seventeen educators had 25% or fewer students with special needs at their school. Nine of seventeen educators' students received less than 25% Individualized Education Programs (IEPs). Five out of 17 educators indicated that free or reduced price lunch was not applicable to their student population. Eight of 17 educators had less than 25% of their students classified as gifted or talented. Full demographic information is available in Appendix K.

Information Needs and Use of Educational Material by Educators

All seventeen educators indicated they used the Web as an educational resource. Table 4.8 shows the resources educators used to discover new Web resources. Educators reported using colleagues, links on Web sites and search engines to discover new Web resources. Listservs, conferences and professional journals also ranked high on the resources used by educators to find Web based resources. These additional resources can be viewed as a network which extends beyond their individual sphere to include a wider spectrum of recommendations from their colleagues.

Table 4.9 highlights the needs which inspired the educators to do a Web search. Educators attempted to find resources which would cover their current content areas and/or to find resources that would meet the needs of their students.

Table 4.8 Resources used by educators to find Web based educational resources

		Participant Number																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Total
Resource	Colleagues	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	16
	Print Advertisements		X	X	X										X				4
	Online Advertisements							X											1
	Direct Mailings (flyers)														X	X			2
	Newsletters (print)		X						X				X					X	4
	Listservs or Electronic Newsletters		X			X		X	X				X	X	X	X		X	9
	Links on Web sites	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	16
	Search engines	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	16
	Professional Development Sessions, Conferences or Organizations		X	X		X		X			X			X	X	X	X	X	10
	Professional Journals or Readings		X	X	X		X	X	X						X	X	X	X	10
	Other[*]																X		1

[*] The respondent indicated “searching myself” as another method for locating Web based educational resources.

Table 4.9 Needs which inspired the educators to do a Web search.

		Participant Number																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Total
Need	Resources that relate to a specific topic or content area	X		X	X	X	X		X	X	X	X	X	X	X	X	X	X	15
	Resources that fit a particular curriculum standard	X	X	X	X						X		X			X	X	X	9
	Resources that meet specific needs of one particular student			X					X			X	X	X	X				6
	Resources that meet specific needs of a small group of students	X		X	X	X			X			X	X	X	X				9
	Resources that meet specific needs of your entire class or activity group	X		X	X	X	X	X	X			X	X	X	X	X	X		13
	Other																		0

Table 4.10 shows the rankings of the materials educators referred to for curriculum planning in the previous month. The following weights were used to calculate the rankings for each resource: 1 = “Never”, 2 = “Used 1-5 times in the last month”, 3 = “Used 6-10 times in the past month” and 4 = “Used more than 10 times in the past month”.

Table 4.10 Ranking of resources educators used in planning for the previous month

Ranking	**Resource**	**Weighted Average**
1	Web sites and other Web-based resources	3.47
2	Textbooks, Encyclopedias, Books, Newspapers and other print-based resources	2.94
3	Colleagues, Librarians, Administrators and other people resources	2.29
4	CD-Roms, DVDs	2.12
5	TV	1.71

In addition to the resources listed in table 4.9, educators relied on a variety of other resources to help them in the planning process including:

- Student IEPs to reference student instructional needs in addition to Standard Course of Study (SCOS)
- Pathfinders created by their librarians
- Ideas from National Public Radio (NPR) to start classroom discussion
- Visual projects and experiments
- Educational software
- Instructional games
- Databases

- Ebooks
- Blogs
- Wikis
- Conference podcasts

These resources were mentioned once.

Design Expectations of Educators

Eight educators named Google as one of their favorite search engines or Web sites, and two mentioned Yahooligans.com. One educator remarked, "Everything starts with Google!" In addition to those resources the respondents mentioned 45 other resources they considered favorites. The median number of resources listed was one; however one respondent listed 32 favorite resources (see Appendix L: "Other favorite Web resources mentioned by educators"). These ranged from resources used to find out about the news such as the NY Times Learning Network, to resources used to locate materials aligned with specific standards such as the Virginia Department of Education Standards and learnnc.org.

Table 4.11 shows design features educators valued most about the Web site or search engine they mentioned in the previous question. In this question educators were asked to rank the most important features by selecting their 1st, 2nd and 3rd choices; the order of the table entries was determined by organizing each feature based on the total number of 1st choices and combined 2nd and 3rd choices.

Table 4.11 Features respondents valued in their favorite search engine or Web site

Feature	Number of educators who valued this feature as their 1st choice	Combined Responses for 2nd and 3rd choice
Easy to search	5	4
Usually has the most relevant information	3	4
Multiple resources available	2	5
From a reputable source	2	5
Limits search to the desired category	2	1
Easy to find what I want	1	3
Easy to use	1	2
Resources easy to customize for my needs	1	0
Resources are culturally / age / developmentally appropriate	0	4
Web site links are up to date	0	3
Well-known	0	2
Downloads quickly	0	1
Web site complements resources already used	0	0

In addition to those mentioned in the table the educators reported the following features:

- Resources interactive, e.g. suitable for a smart board
- Provide video
- Resources which are student-friendly and not full of teacherly jargon
- Provides ideas which are creative and engaging to learners
- Accessible and allows the educator to do preliminary work when it is convenient
- Has a fairly simple, straightforward design. Aesthetically pleasing while also providing a lot of information

Next, educators were asked if they used Web based video. Thirteen respondents said yes and four said no. Table 4.12 shows frequency of use in the past month for the 13 educators who said "yes".

Table 4.12 Frequency of Web based video use in the past month

Frequency of Web based video use in the past month	**Number of Respondents**
Never	0
1-14 times	10
15-30 times	1
More than 30 times	2
Total	**13**

When the 13 educators who used Web based video were asked how much they thought online video contributed to the learning of their students, 9 said the video contributes a fair amount and 4 said the video contributes as a major source of learning. Table 4.13 outlines the actions the 13 participants said they would take if online video was not available from their primary Web site.

Table 4.13 Actions taken if videos were not available from their primary Web site

		Participant Number													
		1	2	3	4	5	6	7	8	9	10	11	12	13	Total
Actions taken	Find another Web site which contains these videos		X	X		X		X	X	X		X			7
	Find equivalent videos	X		X	X	X	X	X	X		X	X	X	X	11
	Find other activities	X		X		X	X					X	X		6
	Not try to find a substitute														0

Educators were asked what related instructional tools they would most like to find on a Web site devoted to online video (Table 4.14).

Table 4.14 Instructional tools educators would most like to find on a Web site which provided online video.

Instructional Tool	**Number of educators who valued this tool as their 1st choice**	**Combined Responses for 2nd and 3rd choice**
Lesson plans, activities and ideas	6	3
Simulations (e.g. Applets, flash presentations…)	4	2
Access to professionals	2	4
Pictures and graphics	1	6
Collaboration tools for students to interact with other students	0	6
Educator guides	0	4
Raw data	0	1

In addition to the resources listed in table 4.14 educators suggested that sites devoted to Web based video include organizers for gathering information, links to additional resources, questions for discussion, access to papers and a reference list for pursuing content in more detail.

Next, educators who used Web based or downloadable video were asked how important it would be for the previous instructional tools to accompany the Web based video (Table 4.15). The following weights were used to calculate the weighted average for each instructional tool: 1 = "Not important at all", 2 = "Not very important", 3 = "Somewhat important" and 4 = "Very important". Each weight was then multiplied by the total number of responses for that tool and response to determine an overall ranking. Table 4.15 highlights an apparent contradiction as it relates to educator guides. In Table 4.14 educator guides ranked low on the list of instructional tools educators would most like to find on a Web site devoted to online video. In table 4.15 however, educator guides were tied for first place as being the most important tool for educators if they were using Web based video.

Table 4.15 Ranking of instructional tools educators would most like to accompany Web based video.

Ranking	**Instructional Tool**	**Weighted Average**
1	Lesson plans, activities and ideas	3.15
1	Educator guides	3.15
3	Pictures and graphics	3
4	Simulations (e.g. Applets, flash presentations…)	2.85
5	Access to professionals	2.62
5	Collaboration tools for students to interact with other students	2.62
7	Raw data	2.46

Next, educators were asked what they thought were the most important design features for Web sites which provide online video. A scale of one to four was assigned to each of the responses, where 1 = “Not important at all”, 2 = “Not very important”, 3 = “Somewhat important” and 4 = “Very important”. Rankings were computed for each desired feature as before. Table 4.16 shows the rankings of each feature with the final weightings.

Table 4.16 Educators' ranking of the importance of each design feature

Ranking	**Design Feature**	**Weighted Average**
1	Search tool	3.54
2	Multimedia content	3.23
3	Related links	3.08
3	Citations and references	3.08
3	Assurance the site is backed by a reputable sponsor	3.08
6	Access to experts / professionals	2.85
6	Way to submit questions	2.85
8	On-line help	2.77
8	Collaboration tools	2.77
10	Pleasing colors	2.62
11	Access to phone help-line	2.46
12	Few flashing buttons / little multimedia	2.38
13	Adjustable font size and color	2.31
14	Text-only options	2.23

In addition to the features listed in the table educators also suggested the following features were important to the use of online video:

- How long it takes to search and use items on the Web site

- Getting additional details about the video in a legend that would identify any codes or parameters entailed

The thirteen educators who use Web based video were asked about their top three challenges in seeking and use of Web based video. Table 4.17 shows their ranked responses. In addition to the challenges in table 4.17 educators mentioned the following issues: connection speed, identifying the reputation of the resources, and finding good videos appropriate to their topic.

Table 4.17 Challenges to the use of Web based video

Challenge	**Number of educators who reported this as their number 1 challenge**	**Combined responses for number 2 and number 3 challenges**
Problems with computer hardware	4	4
Takes to long to locate video	3	2
Products / Web sites are too expensive	2	2
Resources are not culturally / age / developmentally appropriate	1	4
Lack of support for hardware or software	1	3
Resources don't align with national or state curriculum standards	1	2
No support from colleagues or administration	1	1
Internet connection problems (e.g. speed)	0	3
Resources are difficult to adapt to my needs	0	3
Unsure about the validity of Web-based resources	0	1
Limited Internet access	0	1

The four educators who reported they did not use online video were asked to respond to a series of statements that described why they did not use Web based video. Table 4.18 shows the final weighted averages for reasons why respondents did not use Web based video. A scale of one to five was applied to each of the reasons where 1 = “Strongly disagree”, 2 = “Disagree”, 3 = “Neither agree nor disagree”, 4 = “Agree” and 5 = “Strongly agree”. From this scale and the number of responses to each reason the final ranking was computed.

Table 4.18 Reasons for not using Web based video

Agree, Neutral, Disagree	**Statement**	**Weighted Average**
Agree	VHS, and DVD video media are more available in my educational setting	4.50
Agree	VHS, and DVD video media are more adaptable to my needs	3.75
Agree	the educational setting in which I work has limited Internet access	3.50
Neutral	the resource are difficult to adapt to my needs	3.00
Neutral	the products/Web sites which offer downloadable or Web-based videos are too expensive	3.00
Disagree	the educational setting in which I work has limited computer access	2.75
Disagree	the Web site I previously used to retrieve video had Internet connection problems (e.g. speed)	2.75
Disagree	there are problems with my computer hardware	2.50
Disagree	it is difficult to determine if the resources align with national, or state curriculum standards	2.50
Disagree	it takes too long to locate appropriate video	2.50
Disagree	the educational setting in which I work has a lack of support for hardware or software	2.50
Disagree	the resources I find are not culturally/age. developmentally appropriate to my students' needs	2.25
Disagree	I am not sure about the validity of Web-based resources	2.00
Disagree	I do not have support from colleagues or administration	1.50
Disagree	I am not comfortable using the Web	1.25

Educators also listed additional reasons for not using online video:

- Equipment limits
- Limitations in playback size due to computer screen size. Quality of video is often not the greatest, and the campus wireless network can be spotty.

One person responded that she was “not sure where to start” and that she also didn’t know “how it looks not to teach and simply have kids watch videos”.

In terms of the overall findings from the online survey there were several contradictions which need to be explored further. When educators were asked what instructional tools they would most like to find on a Web site which provided online videos, lesson plans and activities were the number one instructional tool educators cited while educator guides were ranked 6th out of 7. On the other hand, when educators were asked what instructional tools they would most like to accompany Web based video, lesson plans and activities were ranked number one along with educator guides. Since lesson plans and activities were ranked at the top consistently it is relatively safe to assume that these resources are important materials which can enhance the use of online video. Educator guides may have ranked low in the initial question because educators may have felt they had to choose between lesson plans and activities and educator guides. Given their similar nature, once educators had chosen lesson plans and activities it is possible they thought that including educator guides would be redundant and therefore selected other options as their top instructional tools to be provided on a Web site.

There were also contradictory findings related to curriculum standards. Previous research, including a focus group I conducted (Brown, 2006a), indicated that alignment with standards was important; however for ten out of the thirteen educators in this survey it was not a great problem if resources weren’t aligned with the standards.

Another contradiction related to Internet connection speed. In Morris’s (2002) study, Internet connection speed was one of the challenges that limited teachers from achieving his definition of access to technology. Additionally in this study, 4 educators in the online survey cited limited Internet access as the third reason why they did not use web based video; however for the other 13 educators in this study, connection speed was not an issue listed as a significant challenge. One reason Internet connection speed may be less of an issue for these educators is due to the increasing bandwidth options available, especially in the last couple of years. These findings, while contradictory, suggest that access to Internet connection speed depends on the setting of the educator and is quickly becoming less of a problem.

Overall, educators valued simple design. Educators who used online video felt the videos contributed a fair amount to the classroom as a learning resource. Additionally, educators who used online video were highly motivated to find them if the resources weren’t available from their primary sources. Colleagues and Web sites were the most reported ways educators used to learn about new Web resources. Educators described their favorite Web site as having the following characteristics: easy to search, has the most relevant information, offers multiple resources and is from a reputable source. These other forms of educational content were lesson plans as well as activities related to the content or topic the educators were covering.

Design Decisions and Functional Requirements

After phase one of the research, design decisions and functional requirements for revising the nasa.ibiblio.org Web site were created from the results of the TLA, online survey and the recommendations found in the literature. The final design decisions from phase one range from those which deserved immediate attention to ones which should be considered in the long term. Overall the determination for classifying decisions as one or the other was based on how long it might take to develop a solution to the problem, and how important the decision was to educators' completing their task of finding online video. Table 4.18 shows the 12 major design decisions with the recommendation for their implementation.

Table 4.18 Twelve Major Design Decisions

Design Decision	**Implementation schedule?**
Data cleaning for queries	Immediate
Truncated queries	Immediate
Plural queries	Long term
Visual aspect of video	Immediate
GEM criteria for design: organization	Immediate
Investigate other types of educational metadata	Long term
Add related content	Immediate
Add full text transcripts	Immediate
Implement captioning	Long term
Integrate search engines and customized search	Immediate
Social networking design	Long term
Miscellaneous design decisions	Immediate

Data cleaning for queries

The first finding from the TLA which deserved immediate attention was the fact that user submitted queries did not go through any cleaning. The median number of searches performed monthly from July 2006 to May 2007 was 266 searches per month. The efficiency of the Web site search was a concern because it will directly impact the efficiency of how educators retrieve online video information. Search efficiency was also a concern because search tools which perform poorly can have a negative impact on the perceptions of the users, making them believe the site is poorly designed or does not contain information relevant to their task. In addition, the omission of data cleaning was a threat to the security of the database. With minimal knowledge of MySQL a hacker could pass information through the Web pages directly to the MySQL server. This type of access would allow a hacker to input a query that could perform any action he or she wanted to the ibiblio database such as maliciously deleting video information. To fix this problem the Web search was redesigned so that any query submitted by the database was cleaned on the Web server end by removing non-alphabetic characters, trailing spaces and leading spaces from the original query. The cleaned user query is then submitted to the MySQL database and the search is performed as usual.

Truncated queries

Another issue which needed to be addressed was the number of characters users were allowed to submit in the text box. When analyzing the Web logs of users' searches it became evident that searches beyond a character length of thirty were truncated. For example, an educator's search for the video, "the case of the wacky water cycle", would be truncated to "the case of the wacky water cy". Friedman (1996) might classify this as misrepresentation by the system because users were being misled to believe their query was of a certain length and included specific information when in fact it was not. In order to address this problem the size of the text box was increased to 60 characters. Setting a fixed length for the text box brought the number of characters users were allowed to type in line with the number of characters submitted to the database.

Plural queries

One observation made from the log of users' queries was that some queries were in the plural form, decreasing the amount of hits the database returned. For example, searches for "airplane" or "hurricane" return 46 and 20 records respectively; while a search for "airplanes" or "hurricanes" return 27 and 14 respectively. Two approaches can be taken to solve this problem: either stemming should be implemented to the queries submitted by users or metadata should be created to include plural forms of nouns in the metadata. This particular design decision was designated as a future work because the focus of the research was not in line with the overall purpose of the study.

This question of how best to handle plurals is an example of Chen and Doty's (2005; 2006) emphasis on understanding the vocabulary of educators and students. In order to better understand educational user's vocabulary, designers need to view searches and results including terms used in queries and searches with empty returns. This is difficult to implement as part of this project because it would require an additional cycle of prototyping, testing and gathering feedback from the digital library providers. This finding points to a long term need to align metadata with user vocabulary and to developing a conceptual framework in relation to using user submitted queries to improve the "ingest" process (the process of bringing new materials into the digital library system).

Visual aspect of video

In the focus group conducted on January 11th 2006, educators often spoke of the visual qualities of video claiming that it "took students to a world they didn't know." In design of an online video library system it becomes important to find ways to represent these visual qualities so that users can more effectively choose videos related to their tasks.

Lee, Smeaton and Furner (1999) discuss different browsing formats for digital video. Two formats which have been used widely are the poster frame and the storyboard. The poster frame format presents a small .gif or .jpeg image to the user. This one still keyframe image is chosen to catch the browser's attention and summarize the online movie: in essence it serves as a digital surrogate similar to a movie poster. The storyboard summarizes video content by presenting videos as a series of still keyframes taken in order. Projects like the Baltimore Learning Community project and the Open Video project adopted poster frames and storyboards for presenting visual summaries of online video to their users. When the focus group participants were shown examples of the storyboard format from the Open-video.org Web site, they said they liked it because it was fast, they could probably visualize what the text was saying and because the storyboard helped educators with the preview process in ways text could not. The decision to include these browsing formats into the system was based on focus group comments and the work done by many related projects. As described succinctly in the AgileViews framework, the posterframe and the storyboard were intended to provide educators with visual *previews* of the video content (Marchionini, Geisler, & Brunk, 2000).

One issue which arose after introducing the visual summaries was that users needed some way of switching between different views based on their preferences. To address this need, a menu was created which allows users to switch between three views: text, text and small thumbnails, and reduced text and large thumbnails. Following the design recommendations of the OpenVideo project, the default view was determined to be the text and small thumbnail view for all users who enter the system. Figure 4.9 shows the text display for the prototype. The text display for the prototype provides each video's title, description and duration. Figure 4.10 shows the text and small thumbnails view; this view contains small posterframe images, in addition to the information provided in the text view. Figure 4.11 shows the reduced text and thumbnail view; this view contains the video title, duration information and date the video was created. Figure 4.12 contains the detailed view of a video that a viewer sees after selecting a video. The large picture on the top left is the large posterframe and the pictures along the bottom of the figure are the storyboard preview.

Figure 4.9 Screenshot of text view

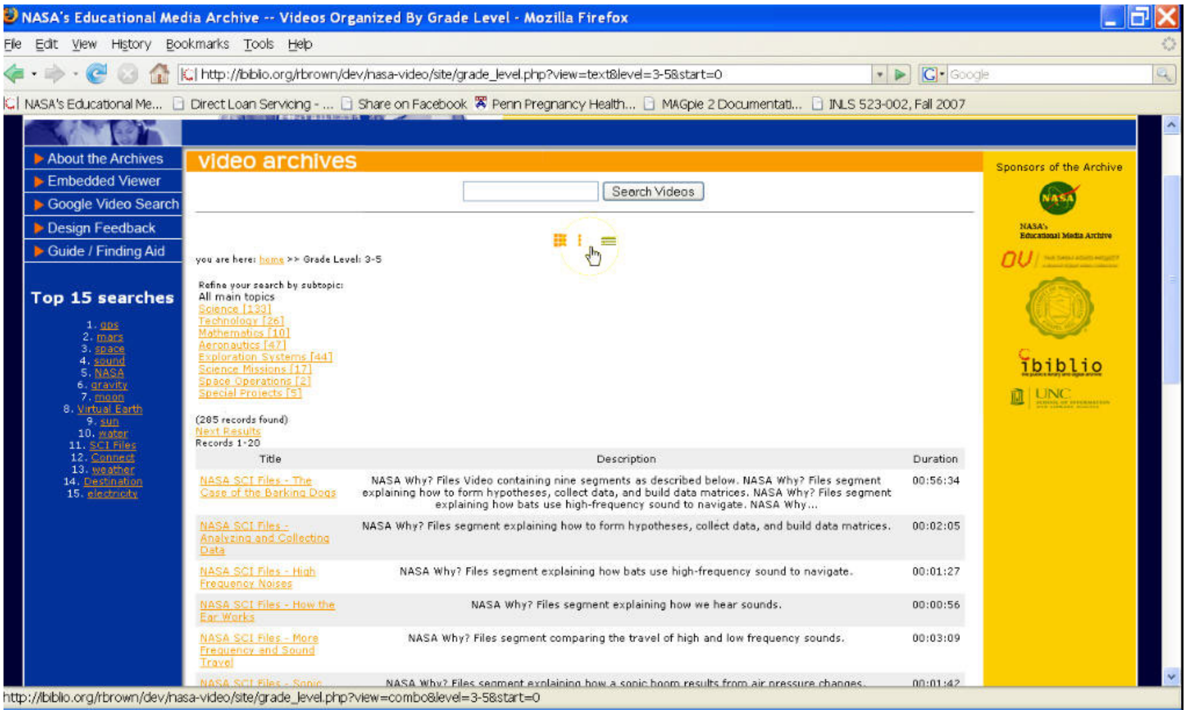


Figure 4.10 Screenshot of small thumbnail and text view

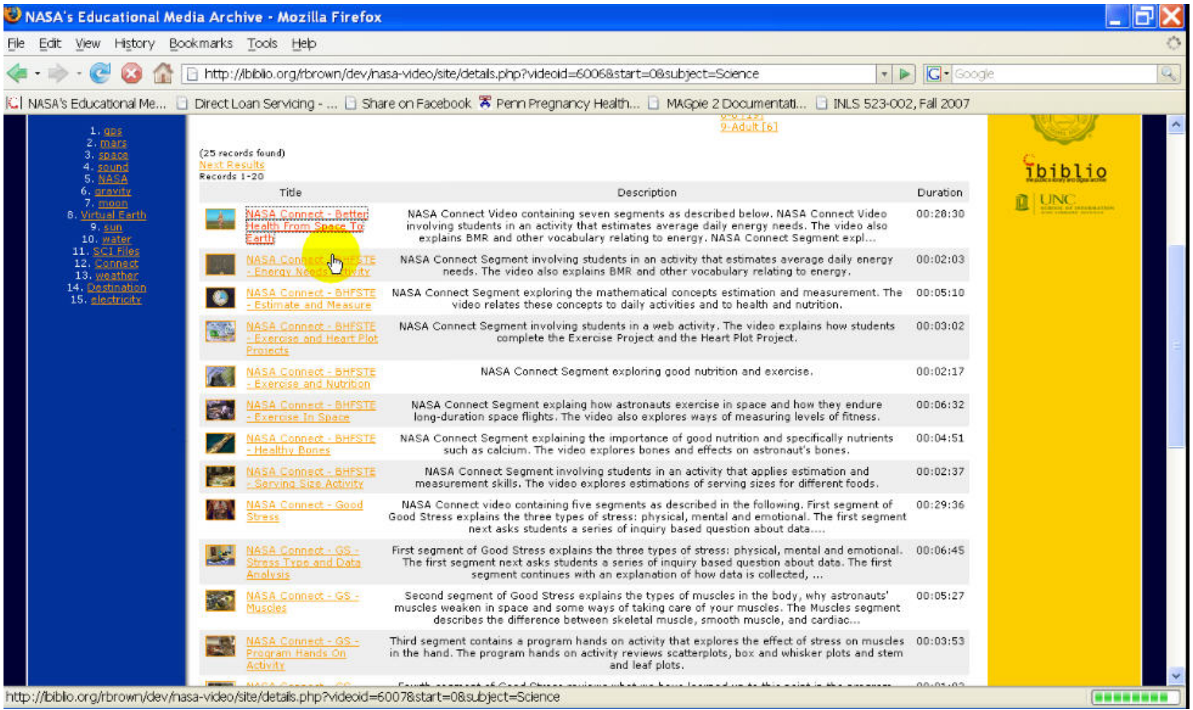


Figure 4.11 Screenshot of the reduced text and large thumbnail view

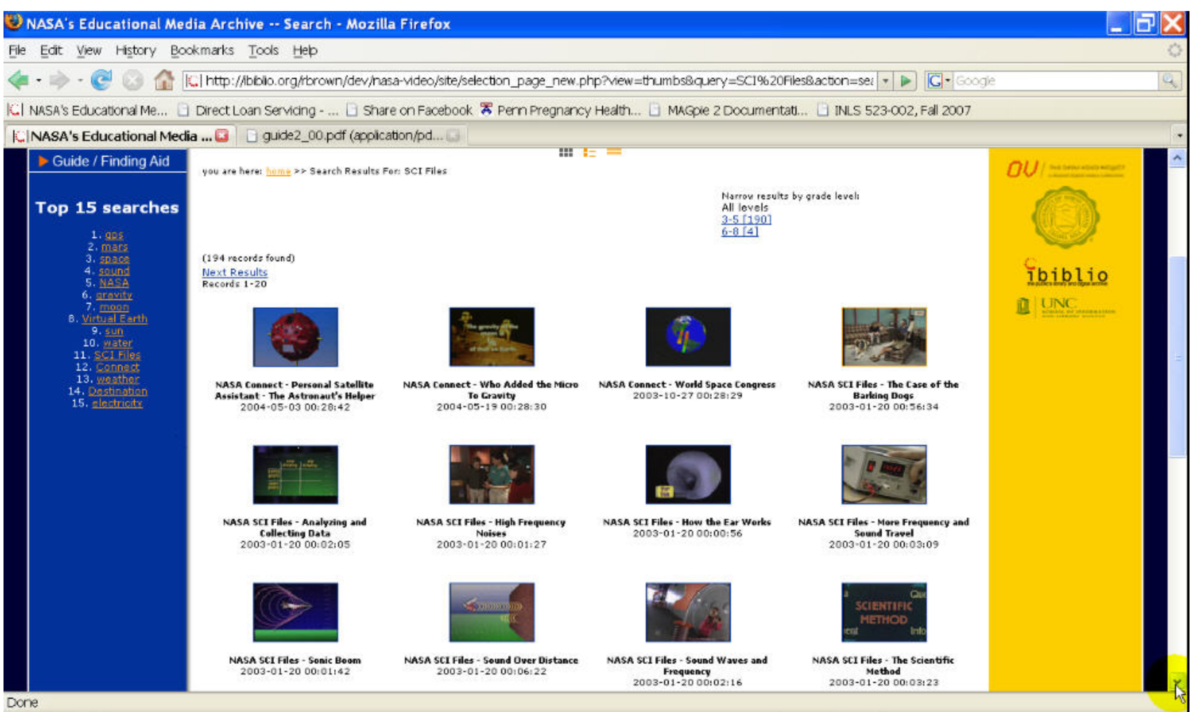
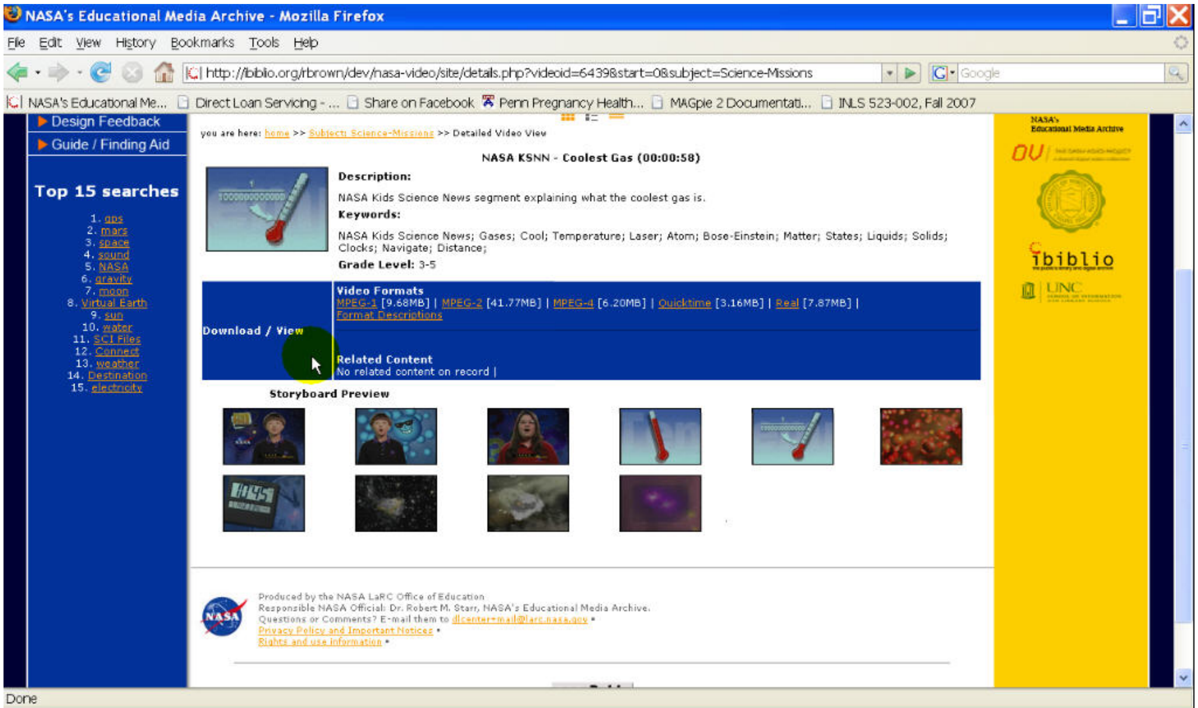


Figure 4.12 Screenshot of detailed video view



GEM criteria for design: organization

During the focus group one educator who was looking for information organized by subject asked if she could do a subject search for NASA videos. Another educator remarked that in other web sites the grade ranges and content areas were available for browsing by following links. These comments suggested improvements could be made to the organizational structure of the Web site. In the previous organizational structure of nasa.ibiblio.org, material was organized by NASA program with videos being organized by the date they were contributed. This organization was based on the video producer's perspective of the videos, and not on the mental models of the people searching for the videos. According to the 4th year evaluation study, material collected in GEM must abide by six criteria (Fitzgerald & McClendon, 2003). The sixth criterion, organization, suggests that “resource[s] should reflect logical development and clear actions to be taken by both the educator and learner" (p.4 Fitzgerald & McClendon, 2003). One way in which GEM meets this functional requirement is by providing drop-down menus of broad and narrow subjects for educators to search.

In order to improve the organization of the materials in the nasa.ibiblio.org collection, grade level and subject level information was added to each of the videos. The subject level information was created using a subject classification system currently used for the Noticiencias NASA and KSNN programs. Additionally, if videos contained educator guides these documents were consulted to help expand the subject level classification beyond one level. Grade level information was added to each video corresponding to the grade level information designated for each NASA program. Figure 4.13 shows the three main browsing options provided by the prototype. Users can browse by 5 NASA programs, 3 grade levels, and are provided with 8 subject categories that are then divided into further subcategories. Figure 4.14 shows the first level of the science subject category. In the subject browsing option, subject subtopics near the top left of the interface can be selected to further narrow video selections, or grade level categories near the top right of the interface can be used to narrow the video results. In the grade level browsing option, users can narrow results by subject and subtopics. In the keyword search option, users can narrow results by grade level.

Figure 4.13 Screenshot of nasa.ibiblio.org main page

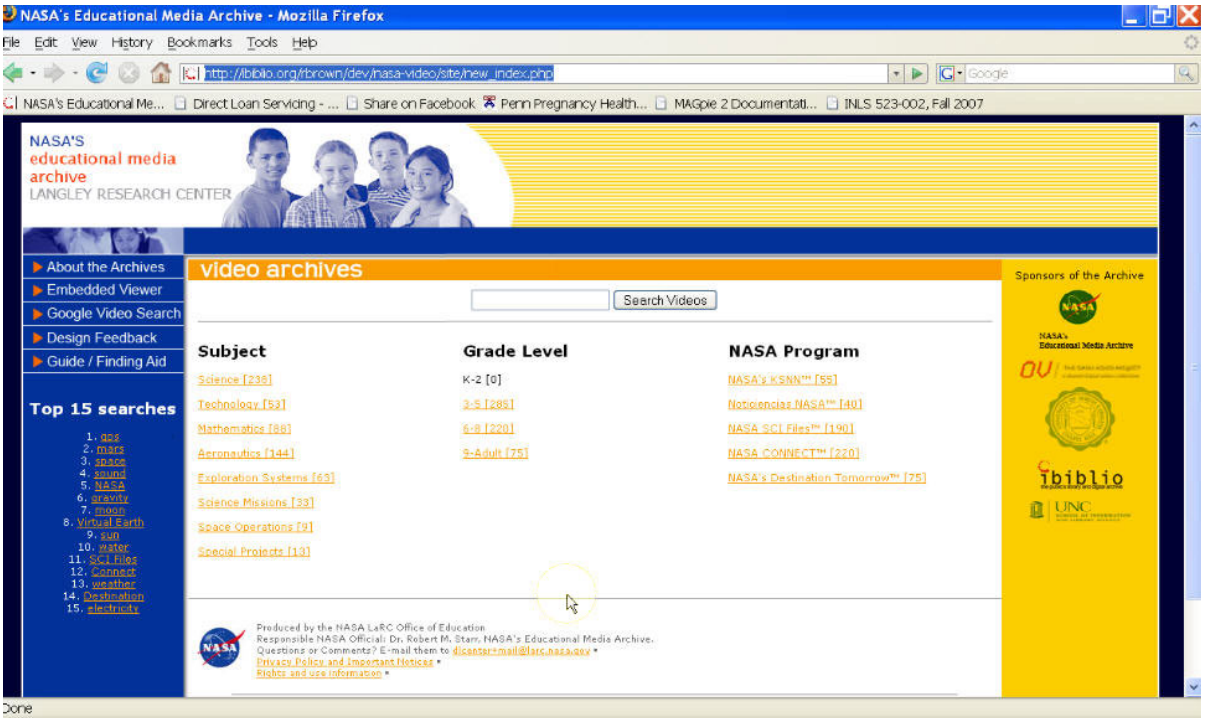
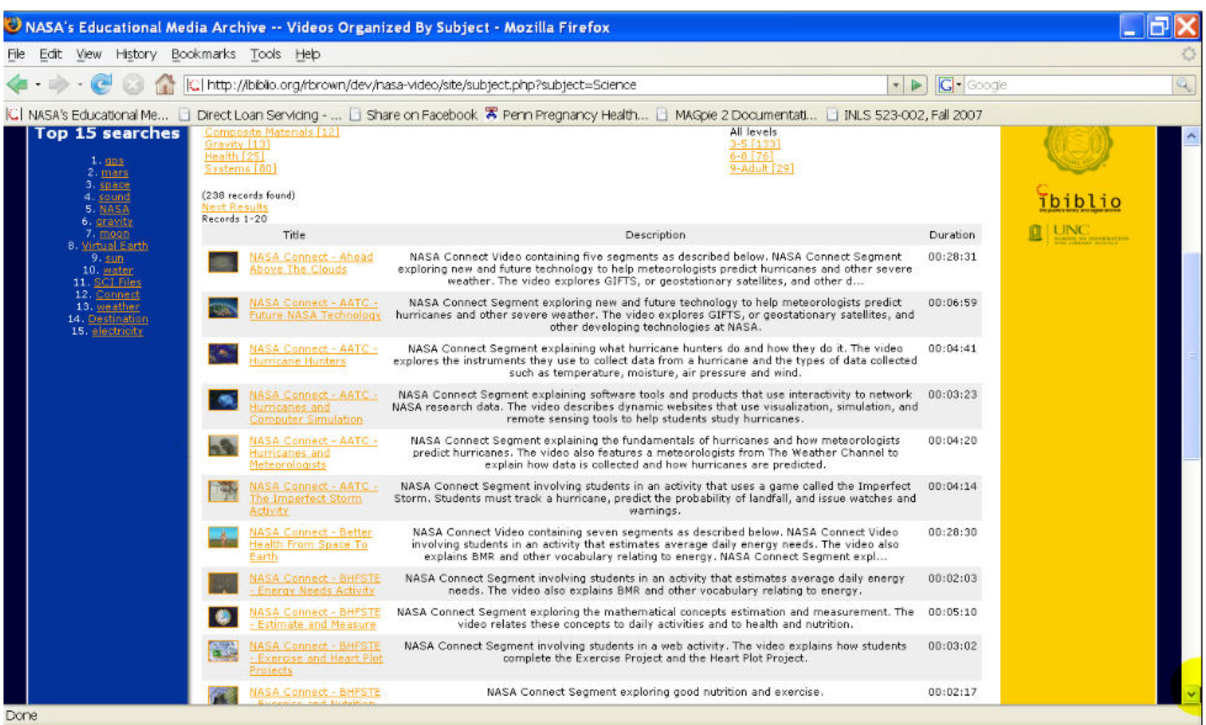


Figure 4.14 Screenshot of first level of science category



With the previous design, there was another issue which did not meet the requirements of the organization design principle; the links to the videos of the nasa.ibiblio.org collection had the exact same names as the links to Web sites for each of the NASA Educational Media Archive programs. Since these links had the exact same names users might logically expect to be taken to the same location if they followed them. In reality, in the previous design these links would take the user to two different locations. Users should be able to clearly tell which links take them to nasa.ibiblio.org content and which links take them to content outside the NASA Educational Media Archive. In the prototype design the links to the outside NASA Educational Media Archive programs were removed.

Investigate other types of educational metadata

The focus group comments and the online survey identified educational metadata elements to include immediately, such as grade and subject level metadata. However, in the long term, other types of metadata which are aligned with the educators' tasks need to be identified and incorporated into the system. These new metadata categories will be relevant to educators' tasks and guide educators to the resources that are most important to their particular educational context.

Curriculum standards are one type of metadata which should be investigated further. From both the survey data and the focus group comments, it appears that curriculum standards were not mentioned as frequently as searching by "content". Although several educators did discuss searching by standards during the focus group, the precise point in the information seeking process when educators used them was ambiguous. This need for clarification suggests educators be further asked about their specific needs for curriculum standards metadata to better determine when standards play a role in an educator's seeking and when they do not. This future research should also investigate how detailed curriculum standards have to be (i.e., national or down to the state level) and how to incorporate standards into the system.

Add related content

Another concern raised by the literature and the results of the survey was the lack of related educational materials in the previous design. In the online survey, educators consistently desired lesson plans and activities to be available with online video. These findings emphasize the idea that videos which have related activities and materials are perceived to be more useful than resources which do not contain those materials. To address this issue, links to educator guides and online Web activities were added in the Web site for videos which had this related material.

Add full text transcripts

Resources imported into the Gateway are indexed on resource titles, full text, authors, and grade level. Although videos in the previous design were indexed by title, keywords and description, there was no full text equivalent in the system. In an effort to improve search, full text indexing was added for the 50 full videos NASA provided transcripts for. Adding full text transcripts has the advantage that this is one way of handling synonyms that do not appear in the metadata. On the downside however, adding transcripts also increases the false positives retrieved. The fact that false positives are increased might be a good reason for not importing transcripts for the segments in addition to the full video. For this project, it was decided that full text indexing would not be provided for the segments of the full videos because that would require segmenting the transcripts provided by NASA. Additionally it was decided that unlike the titles, keywords, and description fields, the transcript field would not be visible to the users. This was decided because the transcript field lacked formatting and would require the user to scroll considerably in order to see the entire transcript.

Implement captioning

A decision related to full text indexing of the online videos was the implementation of captioning on the streaming real media files. In order to make the online video accessible to persons with hearing disabilities captioning should be added. This decision was categorized as long term because incorporating captioning into the display of the videos and video segments for hearing-impaired users will involve the creation of smil files which are aligned with the audio in the videos. This task, along with the segmentation of the transcripts to provide captioning for the video segments was beyond the scope, resources and purpose of this project.

Integrate search engines and customized search

Many educators surveyed in the Hanson and Carlson (2005) study commented they used Google to begin their search (20 out of 26) and many claimed Google was their favorite Web site or search engine (12 out of 26). Eight out of 17 educators in our online survey mentioned Google in their comments. These data suggest many educators rely on Google as a starting point for their Web searches. Due to the popularity of Google, three new features were introduced into the prototype in an effort to provide capabilities similar to the convenience and ease of the familiar Google search engine. The first new feature incorporated was the addition of the Top 15 Searches, the second was the Embedded Viewer, and the third feature was the Google Video search.

The purpose the Top 15 Searches feature was to provide educators with the most popular searches which have been conducted on the Web site. The most frequently searched terms were taken from the Web log data and transformed into links which displayed on the web page. The final terms used for the prototype were:

1. Gps
2. Mars
3. Space
4. Sound
5. NASA
6. Gravity
7. Moon
8. Virtual Earth
9. Sun
10. Water
11. SCI Files
12. Connect
13. Weather
14. Destination
15. Electricity

This feature was designed to provide convenient ways for educators to access popular content and topics of the Web site. Recall that in the online survey and focus group, “content” was one of the main motivating factors for their searches.

The next two features were developed using the Google AJAX Search Application Programming Interface (API) (http://code.google.com/apis/ajaxsearch/multimedia.html). The Google AJAX Search API allows developers to add strips of video content to their Web sites.

Although this API is often used for blogs, it was used here to retrieve NASA ibiblio contributed content from the YouTube and Google Video Web sites for display on the nasa.ibiblio.org Web site. Videos were retrieved from YouTube and Google Video because their video has the advantage of being designed to play directly in the users' Web browsers using a flash video format and not requiring additional external players.

The Embedded Viewer uses the video bar API to display 8 NASA ibiblio videos at a time. Using the auto execute list option, a list of search expressions were created which scroll through the first 8 videos of each NASA program (see Figure 4.15). The video bar was set to display for 10 seconds before the posterframe images refreshed to the next set of videos. Any video in the video bar can be displayed in the video display area if the user clicks on the poster frame (see Figure 4.16). Additionally with the Embedded Viewer, educators had the option to perform searches of the Web site using Google's search. The Google Custom Search limited educators to searching the Web sites for the 5 NASA programs and to searching within nasa.ibiblio.org itself (see Figure 4.17).

One reason the Embedded Viewer was developed was to further test the extent of the preferences educators had for Google content. In particular, I was interested in what educators' reactions to the Google Custom search, and the use of nasa.ibiblio.org as a portal to Google Video content. Another reason this feature was provided was because educators in the focus group spoke of the importance of the visual qualities of video and the need to preview video segments before use. The posterframes of the video bar provides educators with small previews of the video. With the click of a button, users can immediately play back any videos they choose to review more in depth. The Embedded Viewer feature differs from the main Web site in that it has no option to provide text summaries of each video; it is purely visual except for the option users have to mouse over a posterframe and see the video title.

Figure 4.15 Screenshot of the Embedded Viewer

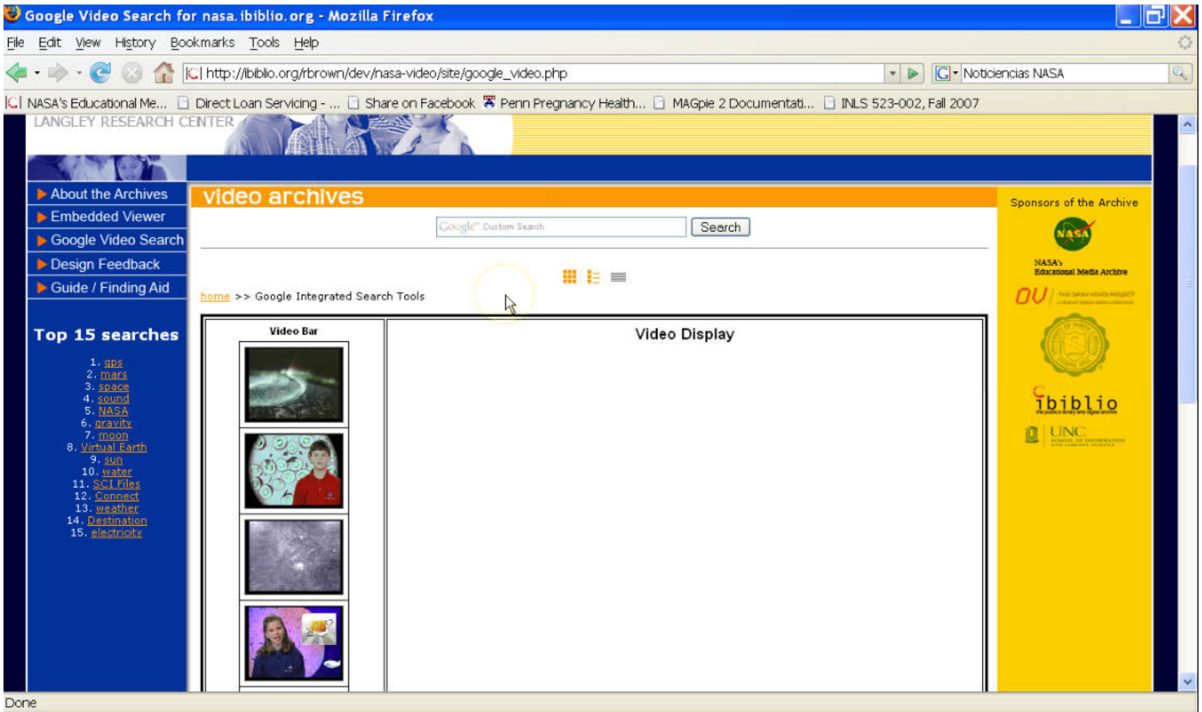


Figure 4.16 Screenshot of a video playing in the video display

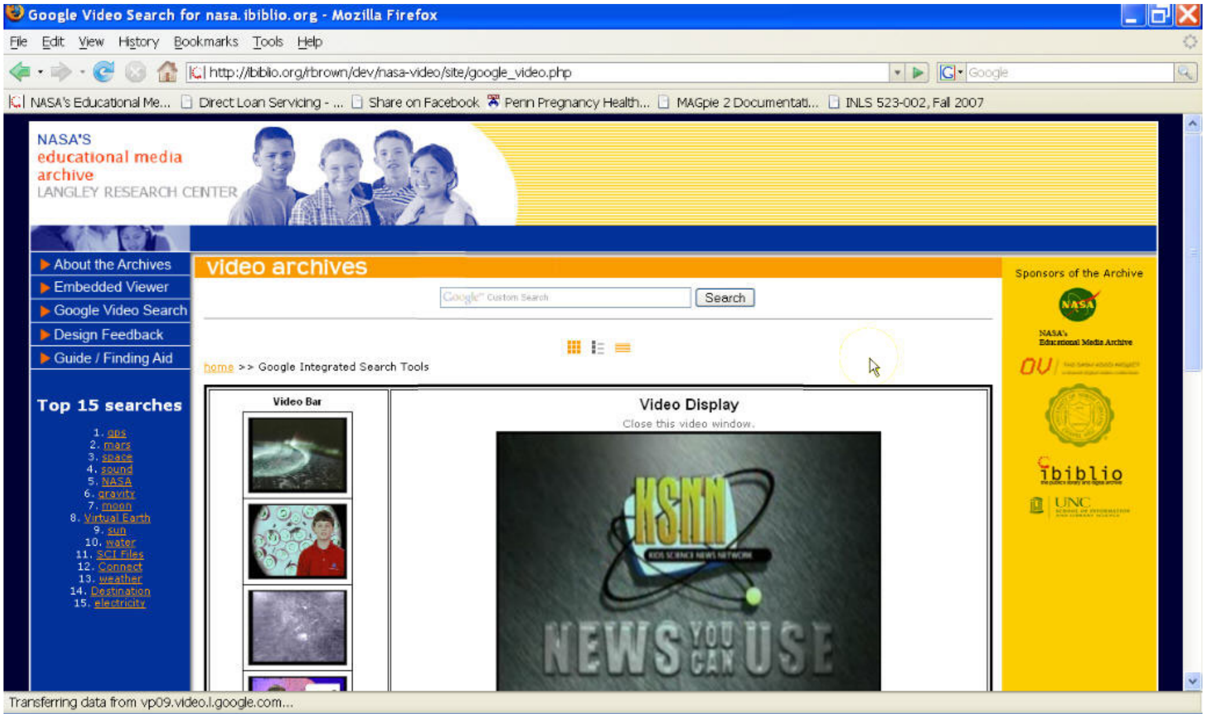
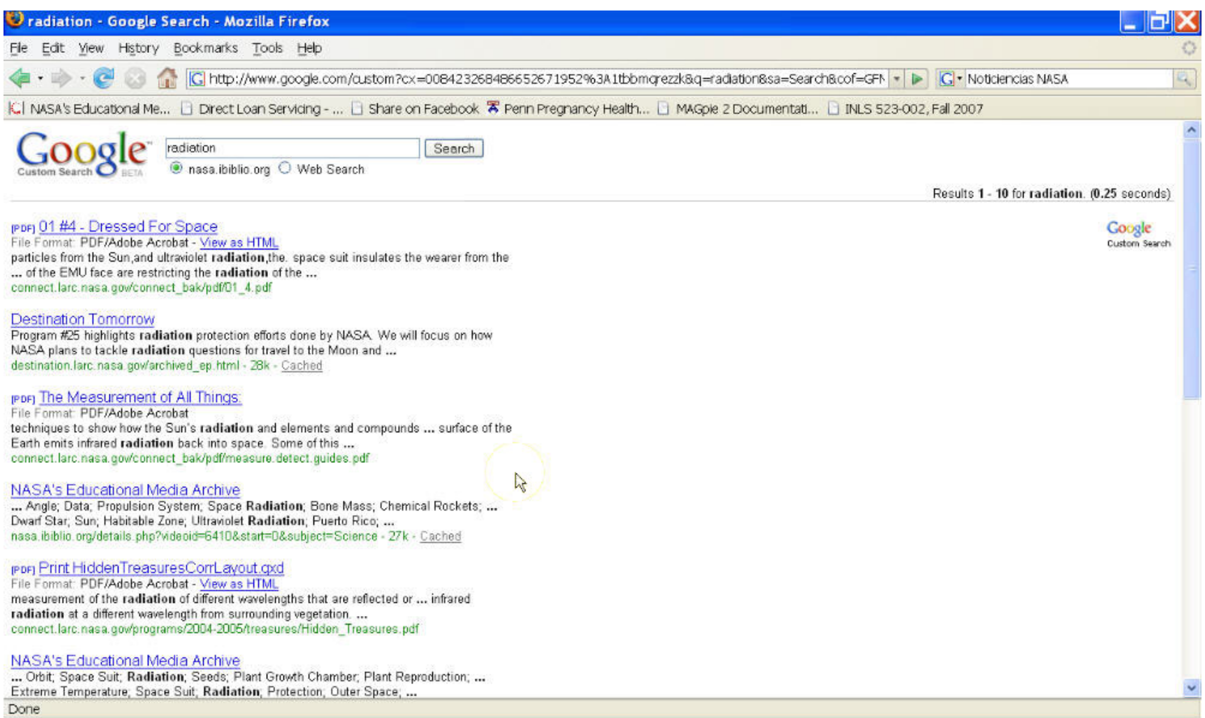


Figure 4.17 Screenshot of the search results for the Embedded Viewer



The Google Video Search feature uses the video Search option of the Google AJAX API to create a search control box and accompanying display for the video results (see Figure 4.18). The initial search control provides "www.open-video.org NASA" in the initial search box to limit the videos retrieved from Google Video to the NASA ibiblio collection. The default result size for this feature is one result, but the Google Video Search provides an option for expanding results that is similar to changing views in the main Web site (see Figure 4.19). After performing a search in the search control, users leave the nasa.ibiblio.org Web site and are presented with results from the Google Video Web site. (see Figure 4.20).

The Google Video Search feature was developed as an alternative portal to NASA ibiblio content on Google Video. The two major differences between the Embedded Viewer and the Google Video Search are the search results and the choice of video display. With Google Video Search, subjects are taken to Google Video visual surrogates of videos and must view video content on Google Video's Web site. With the Embedded Viewer subjects can view external content in the current Web site. The Embedded Viewer search forwards subjects to a Google Custom Search Engine which allows users to search nasa.ibiblio.org content or the entire Web. Given Google's popularity as a search engine, educators may find access to the integrated resources more appealing. Evaluation of these features should reveal what educators think about these two delivery mechanisms for integrating content located outside the educational digital library and of the immediacy that the flash video format provides users.

Figure 4.18 Screenshot of the initial Google Video Search page.

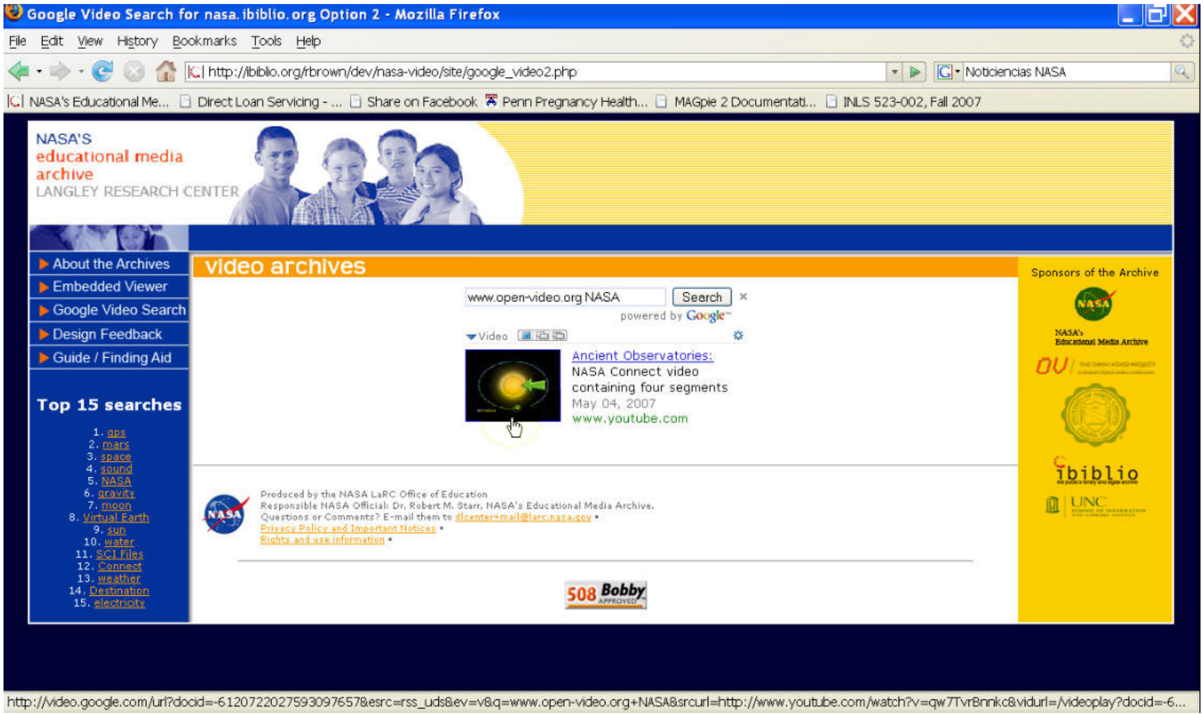


Figure 4.19 Screenshot of the expanded results for the Google Video Search page

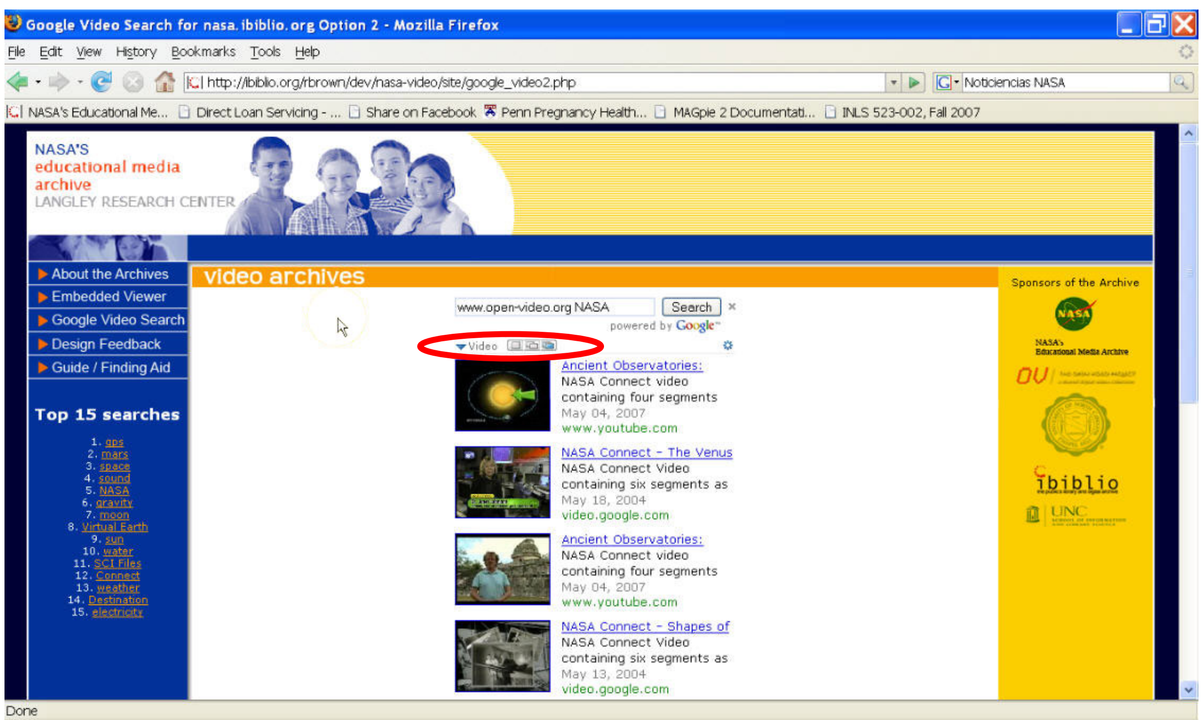
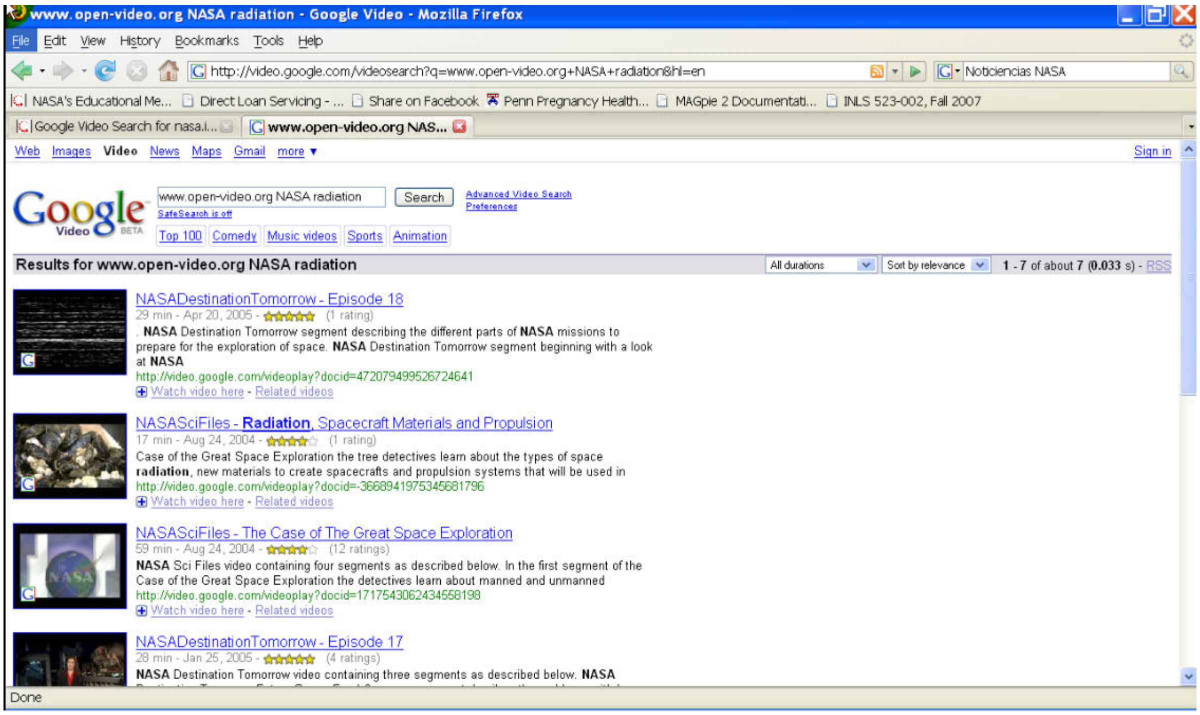


Figure 4.20 Screenshot of the Google Video display shown after performing a search



Social networking design

One final design decision is related to the social networking nature of the information seeking process for educators. In the online survey, educators reported colleagues and search engines as the primary sources they used to find web based educational resources, followed by Links on web sites, Professional Development Sessions, Conferences or Organizations, and Professional Journals or Readings. Of the primary sources educators mentioned, 3 out of the top 7 were related to social contexts. In the Hanson and Carlson (2005) study, educators were asked the same question. Search engines were the number one resource educators used to find out about new Web resources followed by Web site links and Colleagues. In both of these studies, search engines, web site links and colleagues all played important roles in how educators found information.

Future studies might analyze how colleagues and other social contexts influence the information seeking of educators. As reported in the focus group, educators remarked that their information seeking was largely word-of-mouth. The various social resources educators use to find web resources may also have a relationship with the other top resources educators used to find web information.

Miscellaneous design decisions

In addition to the previous design decisions there were a host of other changes which were made to improve minor design flaws of the original design. The purpose of these changes was to bring the new design more in line with standard practices of good design and the expectations of the general user.

- Changed ‘like %term%’ search on the description to a full text search.
- Updated the following Noticiencias NASA fields: titles, descriptions, and keywords. This fixed characters in those fields which were corrupted by the import into the database.
- Added a “breadcrumbs” menu which allows users to move back and forth in the video hierarchy.
- Addressed the use of space and frames so that users can view more content without scrolling.
- For a given result set users are given next results, and previous results (if previous results exist).
- For a given result set users are given videos in increments of 20 videos.
- Added program description to each NASA program page.
- Descriptions in the combo view and the text view are limited to 258 characters with spacing in order to limit the scrolling users must perform to see search results.

The purpose of these design decisions was to provide the user with a clear, aesthetic and intuitive system and reduced the need for prior experience on the site.

The overall design decisions made here served as a first step towards improving the design of the nasa.ibiblio.org Web site. It was important to address the navigation of the Web site. This was done by introducing browsing options which were more aligned with the teaching task such as subject and grade level browsing. Additionally Web activities and educator guides were added for videos for which the materials already existed, poster frames and storyboards were added to give educators a visual sense of what goes on in the video, and several steps were taken to improve search of the Web site. A series of pages also were developed to see if educators would find content which was closely tied to Google searching useful.

There are several decisions which were not addressed given the time frame and resources of this project. More investigation will be needed to unpack the large social networking structures behind the way that educators share information and the technologies that will best facilitate the way they search for information. Transcripts need to be segmented and applied to all the NASA videos which currently have transcripts in an effort to improve search and provide captioning for hearing disabled audiences. The types of metadata educators require needs to be explored further through additional investigation, with the goal of refining the current metadata fields and adding any additional fields. Research needs to continue to explore the development of automatic methods of creating reliable metadata. Such research should leverage the physical content of video, such as educator guides and audio transcripts. If such methods are successful they have the potential to reduce the cost and manpower necessary for getting quality metadata into the information system. Future research should also explore the need for additional stemming and query cleaning.

Finally, maintenance of the Web site must be ongoing. The design should present users with clear and concise views of the information while following principles of good design by incorporating new techniques and design elements.

After the decisions were incorporated into the prototype, the next step was to evaluate if the changes helped educators to understand and interact efficiently with the Web site. This issue is addressed in the next section.

Interviews and Cognitive Walkthrough Analysis

The second phase of this research used a combination of interview and cognitive walkthrough methods to observe educators' use of the prototype representations and functions, and how they used them for searching and browsing tasks. Tasks for the second phase of research were designed to collect data on each of the design decisions implemented in the prototype. An overview of these tasks are in Figure 4.21.

Figure 4.21 Overview of tasks and questions for cognitive walkthrough

1. Browsing/exploration tasks
    a. Brief rationale for tasks
        i. Locate a video or videos using the top fifteen searches
        ii. Locate a video or videos using grade level
        iii. Locate a video or videos using subject headings
2. Browsing/exploratory tasks debriefing questions
3. Retrieval tasks
    a. Brief rationale for tasks
        i. Locate a video or videos using NASA program
        ii. Locate a video or videos using “Embedded Viewer” page
        iii. Locate a video or videos using “Google Video Search” page
        iv. Locate a video or videos using keyword search
4. Retrieval tasks debriefing questions
5. Overall debriefing questions

The primary categories on which these tasks were based came from what the previous literature said about educators’ information seeking and use of educational materials. These tasks were also based on focus group and survey data I collected. In both phases of this research, educators provided opinions on design features of their favorite web sites and their use of video in the classroom.

One trend that is emphasized in the research literature and in phase one of my research was that educators prefer to have browsing options available. To address this need for browsing, three options were built into the revised interface which allowed educators to explore based on their needs. In the initial nasa.ibiblio.org interface users could only browse the web site using NASA program. The revised interface allowed users to browse based on NASA program, by subject, and grade level. In addition to being able to browse by facets which are more aligned to the teaching task users also had the ability to browse the top fifteen search terms; the intention is for this list to be recalculated at the end of every month if this feature is fully implemented into the final design of the site. The first series of tasks were designed to evaluate the new services to see if educators find the new functionality helpful. In the study educators were asked to evaluate the new services and if there were additional suggestions for improving the services.

In terms of study design we felt the tasks should reflect the emphasis educators placed on browsing. In order to accommodate this preference the browsing tasks were placed at the beginning of the study.

From task 1.a.i (locate a video using top 15 searches) I hoped to learn if the terms in the list made sense to teachers, if the list contains terms they might like to browse and whether the teachers found the kinds of videos they were expecting to find from the terms they searched. I also explored teachers' thoughts about the combination of terms on the list (the top 15 list is composed of teaching concepts, video titles, and NASA programs), how they would represent the difference between terms and whether they found this mixture of terms confusing. The first task also explored how aware educators were of the basic interface controls. Overall the purpose of the first task was to evaluate the usefulness of the top 15 searches list. The usefulness of the list was evaluated by asking teachers if the terms of the list made sense to them, if the list contained terms they might like to browse and if the results contained videos they would expect to find based on the terms they searched.

The main purpose of task 1.a.ii (locate a video or videos using grade level) was to determine how useful teachers believed browsing by grade level was and whether the NASA classification of grades was appropriate. As with other tasks this task continued to explore educator perceptions of basic functionality of the system. In particular this task was designed to see if the teachers would like to have more control over the number of results displayed and how they navigated through the results.

Task 1.a.iii (locate a video or videos using subject) attempted to evaluate the subject categories to determine if the categories were intuitive to teachers and if the subject categories were useful to the teaching task overall. Another purpose of the task was to elicit what educators thought of the most detailed video view. It specifically asked educators their perceptions of the storyboard preview, the links of the different video formats and access to related content.

Task 3.a.i (locate a video or videos using NASA program) was designed to determine how efficient NASA program was for searching for a specific video. Educators were asked to find the video “Virtual Earth” using the NASA Connect™ program. The video selected was one that appeared frequently in the list of terms used to search the web site. Next educators were asked if they could identify if the video title they found had segments and if video segments would be useful. Lastly educators were asked how they believed the relationship between video and video segment should be represented at the system level.

Task 3.a.ii (locate a video or videos using "Embedded Viewer" page) explored if the system performed as teachers expected it to perform. In particular this task focused on the functionality of the search box and the page itself. The "Embedded Viewer" feature was designed to give educators immediate playback access to the video collections. The video bar on the left side of the page cycles through different videos. If a user clicks on a video to the left then it begins to play in the video display. The Google custom search box on this page returns results from the five NASA program web sites as well as results from nasa.ibiblio.org. Educators may want to use this option when they are more interested in previewing video content than reading text metadata related to the video. The only text metadata this feature offers is the video title and the video duration. To access this information the user must either click on a video title to play the video or mouse over the thumbnail in the video bar. These differences were presented so that in the debriefing questions users could be asked which option they preferred.

Task 3.a.iii (locate a video or videos using "Google Video Search" page) presented users with another way of viewing and searching for video. This option sends users to the video.google.com webpage and allows them to search video.google.com for NASA videos. This task explored how educators might expect the given design to function. Overall this task is important because in the debriefing questions we asked which of the designs overall users preferred.

The purpose of task 3.a.iv (Locate a video or videos using keyword search) was to analyze how educators performed keyword searches. In particular this task focused on what teachers did to refine their search if the results were not optimal. In order to get educators to refine their search they were asked if they had considered specific options for refining their search, such as starting over with different search terms or using one of the system options for narrowing their search results. This task was also designed to try and elicit from educators what made them choose a specific video over another.

The script and interview questions are provided in Appendix I. Thirteen subjects who participated in the online survey portion of the study indicated they would be willing to participate in a follow-up interview. Email invitations were distributed to the 11 subjects who indicated their address was in North Carolina asking them to participate in the cognitive walkthrough and interview portion of the study. None of the previous participants chose to participate in the follow-up interview, so recruitment letters were devised and new participants were invited take part in the second phase of the research study. Twelve educators participated in the interviews and cognitive walkthrough of the prototype interface. All of the people who participated were teachers and one participant was also a planetarium director. For the remainder of this discussion this group of participants will be referred to as the "walkthrough participants". On average, walkthrough participants took 1 hour to complete the session. On-screen actions and audio comments were recorded using Camtasia studio software. Although most sessions went smoothly one session needed to be redone due to technical problems with the Camtasia software. In another session, comments were not collected on the Embedded Viewer and Google Video Search features because the school firewall restricted viewing of Google Video content.

Interview and Cognitive Walkthrough Demographic Information

Walkthrough participants were asked to complete the demographic portion of the online survey both to gather information about them, their teaching and their use of video, and to see how they compared to the online survey group. This section presents the most frequent responses walkthrough participants recorded in phase two for each of the demographic questions. The age distribution of walkthrough participants was 50-59 age range (41.67%), the 30-39 age range (25%), the 40-49 age range (16.67%), and the 18-29 age group and the 60 years and above age groups with one participant each (8.3%). Seven of the walkthrough participants were female and 5 were male. Ten of the walkthrough participants had obtained a Master's degree, the other 2 participants had obtained Bachelor's degrees. Five of the walkthrough participants reported they had over 21 years of teaching experience, 3 reported having between 11-20 years experience, 2 reported having 7-10 years experience and the 4-6 years experience and the one year or less experience ranges had 1 participant each.

Seven walkthrough participants were Caucasian. Eight walkthrough participants indicated the race of the majority of their students was Caucasian. Four walkthrough participants taught their courses in the state of Pennsylvania, 3 taught their courses in the state of South Carolina, and the remaining 5 participants taught courses in Massachusetts, Michigan, New York, Oklahoma, and Texas. Each of the sessions with the walkthrough participants was conducted face-to-face. Nine of the sessions were conducted in conjunction with a NASA workshop, two sessions were conducted on the University of South Carolina at Columbia's campus and educators were asked to travel to the university, and one session was conducted at a rural school in South Carolina. The participants in the NASA workshop were educators who had been invited to NASA's Langley location to learn about NASA lesson plans, educational materials, and datasets. Given the highly technical and advanced nature of the workshop, the 9 educators from the NASA workshop are not likely to be representative of the general population of educators. All twelve walkthrough participants taught in a formal classroom with one participant teaching in both formal and informal settings. The most common educational location was in a suburban area. The most frequently taught grade range was sixth through eighth grades with 7 walkthrough participants teaching at this level.

Nine out of twelve walkthrough participants had 25% or fewer students with special needs at their school. Nine out of twelve walkthrough participants' students received less than 25% Individualized Education Programs (IEPs). Four out of twelve walkthrough participants indicated their students received free or reduced price lunch; three walkthrough participants indicated 50-75% of their students received free or reduced price lunches and three indicated 25-50% of their students received free or reduced price lunches. Ten out of twelve walkthrough participants had less than 25% of their students classified as gifted or talented. Full demographic information is available in Appendix M: "Demographic information of interview and cognitive walkthrough participants".

Data was collected on walkthrough participants' actions, their responses to questions from the interview script and other general comments. Using this data, open coding analysis was performed in Nvivo to develop themes.

After completing the demographic information, the cognitive walkthrough and interview session was conducted in two parts. The first part focused on the browsing options provided by the prototype. After completing the first part participants were asked a set of debriefing questions concerning the first set of tasks. The second part focused on using the new features of the prototype and using the keyword search. After the second part, participants went through debriefing for the second set of tasks and finally an overall debriefing.

The Top 15 searches task asked participants to evaluate the terms in the list. Participants often commented that some of the terms didn't belong. The main reason for this was that they felt the terms were broad and they would have composed a different list of terms. During this task participants were also asked to evaluate the ability to switch between text, small thumbnail and text, and large thumbnail and reduced text views. Most of the time participants did not notice or ignored the icons to change between different views.

In the grade level browsing task, participants remarked that the categories provided were pretty standard and this high level of detail often met their needs. Participants noticed the previous, next and number of search results because that type of functionality is common to most search engines.

Participants in the study almost exclusively first explored the science category from the subject headings. Participants in the study saw related content as being a useful addition because it meant they did not have to perform a separate search for the material. Some of the terms in the subject headings (like Special Projects and Exploration Systems) weren't clear to the participants. These vague terms were only explored if educators had extra time. In these tasks, participants noticed the video formats; some asked for a definition of the formats when one was already available and they said they would use trial and error to determine the video that was compatible with their system.

Browsing by NASA program was a problematic task for most of the users. They mistakenly assumed that the collection was organized alphabetically and often made errors on the task of finding the video "virtual earth". Many participants skipped forward through the pages quickly and at about the 7th or 8th page, many participants realized that the organization was not alphabetical; from there they usually restarted their searches.

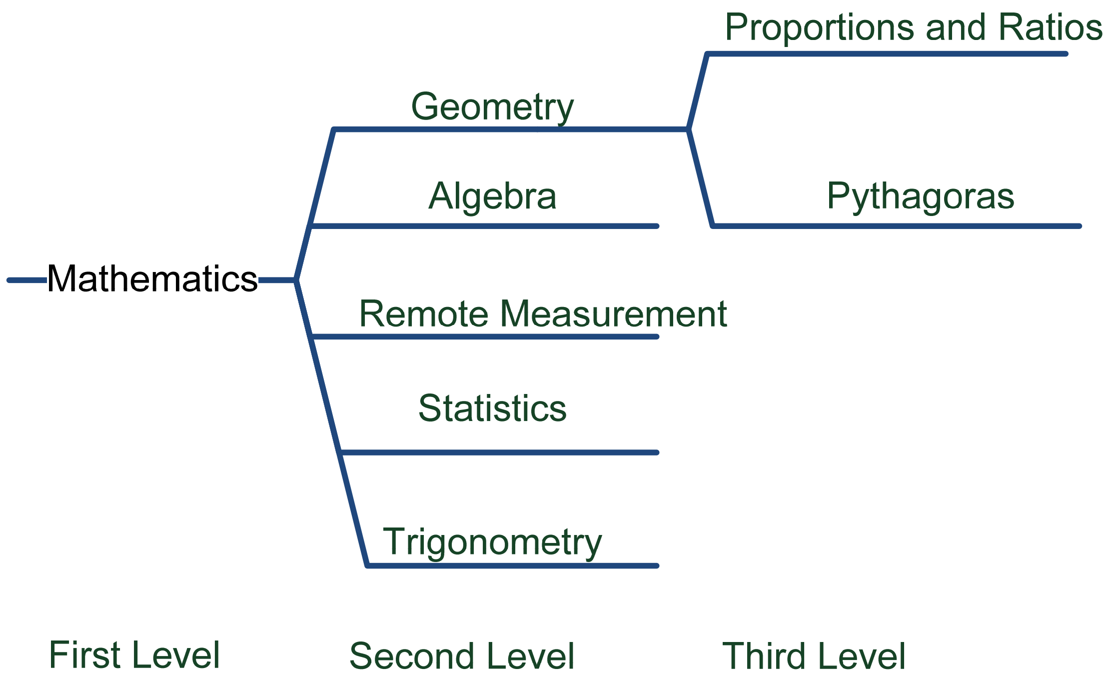
Additionally, participants in the walkthrough had trouble determining if videos in the system contained segments or if it provided segments separately. To fix this, participants suggested that segments be removed from the second level of search results and be placed at the video detail level of the system along with the related content and the full description of the video.

Overall, participants preferred the normal Web site searching and browsing over the Embedded Viewer and the Google Video Search features. On a scale of 1 to 3 participants generally gave the site a 3 for ease of search and relevance of information. Participants also said they would recommend the system to their colleagues and they would use the Web site in the future. The next sections describe specific findings and general themes that emerged from the walkthroughs.

Revising the Science Category

One theme that arose from the analysis of the interviews and cognitive walkthrough was the theme of revising the science subject category. Subject level categories were initially created using a subject classification system developed for the Noticiencias NASA and KSNN programs. This initial classification contained only top level categories: Science, Technology, Mathematics, Aeronautics, Exploration Systems, Science Missions, Space Operations, and Special Projects. Educator guides for videos in each category were consulted to help expand the subject level classification beyond one level. For the most part, the subcategories were helpful. For example, participant seven was excited about how math was divided into categories on the Web site (Figure 4.22) She remarked, “Yeah, that sounds good because… [Clicks on Mathematics category] NASA has a lot I can always apply science. Sometimes what I need what I have to do is get a little bit more specific on the Math. Oh my Gosh! Geometry. Oh Yes!! [Clicks on Geometry subtopic within Mathematics.] Oh look at that Pythagorean Theorem that’s even cooler. Proportion and Ratios that is great! Are these all NASA Connects? Oh, how cool is this?”

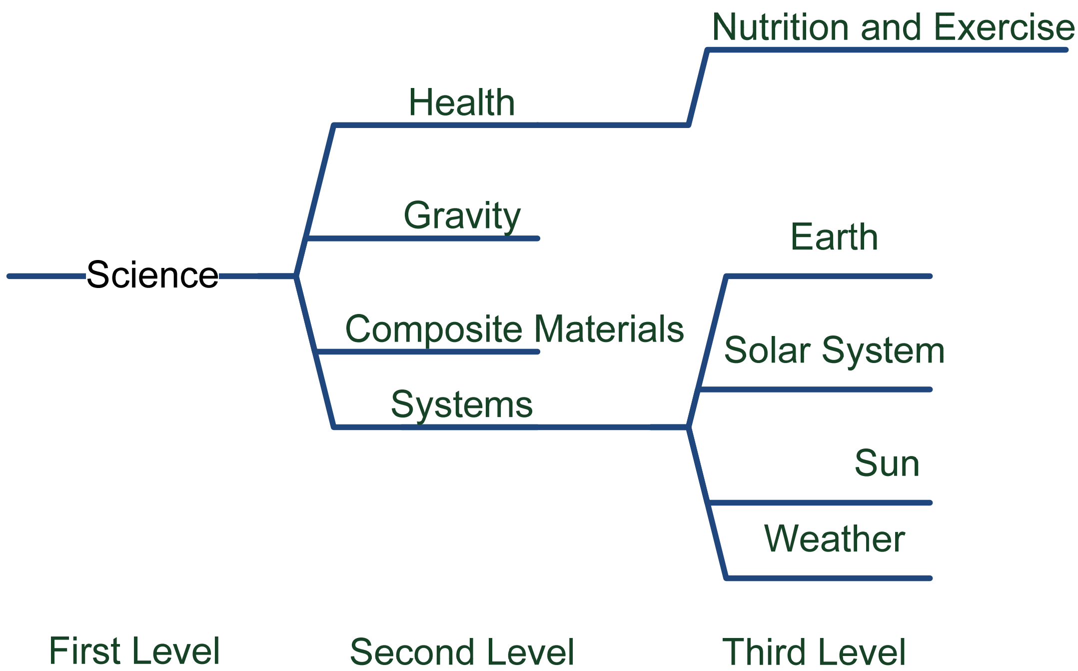
4.22 Mathematics category and subtopics



Comments for revising the subject level categories were primarily directed toward the science category, Figure 4.23 shows how the science category is divided on the Web site. Walkthrough participants consistently described the science category in the prototype system as broad. Participant two described the category as, "Very broad. I mean like science. In my particular view to even break it down—this seems to be NASA focused—if you said life science, earth science, physical science which are your three general sciences, and grouped it that way." Stated more specifically, participant four wished "…the subtopics were listed by the grade marks or the standards topics. Like physical science, biology, earth science…" and participant five wanted levels organized "[a]lmost by subject area somewhat".

One reason walkthrough participants were not satisfied with the science category was that it didn't contain enough subtopics. Participant nine described what she would like to see: "When you click science I would actually like to see 10 or 12 topics, in[stead] of just 4. 4 is just really a small amount."

Figure 4.23 Science category and subtopics



The breadth of the science category even caused one person to change how they searched. Participant three said, “When I look at this I probably would not search the normal way I would search because science is so broad. It’s not really saying life science or earth science or you know. So I would probably go back and do a search according to the grade level from just briefly looking at this.”

Overall this theme suggests that the science subject heading be revised to include subjects educators are familiar with, like life science, earth science, physical science, etc. This finding would also suggest that a classification system which is based on the different subjects would serve educators better than the current classification, which according to participant two was “NASA focused”. A revised classification should be more in line with how educators work and perceive their educational information problems.

Revising the Images and Text

Another theme that arose from the analysis of the interviews and cognitive walkthrough concerned the size of images and text. One concern was about displaying the video in the classroom setting. Participant 12 asked, “Now the only problem I see with using these in the classroom is that these would then go onto the television monitor and can you make these full screen?” Similarly participant ten remarked, “If I could make it use the whole page. I don’t know how to do that but I would think that you could do that.” Overall this theme suggested that participants wanted the ability to project video at larger sizes.

Another concern with images and text was the size of the keyframes in both the posterframes and storyboards. For many participants the size of the keyframes in the standard text+thumbnail view was too small. Participant seven said, “Oh okay. It’d be pretty nice if you could click on it and enlarge it a little bit. For us people who don’t wear glasses.”

The images were so small that in some cases they had an unexpected effect on the participants’ behaviors. Participant eight said, “It’s hard for me to see what is going on in many of these pictures, many of the posters so that’s part of the reason why I was ignoring them.”

Participant one changed her browsing behavior as well because of the size of the posterframes. When asked why her browsing behavior was different for the thumbnail view she remarked, “Can I tell you why? Pictures are too small. Pictures are too small [in the thumbnail+text view] I can’t see them. So if I was in this view I can’t see the pictures. This view [thumbnail view] it is actually big enough for me to see the pictures.”

Participant two preferred the thumbnail view because of the larger keyframes. She said, “Now I do like this one [thumbnail view] just because the pictures are a little bit bigger I can see them a little bit better.” Despite the pictures being larger in the thumbnail view some participants still expressed an interest in keeping the textual information the system offered. For example participant four said, “Yeah, if the size of the picture [in the standard view] were a little bit bigger that might be helpful. Like the size of the picture on the bigger picture one [thumbnail view] with all of the other information [title, description, duration] would be the best for me.”

One concern these comments illustrate is that in order to better meet the needs of educators the system needs to include the ability to resize video for classroom viewing. Further, larger images for the posterframes, and storyboards as well as larger texts and icons for the web site will lead to more satisfactory browsing experiences and reduce the need for users to change their own behavior to better use the system.

Revising the presentation of video segmentation

One problem that was known prior to conducting the interviews and cognitive walkthrough was that a better way was needed to represent the relationship between videos and video segments. Apparently this problem is not unique to this site. According to participant one, United Streaming (http://streaming.discoveryeducation.com/index.cfm), a Web site which provides online video to schools for a fee, has similar issues. With United Streaming schools enter into agreements with each other in order to share the financial burden of obtaining the online video service. Participant one had negative comments about the service, she remarked, “United Streaming embarrassed me a lot. Last year that’s why I had to stop and preview everything because several times I clicked on a video to get started and it was the same video they had just seen. So this is good.” However according to participant seven, video segmentation for United Streaming was straight forward. Participant seven said, “Again on United Streaming they have… how does it come up? It comes up and it tells you that it is a segment or a whole video but it doesn't have to be a whole video because a lot of times you know United Streaming there's broken up into segments."

Many times participants didn't realize the archive provided videos and video segments until it was brought to their attention. Participant two said, "[this] is a little bit confusing because the way that it is all listed here these all look like separate individual videos. Except for your duration time I wouldn't have known that this was part of the bigger picture." Participant three also discovered the relationship after it was pointed out. "With you telling me that, now I would assume that everything that has this similar thing [the acronym for video title] would be a similar one but I wouldn't know that was one entire video. Because I wouldn't know what the acronym was for at first. Studying it I would know that this is the Better Health from Space to Earth video and these are the segments. I would assume with you telling me… [From] me just looking at it no, I wouldn't know that."

Some walkthrough participants attributed not seeing the video segmentation to themselves as opposed to the system not providing them with enough interface cues. One good example of this is the statement made by participant nine who said, "No I didn't notice that. How can you tell the difference? Because I see like AATC future NASA technology... I don't know of any—if all of that is from the same video or not. I don't know if it's from this A—here is ahead above the clouds maybe that's what A-A-T-C stands for and these are all parts of that one. That's the only thing I could think…"

In order to improve user recognition of video segments, participants suggested indenting video segments after each full video or adding another level of navigation by only allowing users to see the segments after they had clicked on the full videos.

Relevance of Standards

Being able to quickly reduce the collection by standards was another theme which was important for all of the walkthrough participants. Walkthrough participants appeared to be satisficing by relying on metadata elements present in the system as substitutes for standards. For example participant one said, “Standards and subjects because what we teach are standard indicators, those are our subjects. Our standard indicators are our subjects. Like this one [video title] that says “A-Train Express” doesn’t tell me anything. So then I look over here [video description] and it talks about aerosols and explaining their effect on changing climate. All they had to do was say that um, something about ozone depletion. Or climate and weather.” In this statement participant one used terms in the description as a substitute for the standard. Similarly participant seven talked about browsing for keyword terms which specifically matched the standard she was trying to teach. Participant seven stated, “…The keywords really tell me more than the pictures do because that’s your vocabulary…Yeah and I probably could hopefully cover the standard looking for a specific keyword. Although sometimes it’s just nice to be able to just click on a standard and see how somebody else approaches it.” Other walkthrough participants performed similar actions while searching. Participant four said, “Finding something that looks appropriate, seeing that the keywords match with the standards that you are trying to teach is a huge bonus.” These comments highlight how standards currently drive and shape the process of finding usable educational materials. In particular they show how educators adapt to information systems which do not have standards level metadata. Furthermore this information suggests that the vocabulary used in title, description, and keyword fields act as a substitute if standards metadata is not present.

Importance of Grade level

Walkthrough participants generally used grade level information as a guideline, especially for at-risk students. For example participant two said, “When we say grade level 3 through 5, okay, I’m thinking it’s 8th grade material and understanding. If this is basic enough for them to understand and present it as it was a 3rd through 5th grader. Like we study Northern Lights, to me that is an 8th grade standard, but if it is on a basic enough idea then my resource kids are going to get it...”

Similarly participant eight said, “I see there are 2 [videos] for 9 to adult. I probably would take a look at all of them although there are 63 [results]. Because sometimes kids will watch a junior high middle school kind of thing, if it’s not too long and get something out of it. And I can introduce it in a way that will make it useful to them.” Participant nine further explains why educators can make the substitution for grade level material. She said, “I’m looking at it and it says grades 3-5. So I would probably watch it and see how basic it is because the bottom line is sometimes during the class I am going to say let’s talk about what static electricity is. I could always sit there and say the exact definition of static electricity… is or I could click on it and have someone else tell them what it is. And most of the time they would rather have someone else tell them rather than me. So even if it is a small kid saying it, then you know it would probably still be used just depending on how they describe it or how they discuss it.”

Overall these comments suggest grade level was important but teachers had the ability to use material marked as other grade levels. This was done in cases where walkthrough participants felt it was appropriate for particular groups of students or in an effort to illustrate a certain point. Also evident from these comments is the fact that educators were able to articulate the level of the resource in relation to their students. In many instances resources were classified as too basic, about right or advanced. This more implicit categorization is what drove walkthrough participants to set aside resources for further review.

Preferred Seeking Style

As walkthrough participants continued using the Web site they quickly developed personal preferences for the options presented by the prototype. When asked about the way they preferred to start their exploration their answers varied. Some participants said that subject was their preferred method of browsing. Participant five said, “I would probably hit subject first. I can’t really give you a good reason but that is normally what I would do if I was searching for something -- I would look to make sure it fit the topic.”

Participants also demonstrated preferences for narrowing browsing using multiple options provided by the system. Participant eleven said, “I would probably begin with science and I would go into grade level and I would wait to see -- if I was looking for a specific topic then I would start with that…”

Other participants preferred using the Top 15 searches or some alternative way not explicitly present in the system. An excerpt from participant six’s transcript demonstrates his preference for the Top 15 searches:

Participant six: I’d go here first.

Interviewer: Top 15 searches?

Participant six: Yeah, because it has spelled it out what I need.

State standards were the most frequently mentioned style not currently in the prototype. Participant four said, “By state standards. By state standards definitely. Yeah that’s the way I usually do it with the United Streaming which I do to introduce and review topics all the time. I find that that's the easiest way to search by state standards because then it separates it by grade level, it separates out the, you know, it does it all for you."

Participants also suggested other ways for accessing content.

Participant five: I don't know whether—I was trying to think maybe by recommendations or something but I'm not sure.

Interviewer: Okay. So being able to see the things that other teachers have said.

Participant five: Have said. Umm, GPS [NASA video title] this is a great movie by such and such a teacher who used it. That's one that came to mind right away -- something that had a recommendation to it.

In general all participants developed personal preferences and strategies for using the prototype quickly. These strategies were based on the components offered by the system, the information participants sought, and their previous searching experience.

Posterframe and Storyboard Surrogates

The walkthrough participants had varying perspectives on the usefulness of the posterframe and storyboard surrogates. Perceived usefulness was dependent on a number of factors. The first factor which played a role was preferred content style. Content style refers to whether participants expressed interest in the reduced text and large thumbnail view, the text and small thumbnail view or the text view. For example, participant one indicated that she, "preferred pictures" but if not given another choice "would read". On the other hand, participant three remarked, "…[b]ut the thing is you don't know what they are talking about. Is there going to be a way where you can print off what the entire video is talking about? …[like] a summary and then like have the minutes [under each story board] like at this minute this is maybe 2.4 minutes and you can tell from that description what they are saying at that exact time." Participants whose preferred mode was textual wanted some text or subtitles to give the images more meaning. The majority of the participants fell in the middle of the spectrum and were like subject two who said, “I actually like that middle one [text and small thumbnail view]. Yeah, cause I can see that there is a picture and I can read a little bit of the description. Now I do like this one [reduced text and large thumbnail view] just because the pictures are a little bit bigger -- I can see them a little bit better. But just seeing that it says above clouds, I would have never thought to look at that one for hurricanes. So having the description with the picture is really much better for me. So I can see what kind of—more detail is in the video. And then I can look at it even further, obviously by clicking on it. But yeah, I like that one.”

The second factor which influenced the usefulness of the storyboard was prior knowledge and/or experience with video content. Participant 6 was able to recognize specific keyframes from the storyboard. “Yeah, this actually parallels some NOAA activities tracking on hurricanes… Those pictures are worth their weight in gold to me. Yep, that’s really valuable.”

Participant 11 made similar inferences from his prior knowledge of NASA material and NASA missions. He said, “I’m looking at this and I’m seeing what looks like the red oxide surface of the Mars; however I can’t really see if that’s Spirit or Opportunity there. So then I am deferring to reading this and I don’t see… I see Mars Rover, I’m making [an] inference that this is referring to the Spirit or Opportunity. I’m wondering if I click on this if there will be something related to the Geology on Mars like the blueberries on Mars or how they drill the surface of Mars…” In this previous comment participant 11 refers to rock formations on Mars that are known for their blueberry-like appearance and is able to speculate about some further content the videos might contain. Other walkthrough participants with prior knowledge were also able to see particular storyboard pictures and make extrapolations on the type of content. If video content contained material which triggered a participant's prior knowledge, participants generally felt the resource was of good quality.

A third factor which played a role in the perceived usefulness of the posterframe and storyboard surrogates was the visual attractiveness of the actual surrogate. Posterframes served almost the same function as attractive book covers. When the posterframes were aligned with the topic and represented easily recognizable topics, it seemed to be more likely that walkthrough participants would explore them further. Participant five reported, "And that's kind of what I thought the picture looked like [posterframe]… the actual satellites. Kind of caught my eye there… Well, knowing a little bit about GPS and knowing that you need at least 4 satellites to have a good link to your receiver, I saw that [in the posterframe] and I was like "ahh, okay. There are your 4 satellites…" Participant six confirmed, saying,, "Eye catchers like this [are important]. That's an eye catcher. [Points to Posterframe]… It is a space probe. You can see a heat shield right there. And I haven't read what it says here but let's see what it looks like." The visual attractiveness factor was also sometimes influenced by a walkthrough participant's prior knowledge, as the previous comment shows.

The posterframe and storyboard surrogates suggested desirable functionality to the participants that is currently not available. For example, participant two asked, "…I like that. Is that printable? Participant six also asked about the possibility of bringing up specific keyframes. "…[y]eah because you'd maybe like to start a discussion out on deep space with a picture like that on the screen. I have a digital projector." For others the storyboard suggested to them that they could get video previews. Participant four remarked, "…it would be really neat if you could like click and watch a small clip of it, you know, on that in the story board. Because you could get a real preview that way. You know I might click on that activity one down a little ways, this one right here and see what that is all about…" Participant seven similarly said, "I guess I thought I could click on the picture and it would bring it up. It appears as if it were broken into segments, so if I were looking for something specifically I wouldn't have to view the whole video. Which I do like that. [Clicks on pictures repeatedly.] But I can't click on the picture." As the previous comment suggests, sometimes the affordances associated with the storyboards were so strong that lack of the expected functionality created frustration for the user.

One interesting dialogue about the storyboards took place between participant nine and the interviewer.

> Participant nine, "The pictures? Well I haven't clicked on one -- let me click on one and see what happens. These don't do anything?
>
> Interviewer: No the pictures don't do anything.
>
> Participant nine: Oh, well what are they there for? Hah Hah. To see what's—basically these are clips from the video and stuff? They would not really do much for me until I actually reviewed the video -- it wouldn't make any difference to me. They wouldn't make me decide I wanted to see it or not. You know it just depends on what they are talking about when they have the pictures."

This conversation again highlights that both prior knowledge and the ability to click on storyboards has the potential to enhance the pictures' usefulness. Overall, the comments from the walkthrough participants provide several possibilities for improving the prototype and making it more useful and searchable from an educator's perspective.

Use of Video

Another theme that arose from the analysis of the interviews and cognitive walkthrough was how walkthrough participants discussed their use of video in the classroom. Walkthrough participants were using video as a supplement or in conjunction with other activities and materials. Participant one said, "…[i]f you have an educator guide to go with each one even though the information is dated, it still is going to reinforce all the things you've taught in school. These are not lessons by themselves, these are supplements to what you're already doing. These lessons don't stand by themselves. Cause if they did then why would they need me? So this is a supplement." This idea of supplementing the video can also be described as using video with a purpose or using video as one part in the larger context of the lesson plan. Participant seven's comments best describe how educators used video with a purpose. She said, "…if there's not student [pages] I may have to create stuff, even if it's nothing more than taking out a transparency and writing out the keywords. Okay, these are keywords; we are going to be looking for definitions or something… They need to be constantly thinking rather than just watching a video."

Teachers also described using video in difficult or special circumstances. Participant two said, "This would be something I would use more in the individual instance. If I had that student—that resource student who probably was having trouble with a concept, I might say okay everyone else is doing this why don't you sit on my laptop and I want you to watch this one and I might pull it up and it might help them understand." In these cases the video was used as a tool to help students who were behind or as an additional way of explaining difficult content to the entire class.

Not only did walkthrough participants use video to teach difficult concepts to their students, sometimes they also described learning from the video and web materials they found. Participant nine described this when she said, "Actually this does because I realize without even looking at anything it's very low level which is 3 to 5. Ah, it has some interesting concepts that I can tell in here but it has a lot of the younger younger kids which would turn my kids off. …but I probably would watch it just to see what they are doing and then do it in class myself.” This comment demonstrates that teachers are constantly on the search for material to use in their class and are not unwilling to adapt materials to make them more useful as long as the content is relevant.

For these educators the purpose of using video was to supplement the current material while engaging students. Walkthrough participants also used the items from their searches to adapt or replace outdated materials and help bring a deeper understanding for topics which students had a difficult time grasping.

New Interface Features

Three features were introduced in the prototype in an effort to see if alternative methods of browsing and retrieving video information would be preferred by educators. The first feature was a list of the Top 15 searches done on the nasa.ibiblio.org web site. The walkthrough participants had varying opinions on the usefulness of the Top 15 searches. Participant two said, “I don’t know that that is necessarily important. I like being able to click on it real easily. Like I said again, if I can put in space myself up here and it would pull up something like this that would be more—I don’t necessarily care if that makes any sense what other people are searching…[it’s] more important to me to be able to search it for myself.”

Participant six had a different opinion on the usefulness of the Top 15 searches:

> Participant six: I’d go here first.
>
> Interviewer: Top 15 searches?
>
> Participant six: Yeah, because it has spelled it out what I need.
>
> This is general, [but] that is specific. This doesn’t matter to me, [and] that doesn’t matter to me.

Interviewer: So what you just said was Top 15 searches first, subject second,, grade level doesn't matter and NASA program doesn't matter.

Participant six: I might even go one, two, three, four in that order.

For all participants, being able to perform specific searches themselves was important and they desired to do so to save themselves time. The Top 15 searches were more important for people when a high number of the terms on the list matched the curriculum they were teaching. The Top 15 was not important at all to people who didn't have a curriculum match or would have used more specific terms to search.

Another finding from the Top 15 searches feature was that some prior knowledge was necessary in order to fully understand the list. For example participant one said, "It gives you enough to want to know where to go next… What you want to go next. Go to. But you need to know what this means. What does SCI Files mean? What does Connect mean? Other than that. What does Destination mean? Where are we going?" Participants who had prior knowledge of the NASA videos were able to look at the terms in the list and recognize that certain terms on the list matched NASA programs. Participants without that knowledge couldn't pick out the NASA programs and found the terms to be confusing.

The second feature introduced was the Embedded Viewer feature. When asked about the Embedded Viewer feature, participant four said, "I didn't think I would use this. First of all I thought it scrolled too fast. I thought it was really good that when you scrolled on top of it showed the title or the topic. I'm not sure if it shows title or topic. More topic than title. I thought that it scrolls too fast -- it doesn't give you time to get the information of all of them off of it." This comment reflects the views of many of the participants. For a few participants the visual aspects of the feature outweighed the negatives. One participant who maintained a positive perspective on the Embedded Viewer said, “I like that idea actually. Again being more of a visual type set up, first of all it is eye catching. I guess not only would I look to see what kind of picture it is; is it a picture that is related to a topic I am going to cover. I guess you could kind of get rid of some text but I guess this would take more room.” However for the majority of the walkthrough participants the Embedded Viewer didn’t provide a pleasant viewing experience. Participant eight’s comments reflect this. “Well, I assume it’s going to play a video but I can’t find something. Like maybe that was about the polarity of water, [points to posterframe of KSNNe – Las Burbujas which quickly disappears] because it had plusses and minuses in it and it disappeared. I have no idea how to get it back. Unless it is really, simply going through them. I guess it is going through a cycle. I’m not finding this very useful.” This comment captures the essence of why the Embedded Viewer was not considered useful to a majority of the walkthrough participants. The first reason was control. Participants wanted to be able to control their browsing experience, but with the Embedded Viewer participants were constrained to the scrolling functionality of the video bar. The second reason was participants did not understand how the system worked. With posterframes of the video and title information only available through mouseovers, the feature was not intuitive to many educators and they were not clear how it functioned. Participants needed to access more information which told them how to use the system and more information so they could make decisions about which videos to select further.

The third feature introduced was the Google Video Search. Walkthrough participants were not enthusiastic about Google Video search and generally not sure about what to do on the initial page (See Figure 4.18). The Google Video Search initially provides one posterframe of the first video in the collection, video title, date information and a description of the video which includes an indication that the video is housed on Google Video or YouTube. The page also has options to display the size of the search results in increments of 1, 4, and 8 and a search box which contains "www.open-video.org NASA". The overall reaction to the first page of the Google Video Search was one of confusion. In the following excerpt the interviewer walks participant seven through using the initial parts of the feature

> Interviewer: What are some of the things you notice about this display?
>
> Participant seven: It's one picture.
>
> Interviewer: Did you notice that it has the little icons so that you can change the display?
>
> Participant seven: Show more results. Oh. Show all the results. That's interesting. What did we put in? We just did a Google.
>
> Interviewer: What we did was the web site donated the videos to Google and so this is actually searching the web site YouTube and Video Google.com and it's coming up with the same videos that we have on our web site but it gives you the option to view the videos on their website.
>
> Participant seven: Oh, that's cool, the little mini descriptions. So I clicked on Google Video search. Is this showing all?
>
> Interviewer: This is showing all the videos in the collection. If you click "search" there, it will take you to Google[video].
>
> Participant seven: It takes me where?

The majority of the walkthrough participants were initially hesitant at exploring the Google Video Search and the different aspects of it. Part of the reason why participants may have been hesitant to explore the feature is the lack of text. The icons to increase the size of the search results were rather small and although mouseover actions would reveal tool tips, the majority of walkthrough participants did not discover this on their own. Instead, walkthrough participants needed to be prompted to click on an icon or the icon had to be brought to their attention. These actions are similar to the behavior walkthrough participants exhibited in relation to the different views offered by the Web site.

Another potential explanation for the lack of exploration is most walkthrough participants expressed mistrust of YouTube content and this lack of trust in the Web content led to reduced use. Participant seven had the following to say about YouTube,"... That's just a bunch of weirdo… people there… And our school has such web site constraints on it that I probably wouldn't be able to go there, to be honest, because if it brings up anything like that… I just heard some really negative things about that… But this, I like this. More results. Now what's it doing? Oh, how cool. I love that. The ratings. So how do you rate it? That is something I really do like. That is something I look for." Despite expressing such negative comments about YouTube, participant seven appeared to like the Google Video Search feature.

The three interface features of the prototype provided a unique opportunity to evaluate different aspects of educators' information seeking. Comments that educators made regarding both the top15 searches and Embedded Viewer features indicate that they valued control over their search and the ability to personalize searches to their specific needs. Comments from the Google Video Search feature indicate that educators have a distrust of YouTube content and believed that it would not be useful in their educational setting due to firewall constraints. Overall, walkthrough participants did not find the display of the Google Video Search feature to be appealing or motivating in terms of search.

Summary of Interview and Cognitive Walkthrough results

Walkthrough participants generally described the prototype system as user friendly and reported that they would use the system again. When asked, the majority of the walkthrough participants indicated they would recommend the web site to a colleague. There are several insights from the comments of the walkthrough participants which can be used for improving the web site and making the information seeking of educators easier.

Several themes from the walkthroughs suggest immediate revisions which need to be incorporated into the prototype. Specifically, walkthrough participants described the science category as being inadequate, as desiring larger images and text displays, and as wanting clearer representations for videos and video segments.

Additionally, the new interface features that were incorporated into the web site need to be refined further before they are included in the final web site. In particular, the visual aspects of the Embedded Viewer were desirable to some, but the lack of control that came with it was not. For the Google Video Search, walkthrough participants desired some way of rating videos but were wary of the problems of accessing videos from YouTube and Google Video. Some walkthrough participants were very aware of the video content belonging to YouTube and others did not seem to recognize this fact. Regardless of what the participants recognized, the fact that school firewalls may block sites like YouTube and Google Video will require the visual components of the features to be implemented, and the video content to be provided, locally from the nasa.ibiblio.org web site rather than from external web sites.

One finding that needs to be explored further is preferred seeking style. Educators often mentioned searching by subject or standards as their preferred ways of interacting with the system. For these subjects the criteria they used to evaluate video were standards-based. On the other hand, Lawley, Soergel and Huang’s (2005) previous research suggested that professors looked for videos in which students could identify with the personal experiences of characters in the video. In order to increase the usefulness of online video, systems need to facilitate users' ability to search through implicit criteria as well as well as explicit.

Perhaps the most interesting finding from the walkthrough was the interactivity educators wanted from the posterframe and storyboard surrogates. Several different ways of improving the surrogates were suggested, such as adding transcript information which matched the action in the keyframe, adding functionality to allow keyframes to be enlarged, and adding functionality to link keyframes to the portion of video from which they were extracted. Future research should develop implementations of these ideas and test them further to see if they improve retrieval performance and/or facilitate the process of making relevance judgments. This research should also strive for a combination of affordances which meet the needs and expectations of educators.

Summary of Research Findings

In the first stage of the research, web transaction log analysis and an online survey were conducted to understand the current state of the system and assess how the site was being used. The TLA provided several important findings. A variety of digital libraries and search engines were the top referrers to the nasa.ibiblio.org Web site. Furthermore, the frequency of video metadata views were slightly greater than views of video titles. These two findings suggest that users may be entering the Web site from points other than the path provided by the Web site. The NASA programs with the most activity were NASA Connect™ and NASA SCI Files™. The grade levels corresponding to these programs were 6^{th} through 8^{th} and 3^{rd} through 5^{th} respectively. To some extent, this finding reflects the size of each program in the collection. At the time of the study NASA Connect™ contained 35 full videos and 187 segments, NASA SCI Files™ contained 17 full videos and 171 segments, Destination Tomorrow™ contained 14 full videos and 61 segments, KSNN™ contained 55 full videos and Noticiencias NASA™ contained 40 full videos. For example, NASA Connect™ is 38% of the items in the collection when you include all the videos and the segments. In terms of number of total downloads, NASA Connect™ is 28%. Despite the differences in the number of videos between collections, normalizing videos does not give a true picture of video use because segmentation is not the same across collections. Given this caveat, the unnormalized results may suggest high use among elementary and middle school environments. The only category in which NASA SCI Files™ and NASA Connect™ weren't the top programs accessed was the view of video metadata. This category was led by the Noticiencias NASA™ and KSNN™ programs.

The online survey asked educators about their use of online video and related content. The findings related to curriculum standards, Internet connection speeds, and the importance of educator guides and lesson plans to educators did not agree with previous research. In particular, previous research placed high importance on standards, whereas this research found mixed results in relation to the standards. Previous research also found that Internet connection speed was an issue for educators, in this research Internet speed was not a prevalent challenge. The contradictory findings indicate that these variables may have changed since they were last studied or they may be dependent on the individual setting of the educator, or these different results may be the result of the sample size of the online survey. Educators who used online video felt the videos contributed a fair amount to the classroom as a learning resource. Additionally, educators who used online video were highly motivated to find them if the resources weren't available from their primary sources. Colleagues and Web sites were the most frequently reported ways educators used to learn about new Web resources. Educators in the online survey relied on Google for their information seeking of educational web materials.

After the web logs and online survey were analyzed, design decisions were created to develop a prototype web site for the delivery of nasa.ibiblio.org online video content. The design decisions addressed the navigation of the Web site, access to related content, the addition of visual surrogates of the video, and improved search of the Web site by adding additional metadata. In addition, a series of new features were developed also to see if educators would find content which was closely tied to Google searching useful.

The interviews and cognitive walkthroughs were conducted to evaluate if the changes made to the prototype helped educators to understand and interact efficiently with the Web site. Overall, walkthrough participants described the prototype system as user friendly and reported that they would use the system again. The cognitive walkthrough revealed several ideas which can be used to improve the information seeking of educators in the prototype and other online digital libraries.

The first theme was immediate revisions necessary for the prototype. Walkthrough participants described the science category as being inadequate, desired larger images and text displays and wanted clearer representations for videos and video segments.

The second theme was the perceived utility of the three new interfaces. The educators desired the scrolling posterframes of the Embedded Viewer but wanted to be able to pause the video bar queue, and for the video bar queue to provide textual metadata. For the Google Video Search walkthrough, participants desired some way of rating videos, but were wary of the problems of accessing videos from YouTube and Google Video. Future research should investigate incorporating the desired visual components of the Google Video Search and the

Embedded Viewer so that nasa.ibiblio.org web site can provide the content rather than an external web site.

Perhaps the most interesting finding from the walkthrough was the interactivity educators wanted from the posterframe and storyboard surrogates. Several different ways of improving the surrogates were suggested such as adding transcript information which matched the action in the keyframe, adding functionality to allow keyframes to be enlarged, and adding functionality to link keyframes to the portion of video they were extracted from.

CHAPTER V

DISCUSSION

The purpose of this study was to address the research questions posed at the beginning of this dissertation. In the first phase of the research an online survey and Web log analysis was undertaken to evaluate the current users of the system and their information seeking patterns and preferences. In the second phase of the research, a cognitive walkthrough was performed with a prototype to gauge how well the current system met their information needs and to determine if a list of practical changes could be developed to improve the prototype.

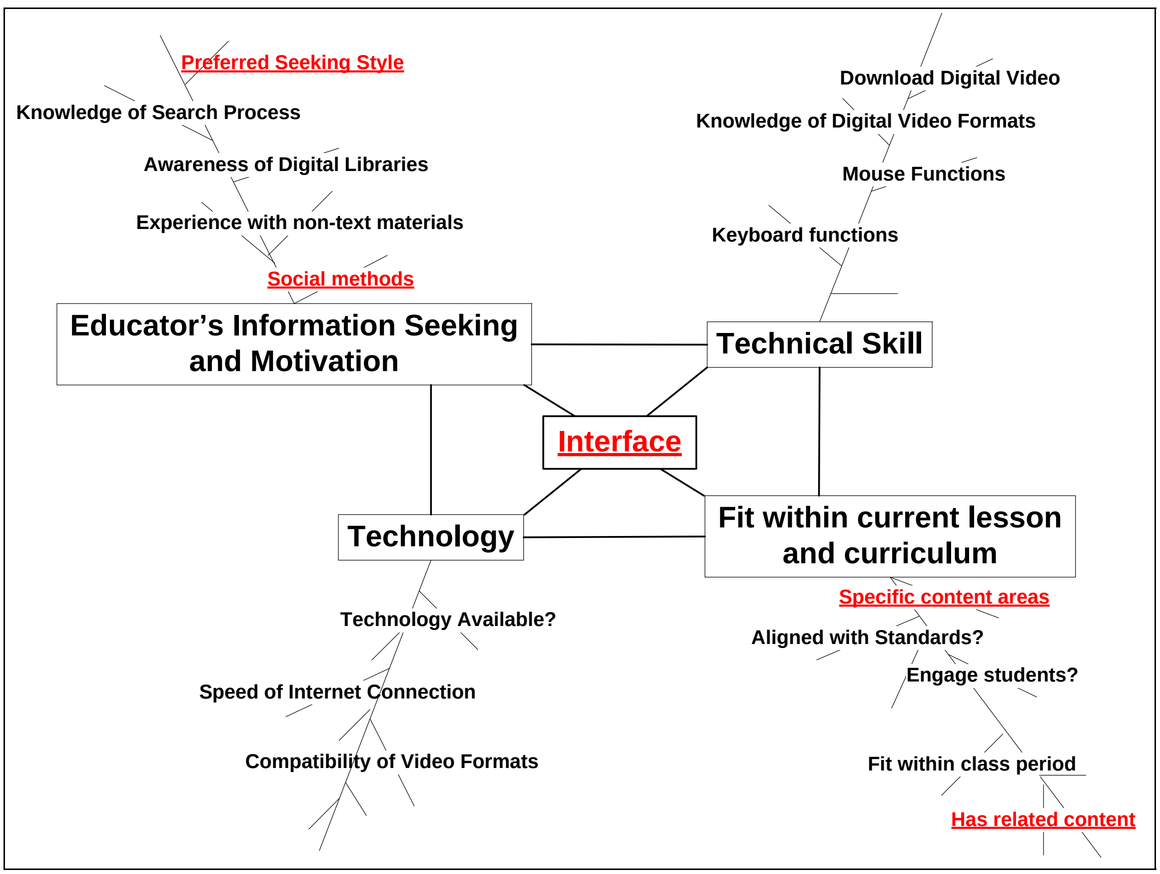
Research question one asked who used this digital collection. This research found the materials from the 3rd to the 8th grade range captured a large portion of the use. Additionally, the collection's Web traffic originated from related digital libraries and search engines. Research question two asked about the information seeking process of educators looking for online video. Results from the study indicated educators use a variety of social resources in their search for educational information. During the study, educators narrowed the collection by subject and used their knowledge of educational standards to search through the fields provided by the system. Educators expressed a desire for a highly interactive system and appreciated the visual qualities provided by the storyboard and posterframe surrogates. Research question three asked how well current retrieval systems meet the needs of educators. Many current systems fail to incorporate the standards based metadata that educators require for their work or fail to incorporate innovative ways for educators to share educational materials. Research question four asked about practical ways to improve the current system. The practical recommendations suggested by this study are to add a classification which would allow educators to narrow information by subject area, provide educational users with a way to manipulate the size of the fonts and images in the system, present the relationship between videos and related videos in a more coherent manner and continue to implement related content as part of each online video record.

Earlier, I presented the Web of Criteria model (Figure 2.1) which seeks to explain the probability a teacher will have a successful interaction with retrieval and use of online video. The model was developed based on personal observations from a focus group and from salient factors drawn from the literature. Nodes in the model represent different criteria related to the retrieval and use of Web based video; if any one criterion cannot be met then the web is weaker and the chance of a teacher being successful in that particular interaction is diminished. In this section, I discuss the results of this research and use them to revise the Web of Criteria (Figure 5.1), the new nodes of the model are underlined and shown in red. It was clear that there was no consensus on a strict order of precedence of nodes in the model, so I removed the arrows in the revised model to reflect this observation.

Information Seeking and Motivation Node

The Web logs and transaction log analysis showed that digital library providers and search engines were the largest identifiable referrers to the Web site. This information, combined with the fact that video metadata views were more frequent than video title views, suggests that users are not relying on the paths provided by nasa.ibiblio.org to browse and search. In relation to the Web of Criteria, this finding suggests some educators' awareness of nasa.ibiblio.org (*awareness of digital libraries* node) may be inextricably linked to outside referrals. This linkage in some instances may mask the full details of the information provided by nasa.ibiblio.org from the user because their only interaction would be with the external search engine and the single page the search engine refers them to. Given this finding, one recommendation to educational digital libraries is to implement TLA as a part of their monthly reporting. TLA can provide understanding of the entrance pages, the exit pages, and the duration of visits for the digital library. This highly specific information will help educational digital libraries to develop strategies for exposing content to search engines and turning single time users into repeat visitors.

Figure 5.1 The Revised Web of Criteria



With respect to the online survey findings, educators ranked a variety of resources relating to social networking as being important to how they searched for online information, including colleagues, listservs, professional conferences, and professional journals. This word-of-mouth information seeking maps to the *awareness of digital libraries* node in the Web of Criteria and suggests that educators use a variety of *social methods* to spread the knowledge of useful resources. This finding is supported by Yang's (2005) work which found that professors participated in informal "word-of-mouth" information seeking with their colleagues. Adding a *social methods* node to the *educator's information seeking and motivation* node reflects this reported need.

A few walkthrough participants liked the ratings which were a part of the YouTube system as seen from the Google Video Search feature. Implementing a rating system for educators would fall within the newly added *social methods* node. Their comments also suggest that more features should be implemented which pull the personal experience of teachers into views like recommender systems. A recommender system for online video would allow educators to rank their favorite videos and allow educators to benefit from the comments of their colleagues. A recommender system also has the potential to save educators time and, if coupled with other communication tools, could facilitate social interaction with colleagues. This finding is supported by Normore's (2005a; 2005b; 2005c; 2006) series of focus groups which suggested educators desired to use *social methods* like recommendations and communication tools in their work. In addition to recommender systems in which users are allowed to leave comments about specific instructional tools, educators may be interested in searching by teacher profiles. In this scenario an educator performs a search which defines their subject, current unit and grade level and the system returns profiles of teachers and the educational materials they used. Other services which digital library providers might implement to facilitate the social aspect of educators' information seeking include the ability to email various content like educator guides and online videos, and listserv or newsletter functions which provide updates about digital library content.

Analysis of the queries submitted to the Web site revealed a large amount of queries for STEM concepts (22%), followed by queries for video titles (9%), queries in Spanish (4%), queries for NASA programs, queries which contained typos and misspellings (3%)and queries for NASA programs (3%). The nature of these searches could indicate problems of clarity with the Web site because queries for NASA program (i.e., NASA Connect) can be more efficiently accessed through the browsing paths. This data could also be suggesting that some users have a preference for performing searches as opposed to browsing for information of which they already have partial knowledge. With respect to the Web of Criteria this suggests that educators' *knowledge of the search process* will inevitably vary due to unfamiliarity and the need to learn search patterns specific to each Web site. Ideally, designers should strive to make the body of prior knowledge necessary for using the system as small as possible in order for interactions to be successful. With respect to design, the implication is that developers need to weigh the trade offs of branding their collections versus making that content searchable. In this case the brand was the NASA name and the NASA program. In the previous version of the system, the brand drove how educators accessed the system because other than keyword search, the only method for browsing was NASA program. Branding does have the effect of confirming the validity of the resource, but once educators are on the Web site they know what material they are searching, and the need for the brand decreases. Additionally, adding too many references to the brand of the digital library decreases the amount of information the digital library can transmit to the user about the content of the resource. Another approach would be to provide educators with methods of searching and browsing that are similar to other sites or that are more general; this would be helpful because it would allow users to rely on their past experiences.

From the cognitive walkthrough another theme that became apparent was the *preferred seeking style* educators developed in relation to the prototype. With respect to the revised Web of Criteria this suggested a *preferred seeking style* node should be added. This node refers to the primary method educators used to interact with this system. Generally the preferred seeking style used by the participants matched the relevance criteria they used for selection of video. Yang (2005) conducted a similar study which looked at professors' selection of video. From all the participants in her study, Yang (2005) proposed three relevance criteria used for the selection of video: textual, audiovisual and implicit. Within the textual category, Yang (2005) found topicality was the most important criterion used for the selection of video. For this study the topicality was the content; video used in the classroom needed to match the topic and standards educators were currently trying to teach.

Preferred seeking style in this study appeared to be closely related to the interface and the task of selecting video. Participants in this study used all three types of Yang's relevance criteria for various reasons. Some participants who looked for textual characteristics in the prototype did so because the image surrogates were small. For many, the textual characteristics of the prototype were used to understand how closely the video matched educational standards. For others, textual characteristics of video were the preferred method of search and images added little information to the process. Future research might address the relationship between preferred seeking style, interface components and individual learning style.

Audiovisual characteristics were very important to a second group of participants. These characteristics were most important when browsing video or for tasks when there was no predetermined goal. In this case participants looked for “eye catchers”; visual surrogates which described content with one or two key frames. However, audiovisual characteristics alone were not enough for participants to make video selections.

Most participants who relied on audiovisual content developed a pattern of searching and browsing the prototype. First, participants would navigate down a set of search results browsing posterframes. Once an appealing posterframe was found they would navigate across the page to explore textual characteristics at that level, such as title, description, and duration. If the video was both visually appealing and contained matching textual content then they would click on the link to see more video information. At the next level of detail, participants would use the storyboard to obtain further information and sometimes explore related content. If video continued to appear relevant educators would then mark the video to be previewed later.

Yang (2005) describes the implicit category as being based on “interest”, “appropriateness” or “pedagogical value”. This aspect of relevance was observed with the participants in varying ways. For one participant, the focus was on examining everything related to “systems”. Systems in this case referred to all systems, e.g. technological, biological, or environmental. The participant was interested in all systems because this was a topic that he felt wasn’t covered well by the standards of his state. Others looked for information on topics of which they had prior knowledge to do a comparison to see if the information they could find on the topic was better than what they had. Another example of implicit criteria was the teacher who looked for examples of African American and minority scientists to use for her classroom. She looked for African American scientists because she was part of a research study examining how minority youth conceptualized careers, and she needed examples to expand her students' mental models of career paths available to them. For many of the participants implicit criteria were important, but these criteria were not necessarily the first purpose of their search.

Overall the *preferred seeking style* node attempts to capture the coping mechanisms participants developed for learning a new system. In general, many participants developed strategies which took advantage of the system components while at the same time revealing the information they needed to complete their task. Finding ways to teach these most efficient paths to users through design cues might improve overall satisfaction with the system. The findings related to *preferred seeking style* may also suggest new selection criteria for visual surrogates. Future visual surrogates might be selected based on visual appeal to educators and how close those surrogates are to STEM concepts. This would mean visual surrogates of individual actors would not be good candidates, but representations of past scientists like Newton; similarly pictures of highly recognizable topics like hurricanes or the aurora borealis would also make good selections.

The *educator's information seeking and motivation* node was revised to include *preferred seeking style* and *social methods*. The branches in this node are dependent on the personal knowledge and characteristics of each individual educator. These branches also reflect the set of information seeking strategies educators use to interact with the world and the mental models which govern those actions.

Technical Skill Node

The nodes under technical skill did not appear as individual themes in this study. Instead, this node appeared in interaction with the *teacher's information seeking and motivation* node and the *technology* node. This interaction will be discussed later in the Multiple Node Interaction section.

Technology Node

The most salient individual theme within the technology node came from online survey data. Educators in the online survey ranked a search tool as the number one feature desired, followed by multimedia content. Similarly, when educators were asked about the challenges to the use of video, being able to locate video resources was ranked number two on the list of challenges, while the number one challenge was problems with computer hardware. These findings suggest that the search tools and computer hardware are important parts of the *technology* node in the Web of Criteria. Additionally, search tools that are not effective from the educators' points of view may lead to decreased motivation in using the system. The importance that educators in the online survey placed on search tools makes sense considering they also valued Google as a search engine.

Current Lesson and Curriculum Node

The first theme that falls within the *fits with current lesson and curriculum node* is related content. Educators in the online survey mentioned lesson plans, educator guides, simulations, and pictures as resources they would like to see in Web sites devoted to online video. *Related content* may be an additional factor which can enhance the use of online video materials in the classroom and thus it was added to the model underneath *fits with current lesson and curriculum*.

The second theme was the *engage students* node. During the cognitive walkthrough, teachers were looking for resources which would engage their students. Sometimes teachers were strict followers of matching the grade level information to their grade level, at other times they used their previous experience with their students to judge whether or not students would be attentive to the material in the resource. Many times the selection of video was determined by the potential of the resource to engage students.

The third theme was *specific content areas*. When educators in the online survey were asked what inspired them to perform a Web search, they reported the need to cover specific content areas or to address the needs of a specific group of students as their primary concerns. With respect to the Web of Criteria this suggests a new node of *specific content areas* may need to be introduced into the model. While the nodes in the model have no inherent order, these findings imply the *specific content areas* node might be slightly more important from a teacher perspective than the need for materials to be *aligned with standards* node. One possible explanation for this is because educators may be accustomed to tailoring content to meet the standards but not always have content available which covers all of their topics. Because of this finding the *specific content areas* node was added to the model and the rest of the nodes within that group shifted down.

The fourth theme in this group was the *aligned with the standards* node. In the cognitive walkthrough, another trend was the emergence of standards as an item relevant and necessary to educators' searches. Some walkthrough participants were able to use their knowledge to browse keyword and descriptions for terms present in the standard they were trying to meet. This finding suggested that educators required their resources to be aligned with the standards.

Results from the Web log analysis point to greater usage of videos from the 3rd to 8th grade range. This finding suggests higher grade level elementary and middle school teachers may be making the most use of these collections, or that materials in this range are the most useful across all grade levels. If this is indeed the largest population of users, then one strategy for providing teachers information *aligned with the standards* is to prioritize metadata efforts on videos in the 3rd through 8th grade range.

One unanswered question was how important standards are to an educator's information seeking. The findings from the online survey suggested that the standards weren't the most important thing to consider when searching for information whereas the findings from the cognitive walkthrough and previous research stressed that educators were significantly using the standards to determine relevant material. Findings from the cognitive walkthrough also suggest that some teachers are able to cope with the lack of standards information on the website by looking for vocabulary which matches standards in the descriptions and in the keywords. One possible explanation for the results of the online survey is that educators were providing the order in which they would like to narrow their search. In this scenario, educators first narrow content by their *specific content areas*, then they consider the needs of the students they are targeting and lastly they look for standards that must be covered for that particular unit. This scenario supports the addition of the *specific content areas* node and the reorganization of nodes with this part of the model. Additionally, the results of the cognitive walkthrough show educators have learned how to retrieve the necessary information in systems which do not incorporate standards. The fact that educators have learned to function in those situations does not lessen the desire for standards metadata or for systems to be designed to include such metadata.

Walkthrough participants described their use of video from the perspective of fitting within the current lesson and curriculum node. Educators constantly stressed that the video needs to have a purpose and must be related to other tasks and activities which will take place in the classroom. This process of supplementing class content was a continuing effort by educators to engage students, cover content and to provide multiple types of learning opportunities.

Interface Node

Walkthrough participant comments suggested several revisions for the prototype interface. These comments highlight both the power of a well-designed interface and the barriers caused by interface design problems. Educator comments suggested that the science category needs to be revised in order to include specific subdivisions by subject area; the size of the text of the Web site, the posterframe surrogates and the storyboard surrogates needed to be increased; and the Web site needed to be revised to more clearly represent the relationship between a video and the segments for that video. These items are related to expectations educators have of the interface and the metadata the interface provides. Taken together all these characteristics form a new node in the model, *interface*. This new node impacts all the dimensions in the model and therefore I placed it at the center of the revised model.

Interactivity with posterframe and storyboard surrogates was another theme that arose from the interviews and cognitive walkthrough. Educators constantly asked if they could click on the storyboard either to enlarge the photo or to see a small clip of the video. Educators also wanted to print photos off to use them in discussion. These findings fell within the design characteristics of the system and were best described by the new interface node. Systems with high interactivity may potentially motivate teachers to further explore content because they find the experience worthwhile and enjoyable.

Participants remarked that, in specific instances, the storyboard was not useful. This finding was supported by the work of Iyer and Lewis (2007), which reported the context of the video can be lost when the keyframes are manually selected for the storyboard format. This finding would suggest that nasa.ibiblio.org should consider implementing other layers of the tiered model presented by Iyer & Lewis (2007), such as adding information to show the themes, background and the locations of keyframes selected.

Another theme related to the *interface* node emerged from the comments about the Embedded Viewer interface. Walkthrough participants had mixed feelings about the Embedded Viewer feature. Some participants were enthusiastic about the visual features of the Embedded Viewer and others were very frustrated. The two most common complaints were that the Embedded Viewer did not allow users to have any control of the speed of the keyframes in the scrolling queue and that the users didn't know what they were looking at in the initial view. In the future, features of the Embedded Viewer which participants liked might be folded into different displays which utilize visual surrogates; additionally, the features which caused confusion and distress in participants will need to be revised.

Multiple Node Interactions

Several themes related to the interactions among nodes. One finding from the Web log analysis which related to the educator's *information seeking and motivation*, *technical skill* and *technology* nodes concerned the online video formats. The most frequently downloaded formats were Quicktime and MPEG-1. There are a number of reasons why this may be the case, but it suggests that these formats are the most compatible with educators' workstations. A variety of nodes from the Web of Criteria could explain this result. For example, educators in the study could have more knowledge of QuickTime and Mpeg-1 formats or schools could have software that would support the playback of these formats. If this scenario is true, both the *knowledge of digital formats* node and the *available technology* nodes are of particular interest in format selection. Other nodes which could be activated in relation to this finding are the experience *with non-text materials* node and the *educator's motivation* node. In the walkthrough, some educators had knowledge of the video formats while others used trial and error to find one that worked for their situation. Educators with more experience with non-text materials or with more motivation will be able to get past recoverable errors they have with browsers and systems used to display content.

Another interaction was between the educator's *information seeking and motivation* node and the *fits within current lesson and curriculum* node. This interaction of nodes was related to findings from the results of the Top 15 searches and the overall results of the walkthrough. The results of the Top 15 searches and the overall results of the walkthrough suggested that educators had a strong desire to perform searches for themselves and in their own words. This result made the Top 15 searches irrelevant to several educators. On the other hand, when the words on the Top 15 list matched the curriculum and interest of the teachers, some participants were more likely to view the Top 15 searches as being a helpful option. In the walkthrough, educators were also able to match concepts from the standards to metadata present in the keywords. The Web of Criteria nodes which were most related to these findings were the *knowledge of the search process* and the *fits with the current lesson and curriculum* nodes. Educators had the desire to perform searches for themselves because they felt it was the fastest way to retrieve information relevant to the educational content they were trying to cover. *Knowledge of the search process* played a role in this interaction because teachers made the assumption that the search for the prototype behaved similarly to searches they had performed in other Web sites and search engines.   These results suggest that in order to improve the Top 15 searches, frequently searched terms would need to be categorized along subject areas or by facets such as people, places, and topic rather than frequency because subject areas relate to teaching tasks. Furthermore, developers should be aware that educators are expecting the keyword search of digital libraries to perform along principles similar to commercial search engines. This maybe an unrealistic assumption given the limited resources some digital libraries have in comparison to commercial search engines. This assumption could increase frustration of users who experience unsuccessful searches and, as a result, these users may leave high quality digital library resources for the gratification of finding information in search engines. Reorganizing terms this way may increase the use of this feature, but this would only happen if the terms matched the way teachers conceptualized their subjects and they were aware of the Top 15 searches feature.

Data from the walkthrough regarding the Google Video Search feature suggested an interaction between the educator's *information seeking and motivation* and the *interface* nodes In the walkthrough, a majority of the participants did not like the Google Video Search feature itself but did find specific components of the feature attractive and useful. One specific feature mentioned was the ability to see related video as a part of a video record. Additionally, the walkthrough comments suggested that Google Video / YouTube were not trustworthy sources from which to retrieve information because the content had the potential to be of an adult nature or from a non-authoritative source. The participants also assumed that accessing Google Video / YouTube content would not be possible from their classroom setting due to school firewall restrictions. The discussion of firewall restrictions usually led to educators mentioning good educational resources they could not access because of restrictions at their school. These findings suggested that specific aspects of the interface negatively affected the motivation of the participants to use the Google Video Search.

The majority of the participants who used the Google Video Search feature had the same, "what am I looking at" comments as they did when first viewing the Embedded Viewer. With the current design, walkthrough participants were presented with a single result, icons for expanding the result set, and the option to perform a search. The educators in the study suggested the initial screen needs to be more interactive so they can immediately begin to explore. More interactivity would entail having more videos to select and having additional video information available besides a single posterframe from one video. Overall, these results suggest that educators may not be willing to use the video search capabilities of Google because they would not be reliable for displaying video in the classroom, as well as a lack of trust in the results they would get.

The results from the online survey related to Google interact with all the nodes in the model. In the online survey, Google was the most frequently mentioned resource educators reported when they were asked what was their favorite Web site or search engine. When asked to describe what they like about that resource they mentioned it was easy to search, and usually had the most relevant information. These findings further suggest that in well designed systems the *technical skill* node and the *technology* node in the Web of Criteria nearly disappear because the system is intuitive and straightforward to use. There may be situations where the reverse is also true, such as when naïve users are faced with technology poor schools; problems with these two nodes cause greater barriers in other parts of the model. Even in this extreme negative case the burden lies with the interface to bridge the gap. As stated in the Introduction, our goal should be to improve systems to the point where educators can devote their attention to the teaching task rather than the technical issues of using the video retrieval system.

Limitations

The small sample size and exploratory nature of this study limits its generalizability or external validity. To reduce this effect a triangulation of methods was used to gather a variety of data points for cross referencing. Findings from previous research, the online survey, and the walkthroughs were triangulated. Although some minor areas of disagreement were found, on the whole, results from the various sources supported each other. This study is also limited by the potentially invasive nature of the cognitive walkthrough. Commonly referred to as the Hawthorne effect, participants in the study may have altered their behavior because they were being studied. This would suggest that the participants would be slightly more positive toward the prototype system in an attempt to please the investigator than they would if using the system while not being monitored. For example, all but one participant said they would use the system again, indicating that some of the participants may have been reluctant to express criticisms. On the other hand, all of the participants suggested revisions to the prototype.

The study participants came from populations which may also prevent the generalization of the findings. Nine of the participants were participating in a NASA teacher workshop, and three of the participants came from an area in SC close to the local university. While the participation of the teachers from the NASA workshop certainly expanded the geographical scope of the teachers in my study, teachers from across the U.S. may have different access to technology, different levels of experience, different levels of expertise and different information behaviors than the study participants. Future research should test the validity of the model with other cross sections of educators from different states. For teachers with high teaching expertise, searching and browsing educational materials is likely to take less time. Teachers with high expertise also might be innvovators when it comes to introducing teaching concepts and rely on their successful past experiences to model their behavior of evaluating and incorporating new resources into the classroom.

CHAPTER VI

CONCLUSION

The revised Web of Criteria answered significant questions about how educators search for online video information. The model also highlights some of the important relevance criteria necessary for educators to successfully interact with an information system and retrieve an online video resource. Future research might also explore specific parts of the Web of Criteria.

One specific part of the Web of Criteria future research might explore is the social methods node. This research emphasized the importance of social networking and communication to the work flow of educators. In the online survey, colleagues, links to Web resources, search engines, listservs, and professional conferences ranked high with respect to how educators searched for information. Findings from the study suggest that innovative ways need to be created for sharing and viewing Web sites, search results and online materials which are closer to the ways educators interact socially. From a theoretical perspective this suggests that depending on the environment and the group being studied, the social contexts of the information seeking may increase in importance. This may require us to reexamine our current information seeking models in an effort to describe the social contexts in which our information needs change.

From a practical perspective online video repository developers may be able to increase the use of online repositories if they can find ways to provide a suite of digital services more tailored to educators' needs. In the Normore (2005a) focus group, educators indicated they wanted access to some type of expert help. This finding suggests that some form of digital reference, whether automated or human intermediated, may be appealing to educators. Other features such as sharing video by email, and providing video spotlights which instruct educators how to use specific videos for particular classes may be useful ways of bringing the collection to the attention of educators. Another possibility is to use technology like Really Simple Syndication (RSS) feeds or pod casts. With this technology educators can share knowledge of updated online content easily with their students and fellow educators. By introducing technology which harnesses the power behind the social networks educators already use, repository developers will make their content easily sharable and less time consuming to retrieve.

This research also explored how important standards were to educators’ information seeking process. The results on this were mixed, with some educators indicating standards were important to the seeking process and other educators indicating content was more important. As stated earlier it is possible that both variables are important to the process but one factor takes precedence over the other, at least for some teachers. We collected data which supported that *specific content areas* superseded the need for information to be *aligned with standards* and so in the model we placed *specific content areas* higher than the *standards* node. Future research should continue to explore educators' need for standards and the role that standards play in the information seeking process.

Participants in the walkthrough shared a variety of comments which suggested the storyboards should have more interactivity than they currently have. Pilot studies might also be undertaken to understand what level of interactivity a variety of user groups desire as it relates to the storyboard surrogate. This study might have storyboards with three varying levels of interaction; static storyboard, storyboard with the ability to enlarge pictures and storyboard with the ability to enlarge pictures and queue video from the selected frame. These future works should also evaluate how much of the desired activity is possible with current, readily available technology.

Participant comments in the walkthrough suggested that there may be some interrelationship between a person's preferred content style, seeking style and their learning style. Future work might design a study aimed at further examining those correlations. With respect to a person's seeking style studies should investigate how to most effectively combine faceted search, and the different formats of video surrogates.

Future work also should explore implementing the design decisions which were designated as long term, in addition to addressing the recommendations noted above.

Appendix A:
Online survey

Demographic Information

1. **What is your current age group? [Survey exits if they select "17 years or below".]**
   17 years or below
   18-29
   30-39
   40-49
   50-59
   60 years or above

Questions related to teaching / instruction

2. **Do you teach or have you instructed students within the past 3 years? [If NO the survey skips to PART B.]**
   Yes
   No

Theme 1 (Educators' searching habits)

3. **Do you ever use the Web to find educational resources for curriculum planning or instructional purposes? [If the answer is NO the survey skips ahead to question 10.]**
   Yes
   No

4. **How do you find Web-based educational resources? (Choose all that apply.)**
   Colleagues
   Print Advertisements
   On-line Advertisements
   Direct Mailings (flyers)
   Newsletters (print)
   Listservs or Electronic Newsletters
   Links on Web sites
   Search engines
   Professional Development Sessions/ Conferences/Organizations
   Professional Journals/ Readings
   Other (please specify)

5. **When you begin a new Web search for curriculum planning or instructional purposes what need most frequently inspires your search? (Choose all that apply.)**
   Resources that relate to a specific topic or content area
   Resources that fit a particular curriculum standard
   Resources that meet specific needs of one particular student
   Resources that meet specific needs of a small group of student

Resources that meet specific needs of your entire class or activity group
Other (please specify)

Theme 2 (Resources educators use from the Internet)

6. **In the past <u>month</u>, how many times have you referred to each of the following resources for curriculum planning (e.g. background information for lesson plans or project ideas)?**
   (Never 1-5 times 6-10 times More than 10 times)
   Textbooks Encyclopedias, Books, Newspapers and other print based resources
   Colleagues, Librarians, Administrators and other people resources
   CD-ROMS, DVDs
   Web Sites and other Web-based resources
   TV
   Other (please specify)

7. **In the past <u>month</u>, how many times have you referred to each of the following resources for instruction (e.g. to support the lecture, to illustrate a class concept, or for class activities)?**
   (Never 1-5 times 6-10 times More than 10 times)
   Textbooks Encyclopedias, Books, Newspapers and other print based resources
   Colleagues, Librarians, Administrators and other people resources
   CD-ROMS, DVDs
   Web Sites and other Web-based resources
   TV
   Other (please specify)

Theme 3 (Favorite tools and the design features educators prefer of those tools)

8. **List a favorite Web site or search engine you use for curriculum planning (e.g. background information for lesson plans or project ideas) or instructional purposes (e.g. to support the lecture, to illustrate a class concept, or for class activities). Briefly describe the purpose of the Web site.**

9. **What do you value most about the Web site or search engine you listed in questions 8? (Choose 3.)**
   Easy to use
   Easy to search.
   Well-known.
   Usually has the most relevant information.
   Limits search results to desired category.
   Downloads quickly.
   Easy to find what I want
   From a reputable source.
   Web site's links are up to date.
   Resources are culturally/ age/ developmentally appropriate.
   Multiple resources are available.
   Resources are easy to customize for my needs.
   Web site complements other resources I use.
   Other (please specify)

Questions related specifically to downloadable or Web-based videos

10. **Do you ever use downloadable or Web-based videos in your instruction? [If the answer is NO the survey skips ahead to PART C.]**

11. **How many times have you used a Web-based or downloadable video within the past year during instruction?**
    Never
    1-14 times
    15-30 times
    More than 30 times

12. **How much do these videos contribute to the learning experience of your students?**
    Makes no difference at all
    Contributes minimally
    Contributes a fair amount
    Contributes as a major source of learning

13. **If these videos were not available on the Web site you typically use what would you do? (Choose all that apply.)**
    Find another Web site which contains these videos
    Find equivalent videos
    Find other activities
    Not try to find a substitute

14. **If you went to a Web site devoted to downloadable or Web-based videos which of the following related instructional tools would you most like to find? (Choose three.)**
    Access to experts/ professionals
    Lesson plans and activity ideas
    Educator guides
    Pictures and graphics
    Raw data
    Simulations (e.g. Applets, flash presentations, etc…)
    Collaboration tools for students to interact with remote students
    Other (please specify)

15. **If you were thinking of using a Web-based or downloadable video, how important would it be that the video be accompanied by each of the following? (Not important at all, Not very important, Somewhat important, Very Important)**
    Access to experts/ professionals
    Lesson plans and activity ideas
    Educator guides
    Pictures and graphics
    Raw data

Simulations (e.g. Applets, flash presentations, etc…)
Collaboration tools for students to interact with remote students
Other (please specify)

16. If you were using a Web site devoted to downloadable or Web-based videos how important would each of these design features be? (Not important at all, Not very important, Somewhat important, Very Important)
On-line help
Access to phone help-line.
Access to experts/ professionals
Search tool
Way to submit questions
Collaboration tools
Text-only option
Audio option
Adjustable font size and color
Pleasing colors
Multimedia content
Few flashing buttons/ little multimedia
Related links
Citations and references
Assurance that the site is backed by a reputable sponsor
Other (please specify)

17. Please identify the top three challenges you face in seeking and using downloadable or Web-based videos (Choose three).
Problems with computer hardware
Resources don't align with national or state curriculum standards.
Resources are difficult to adapt to my needs.
Takes too long to locate video.
Resources are not culturally/ age/ developmentally appropriate.
No support from colleagues or administration.
Not comfortable with using the Web.
Unsure about the validity of Web-based resources.
Products/ Web sites are too expensive.
Limited Internet access.
Lack of support for hardware or software
Printing problems
Internet connection problems (e.g. speed)
Other (please specify)

Remaining Demographic Information

18. What is your current occupation / job title?

Teacher
Teacher's Aide
Student
School Librarian
Home Schooler
Other (Please Specify)

19. Please indicate your ethnicity.

American Indian or Alaska Native
Asian or Pacific Islander
Black or African American
Hispanic, Latino or Spanish Origin
White
Mixed or multiple ethnicity
Some other race or ethnicity (Please specify)

20. Please indicate your gender

Female
Male

21. What is the highest level of education you have currently attained?

Bachelor's
Master's
Doctorate
Other (Please specify)

Remaining questions related to teaching / instruction

22. **For how many years have you been employed as an educator?**
    1 Year or Less
    2-3 Years
    4-6 Years
    7-10 Years
    11-20 Years
    21+ Years

23. **For how many years have you been employed at the educational setting in which you are currently working?**
    1 Year or Less
    2-3 Years
    4-6 Years
    7-10 Years
    11-20 Years
    21+ Years

24. **What courses / subject areas do you currently teach?**

25. **What state do you currently teach in? (If not in the United States indicate country. If not currently teaching indicate the last location in which you taught.)**

26. **What is the location of your institution?**
    Rural
    Suburban
    Urban

27. **What is the setting of your instruction?**
    Formal (school classroom)
    Informal (boys club, girls club, home schoolers, planetarium)

28. **What is the race/ethnicity of the majority of your students?**
    American Indian or Alaska Native
    Asian or Pacific Islander
    Black or African American
    Hispanic, Latino or Spanish Origin
    White
    Mixed or multiple ethnicity
    Some other race or ethnicity (please specify)

29. **What grades do or did you teach? (Please choose all that apply.)**
    Prekindergarten, Day Care
    K-5
    6- 8
    9-12

Undergraduate /Graduate
Not applicable N/A

30. What percentage of your students have special needs?
Less than 25%
25-50%
50-75%
75-100%
Not Sure
Not applicable N/A

31. What percentage of your students have Individualized Education Plans (IEPs) or 504 plans?
Less than 25%
25-50%
50-75%
75-100%
Not Sure
Not applicable N/A

32. What percentage of your students receive free or reduced price lunch?
Less than 25%
25-50%
50-75%
75-100%
Not Sure
Not applicable N/A

33. What percentage of your students are classified as gifted or talented?
Less than 25%
25-50%
50-75%
75-100%
Not Sure
Not applicable N/A

Exit Questions

34. **Are there any other comments you would like to make?**

35. **Would you be willing to participate in a follow-up interview? [If the subject selects "Yes" they are prompted to provide their email address]**
    Yes
    No

Please indicate if you would like to receive a vodcast of all the videos in the nasa.ibiblio.org collection or a DVD containing 3 of the videos in the collection. [If the subject elects to receive the DVD they will be prompted to provide their name and a mailing address so the DVD can be mailed to them. If the subject elects to receive a vodcast then either their email information will be used from the previous question or they will be prompted to supply their email information.]
I would like to receive the vodcast
I would like to receive a DVD containing 3 videos of my choice.
I do not wish to receive anything for participation in this study.

PART B – Users not involved in instruction or teaching

3. **List a favorite Web site or search engine you use. Briefly describe the purpose of the Web site.**

4. **What do you value most about the Web site or search engine you listed above? (Choose 3.)**
   Easy to search.
   Well-known.
   Usually has the most relevant information.
   Limits search results to desired category.
   Downloads quickly.
   Easy to find what I want
   From a reputable source.
   Web site's links are up to date.
   Resources are culturally/ age/ developmentally appropriate.
   Multiple resources are available.
   Resources are easy to customize for my needs.
   Easy to use
   Web site complements resources already used.
   Other (please specify)

5. **Do you EVER use downloadable or Web-based video? [If NO survey exits.]**

6. **What do you use downloadable or Web-based video for?**

7. **What is your current occupation / job title?**
   Teacher
   Teacher's Aide
   Student
   School Librarian
   Home Schooler
   Other (Please Specify)

8. **Please indicate your ethnicity.**
   American Indian or Alaska Native
   Asian or Pacific Islander
   Black or African American
   Hispanic, Latino or Spanish Origin
   White
   Mixed or multiple ethnicity
   Some other race or ethnicity (Please specify)

9. **Please indicate your gender**
   Female
   Male

10. What is the highest level of education you have currently attained?
Bachelor's
Master's
Doctorate
Other (Please specify)

PART C – Nonusers of digital video
(ALTERNATE 17)

11. Please indicate how much you agree or disagree with the following statements I don't use downloadable or Web-based videos because...

VHS, and DVD video media are more available in my educational setting
VHS, and DVD video media are more adaptable to my needs
there are problems with my computer hardware.
it is difficult to determine if the resources align with national, or state curriculum standards.
the resources are difficult to adapt to my needs.
it takes too long to locate appropriate video.
it takes too long to download or stream appropriate video.
the resources I find are not culturally/ age/ developmentally appropriate to my students needs.
I do not have support from colleagues or administration.
I am not comfortable with using the Web.
I am unsure about the validity of Web-based resources.
the products/ Web sites which offer downloadable or Web-based videos are too expensive.
the educational setting in which I work has limited Internet access.
the educational setting in which I work has limited computer access.
the educational setting in which I work has a lack of support for hardware or software
the Web site I previously used to retrieve video had Internet connection problems (e.g. speed)
Other (please specify)

12. What is your current occupation / job title?
Teacher
Teacher's Aide
Student
School Librarian
Home Schooler
Other (Please Specify)

13. Please indicate your ethnicity.
American Indian or Alaska Native
Asian or Pacific Islander
Black or African American
Hispanic, Latino or Spanish Origin

White
Mixed or multiple ethnicity
Some other race or ethnicity (Please specify)

14. Please indicate your gender
Female
Male

15. What is the highest level of education you have currently attained?
Bachelor's
Master's
Doctorate
Other (Please specify)

Remaining questions related to teaching / instruction

16. For how many years have you been employed as an educator?
1 Year or Less
2-3 Years
4-6 Years
7-10 Years
11-20 Years
21+ Years

17. For how many years have you been employed at the educational setting in which you are currently working?
1 Year or Less
2-3 Years
4-6 Years
7-10 Years
11-20 Years
21+ Years

18. What courses / subject areas do you currently teach?

19. What state do you currently teach in? (If not in the United States indicate country. If not currently teaching indicate the last location in which you taught.)

20. What is the location of your institution?
Rural
Suburban
Urban

21. What is the setting of your instruction?
Formal (school classroom)
Informal (boys club, girls club, home schoolers, planetarium)

22. What is the race/ethnicity of the majority of your students?
American Indian or Alaska Native
Asian or Pacific Islander
Black or African American
Hispanic, Latino or Spanish Origin
White
Mixed or multiple ethnicity
Some other race or ethnicity (please specify)

23. What grades do or did you teach? (Please choose all that apply.)
Prekindergarten, Day Care
K-5
6- 8
9-12
Undergraduate /Graduate
Not applicable N/A

24. What percentage of your students have special needs?
Less than 25%
25-50%
50-75%
75-100%
Not Sure
Not applicable N/A

25. What percentage of your students have Individualized Education Plans (IEPs) or 504 plans?
Less than 25%
25-50%
50-75%
75-100%
Not Sure
Not applicable N/A

26. What percentage of your students receive free or reduced price lunch?
Less than 25%
25-50%
50-75%
75-100%
Not Sure
Not applicable N/A

27. What percentage of your students are classified as gifted or talented?
Less than 25%
25-50%
50-75%

75-100%
Not Sure
Not applicable N/A

Exit Questions

28. Are there any other comments you would like to make?

29. Would you be willing to participate in a follow-up interview? [If the subject selects "Yes" they are prompted to provide their email address]
Yes
No

Please indicate if you would like to receive a vodcast of all the videos in the nasa.ibiblio.org collection or a DVD containing 3 of the videos in the collection. [If the subject elects to receive the DVD they will be prompted to provide their name and a mailing address so the DVD can be mailed to them. If the subject elects to receive a vodcast then either their email information will be used from the previous question or they will be prompted to supply their email information.]
I would like to receive the vodcast of all the videos in the nasa.ibiblio.org collection.
I would like to receive a DVD containing 3 videos of my choice.
I do not wish to receive anything for participation in this study.

Final Thank You Message [This message will appear regardless of which survey the subject completes.]

Thank you for your time and consideration in filling out this survey. With your help we will gain a deeper understanding of how educators would like Web interfaces designed for digital video retrieval.

If you elected to participate in a follow-up phone or face-to-face interview we will be contacting you shortly so that we can schedule a time which is convenient for you.

Appendix B:
Web page introduction to survey

Subject: Invitation to participate in the understanding use of digital video and Web features educators desire of digital video Web sites study

Hello, my name is Ron Brown.

I am a doctoral student at the University of North Carolina at Chapel Hill in Information and Library Science. Under the guidance of my faculty advisor, Stephanie W. Haas, I am studying how teachers use digital video in their classes. For the purposes of this study, digital video is defined as video which is Web based, and is used by either downloading or streaming the video from some video provider to a local computer. This message is to invite you to participate in a study about how web sites which provide digital video to educators can be more effectively designed.

To join the study is voluntary and you are in no way required to participate. You may refuse to join, or you may withdraw from the study, without penalty at any time. Also bear in mind this Web site does not require you to participate in this study.

If you would like to participate in the study please follow the link to the consent form and the survey which follows the signature at the end of this email. The consent form will provide a more detailed description of the study including the risks involved to you the participant and as well the benefits to the educational community. It is important that you understand this information so that you can make an informed choice about being in this research study. You should contact me at the email address below with questions you have about this study at any time.

Thank You.

Sincerely,
Ron T. Brown
Doctoral Student, University of North Carolina at Chapel Hill
ronT@email.unc.edu
919-962-8274

Link to the Questionnaire:
https://www.surveymonkey.com/s.asp?u=433892282673

Appendix C:
Email introduction to survey

Subject: Invitation to participate in the understanding use of digital video and Web features educators desire of digital video Web sites study

Hello, my name is Ron Brown.

I am a doctoral student at the University of North Carolina at Chapel Hill in Information and Library Science. Under the guidance of my faculty advisor, Stephanie W. Haas, I am studying how teachers use digital video in their classes. For the purposes of this study, digital video is defined as video which is Web based, and is used by either downloading or streaming the video from some video provider to a local computer. I received your name and email from the school district X. This letter is to invite you to participate in a study about how web sites which provide digital video to educators can be more effectively designed.

To join the study is voluntary and you are in no way required to participate. You may refuse to join, or you may withdraw from the study, without penalty at any time. Also bear in mind your school district does not require you to participate in this study.

If you would like to participate in the study please follow the link to the consent form and the survey which follows the signature at the end of this email. The consent form will provide a more detailed description of the study including the risks involved to you the participant and as well the benefits to the educational community. It is important that you understand this information so that you can make an informed choice about being in this research study. You should contact me at the email address below with questions you have about this study at any time.

Thank You.

Sincerely,
Ron T. Brown
Doctoral Student, University of North Carolina at Chapel Hill
ront@email.unc.edu
919-962-8274

Link to the Questionnaire:
https://www.surveymonkey.com/s.asp?u=433892282673

Appendix D: Letter To Previous Participants

Hello, my name is Ron Brown.

I am a doctoral student at the University of North Carolina at Chapel Hill in Information and Library Science. Under the guidance of my faculty advisor, Stephanie W. Haas, I am studying how teachers use online video in their classes. You previously participated in Study # 06-0269, Understanding Use of Digital Video and Web Features Educators Desire of Digital Video Web Sites, and indicated you would like to be contacted for a follow-up interview.

This letter is to invite you to participate in the follow-up study (Study # 07-0597, User Testing for Revised nasa.ibiblio.org Interface). If you would like to participate in this study, please schedule a follow-up interview by contacting me at ront@email.unc.edu.

Attached is a consent form which explains the details of the study. Before you participate in the study you will be asked to sign the consent form. You *do not* need to sign and return copies of the consent form to me immediately. Copies of the consent form will be provided at the interview session for you to sign.

If you would like to participate in the study please remember to reply to the email address given below to schedule an interview. In your email, please indicate your preferred location for the study (on UNC-CH's campus or at a site of your choosing) and the dates and times most convenient for you.

Thank you for considering participation in this study. I hope you agree to contribute your responses to help shape how web sites are designed for teacher retrieval of digital video.

Sincerely,

Ron T. Brown
Doctoral Student, University of North Carolina at Chapel Hill
ront@email.unc.edu
919-962-8274

Appendix E: Introductory Email Letter to Recruit New Subjects

Hello, my name is Ron Brown.

I am a doctoral student at the University of North Carolina at Chapel Hill in Information and Library Science. This letter is to invite you to participate in a study titled "User Testing for Revised nasa.ibiblio.org Interface." Under the guidance of my faculty advisor, Stephanie W. Haas, I am studying how teachers use online video in their classes. In a previous study I collected information on the web features educators desire of online video web sites. In this study, I would like to evaluate if the features I incorporated into the nasa.ibiblio.org interface meets the needs of educators.

Attached is a consent form which explains the details of the study. Before you participate in the study you will be asked to sign the consent form. You *do not* need to sign and return copies of the consent form to me immediately. Copies of the consent form will be provided at the interview session for you to sign.

If you would like to participate in the study, please reply to the email address given below to schedule an interview. In your email, please indicate your preferred location for the study (on UNC-CH's campus or at a site of your choosing) and the dates and times most convenient for you.

Thank you for considering participation in this study. I hope agree to contribute your responses to help shape how web sites are designed for teacher retrieval of digital video.

Sincerely,

Ron T. Brown
Doctoral Student, University of North Carolina at Chapel Hill
ront@email.unc.edu
919-962-8274

Appendix F: New letter to recruit teachers from South Carolina

Subject: User testing for revised nasa.ibiblio.org interface
Hello, my name is Ron Brown.

I am a doctoral student conducting a study on how teachers use online video in their classrooms. In this study I would like to evaluate some of the features I incorporated into the nasa.ibiblio.org interface. During the study teachers will be interacting with a Web site which provides NASA educational videos via the Web to students and teachers. The study is designed to evaluate if the Web site provides enough information for teachers who want to select and use online video in their classrooms. If teachers participate they will be one of approximately fifteen teachers to be interviewed for the study. Teachers who participate in the study should ideally teach Science, Technology, Engineering, and Mathematics subjects from the K-12 grade range. The interview session should last between one hour and one hour and fifteen minutes.

In terms of location you have a variety of options. The first option is to have the study take place in Columbia, SC on the University of South Carolina's campus at Davis College. Now that semester is over parking will not be an issue and you can schedule the interview for anytime between 3:00pm and 8:00pm. With this option you will be compensated $40 for participation in the study and provided with a gift card to Barnes and Noble in the amount of $20. Once the interview is scheduled you will be provided with interview location and parking information.

The second option is to choose a coffee shop or other location for the study as long as it has access to high speed wireless Internet, with this option teachers will be compensated $20 for participating in the study and the Barnes and Noble gift card in the amount of $20.

Attached to this message is the consent form. Please use the email below for correspondence regarding the study.
--
Ron T. Brown
ront@email.unc.edu
University of North Carolina at Chapel Hill
School of Information and Library Science (SILS)
CB# 3360, 100 Manning Hall
Chapel Hill, NC 27599-3360
(o) 919-962-8274
(f) 919-962-8071

Appendix G: New letter to recruit teachers from Durham Public Schools

Subject: User testing for revised nasa.ibiblio.org interface
Hello, my name is Ron Brown.

I am a doctoral student conducting a study on how teachers use online video in their classrooms. In this study I would like to evaluate some of the features I incorporated into the nasa.ibiblio.org interface. During the study teachers will be interacting with a Web site which provides NASA educational videos via the Web to students and teachers. The study is designed to evaluate if the Web site provides enough information for teachers who want to select and use online video in their classrooms. If teachers participate they will be one of approximately fifteen teachers to be interviewed for the study. The interview session should last between one hour and one hour and fifteen minutes.

In terms of location, teachers can choose the location for the study as long as it has access to high speed wireless Internet, with this option teachers will be compensated $20 for participating in the study. Teachers can also choose to travel to UNC's campus to participate in the study, with this option teachers will be given instructions for parking and will be compensated $40 for participating in the study.

Attached are the introduction to the study and the consent form. Teachers are free to contact me now to schedule an interview or after their school session has ended. Please use the email below for correspondence regarding the study.
--
Ron T. Brown
ront@email.unc.edu
University of North Carolina at Chapel Hill
School of Information and Library Science (SILS)
CB# 3360, 100 Manning Hall
Chapel Hill, NC 27599-3360
(o) 919-962-8274
(f) 919-962-8071

Appendix H: Consent Form

University of North Carolina-Chapel Hill
Consent to Participate in a Research Study
Adult Participants
Social Behavioral Form

IRB Study # 07-0597
Consent Form Version Date: 04-12-2007

Title of Study: User Testing for Revised nasa.ibiblio.org Interface

Principal Investigator: Ron T. Brown
UNC-Chapel Hill Department: School of Information and Library Science
UNC-Chapel Hill Phone number: 919-962-8360
Email Address: haas@ils.unc.edu
Faculty Advisor: Dr. Stephanie Haas

Study Contact telephone number: 919-962-8274
Study Contact email: ront@email.unc.edu

What are some general things you should know about research studies?
You are being asked to take part in a research study. To join the study is voluntary. You may refuse to join, or you may withdraw your consent to be in the study, for any reason, without penalty.

Research studies are designed to obtain new knowledge. This new information may help people in the future. You may not receive any direct benefit from being in the research study. There also may be risks to being in research studies.

Details about this study are discussed below. It is important that you understand this information so that you can make an informed choice about being in this research study. You will be given a copy of this consent form. You should ask the researchers named above any questions you have about this study at any time.

What is the purpose of this study?
The purpose of this research study is to learn about what teachers think of the revised interface for nasa.ibiblio.org. In the study you will be shown a web site that provides access to NASA educational videos. During the study you will be asked to perform a series of tasks related to the web site and provide your feedback on how useful you believe the web site is to teaching.

How many people will take part in this study?
If you decide to be in this study, you will be one of approximately 15 people in this research study.

How long will your part in this study last?
The interview should take approximately one hour to one hour and fifteen minutes.

What will happen if you take part in the study?
First, if you did not participate in companion study to this one (the survey portion of the study), you will be asked to complete a short demographic questionnaire. During the interview session you will be asked to interact with an online system that provides access to web-based video designed for educators. The interview session will be broken into three parts. In the first part of the interview session you be asked to conduct a series of browsing tasks. After those tasks are completed you will be asked a series of questions in relation to the browsing tasks you just completed. In the second part of the interview session you will be asked to find specific items in the web site. After those tasks are completed you will be asked about your experience. In the third and final part of the study you are going to be asked what you thought of the system and whether you believe the system is useful for teaching.

To obtain the most accurate record of the session, your on-screen actions and verbal comments will be recorded as you interact with the system. In addition, you will be interviewed about your impressions of the system and the interviews will be recorded as well.

What are the possible benefits from being in this study?
Research is designed to benefit society by gaining new knowledge. You may not benefit personally from being in this research study. However, there will be professional benefit from this study, as the information we obtain will be communicated to the profession through publication in the literature, presentation at professional meetings and directly dissemination to the professional associations.

What are the possible risks or discomforts involved from being in this study?
There are no risks anticipated should you participate in this research study; however, unknown risks may exist and you should report any problems to the researcher.

How will your privacy be protected?
Every effort will be taken to protect your identity as a participant in this study. Study data will be secured on a password protected drive which has been encrypted for added security. Only the principal investigator will have access to individually identifiable data. ID numbers will be used to link names to study responses. Code numbers will be assigned randomly using a random number generator and the linkage file will be secured on a separate password protected computer and drive.

Participants will not be identified in any report or publication about this study. Although every effort will be made to keep research records private, there may be times when federal or state law requires the disclosure of such records, including personal information. This is very unlikely, but if disclosure is ever required, UNC-Chapel Hill will take steps allowable by law to protect the privacy of personal information. In some cases, your information in this research study could be reviewed by representatives of the University, research sponsors, or government agencies for purposes such as quality control or safety.

Although your comments will be recorded using the microphone on the computer and your screen actions will be recorded using screen capture software, the only information matching your identity to your responses will be the linking file. After the interview has been transcribed and all the interview sessions have been analyzed, the linking file will be destroyed. After all data analysis is complete and any reports have been published the digital audio files and the screen capture recordings will be destroyed.

Will you receive anything for being in this study?
You will receive $20 for completing the study at a location of your choice. If you choose to participate in the study on UNC Chapel Hill's campus, you will receive an additional $20 for the inconvenience of having to travel to the school. If you should exit the study early however, you will not receive anything for participating in the study.

Will it cost you anything to be in this study?
There will be no costs for being in the study

What if you have questions about this study?
You have the right to ask, and have answered, any questions you may have about this research. If you have questions, or concerns, you should contact the researchers listed on the first page of this form.

What if you have questions about your rights as a research participant?
All research on human volunteers is reviewed by a committee that works to protect your rights and welfare. If you have questions or concerns about your rights as a research subject you may contact, anonymously if you wish, the Institutional Review Board at 919-966-3113 or by email to IRB_subjects@unc.edu.

Participant's Agreement:

I have read the information provided above. I have asked all the questions I have at this time. I voluntarily agree to participate in this research study.

_________________________________ _______________
Signature of Research Participant Date

____
Printed Name of Research Participant

_________________________________ _______________
Signature of Person Obtaining Consent Date

____
Printed Name of Person Obtaining Consent

Appendix I:
Phase two script and interview questions

Tasks For Cognitive Walkthrough:
Browsing/exploration tasks and retrieval tasks

Overview of tasks and questions for cognitive walkthrough

6. Browsing/exploration tasks
    a. Brief rationale for tasks
        i. Locate a video or videos using the top fifteen searches
        ii. Locate a video or videos using grade level
        iii. Locate a video or videos using subject headings
7. Browsing/exploratory tasks debriefing questions
8. Retrieval tasks
    a. Brief rationale for tasks
        i. Locate a video or videos using NASA program
        ii. Locate a video or videos using "Embedded Viewer" page
        iii. Locate a video or videos using "Google Video Search" page
        iv. Locate a video or videos using keyword search
9. Retrieval tasks debriefing questions
10. Overall debriefing questions

The primary categories on which these tasks are based come from what the previous literature says about educators' information seeking and use of educational materials. These tasks are also based on focus group and survey data I collected. In both of those studies educators provided opinions on design features of their favorite web sites and their use of video in the classroom.

One trend that is emphasized in the research literature and in phase one of my research is that educators prefer browsing over keyword search. To address this need for browsing three options were built into the revised interface which allows educators to explore based on their needs. In the initial nasa.ibiblio.org interface users could only browse the web site using NASA program. The revised interface allows users to browse based on NASA program, by subject, and grade level. In addition to being able to browse by facets which are more aligned to the teaching task users also have the ability to browse the top fifteen search terms; this list is recalculated at the end of every month. The first series of tasks are designed to evaluate the new services to see if educators find the new functionality helpful. After determining how helpful the new services are then we will ask educators if there are additional suggestions for improving the services.

In terms of study design we felt the tasks should reflect the emphasis educators placed on browsing. In order to accommodate this preference the browsing tasks were placed at the beginning of the study.

From task 1.a.i (locate a video using top fifteen searches) I hope to learn if the terms in the list make sense to teachers, if the list contains terms they might like to browse and whether the teachers find the kinds of videos they were expecting to find from the terms they searched. I would also like to explore how teachers would represent the difference between terms which represent teaching concepts and terms which represent video titles, or NASA programs. The first task also explores how aware educators are of the basic interface controls and bring those controls to their attention and ask about their design. Overall the purpose of the first task will be to evaluate the usefulness of the top fifteen searches list. The usefulness of the list will be evaluated by asking teachers if the terms of the list make sense to them, if the list contains terms they might like to browse and if the results contain videos they would expect to find based on the terms they searched.

The main purpose of task 1.a.ii (locate a video or videos using grade level) is to determine how useful teachers believe browsing by grade level is and whether the NASA classification of grades is appropriate. As with other tasks this task will to continue to bring basic functionality of the system to the attention of the teachers. In particular this task is designed to see if the teachers would like to have more control over the number of results displayed and how they navigate through the results.

Task 1.a.iii (locate a video or videos using subject) attempts to evaluate the subject categories to determine if the categories are intuitive to teachers and see if the subject categories are useful to the teaching task overall. Next the task tries to elicit what educators think of the most detailed video view. It specifically asks what educators think about the storyboard preview, the links of the different video formats and access to related content.

Task 3.a.i (locate a video or videos using NASA program) is designed to determine how efficient NASA program is for searching for a specific video. Educators will be given the NASA program and title for the video they will be asked to find. The video selected will be one that appears frequently in the list of terms used to search the web site. Next educators will be asked if they can identify if the video title they found has segments and if video segments would be useful. Lastly educators will be asked how they believe the relationship between video and video segment should be represented at the system level.

From task 3.a.ii (locate a video or videos using “Embedded Viewer” page) we would like to explore if the system performs as teachers expect it to perform. In particular this task focuses on the functionality of the search box and the page itself. The “Embedded Viewer” feature is designed to give educators immediate playback access to the video collections. The video bar on the left side of the page cycles through different videos. If a user clicks on a video to the left then it begins to play in the video display. The Google custom search box on this page returns results from the five NASA program web sites as well as results from nasa.ibiblio.org. Educators may want to use this option when they are more interested in previewing video content than reading text metadata related to the video. The only text metadata this feature offers is the video title and the video duration. To access this information the user must either click on a video title to play the video or mouse over the thumbnail in the video bar. These differences are presented so that in the debriefing questions users can be asked which option they prefer.

Task 3.a.iii (locate a video or videos using “Google Video Search” page) presents users with another way of viewing and searching for video. This option sends users to the video.google.com webpage and allows them to search video.google.com for NASA videos. This task explores how educators might expect the given design to function. Overall this task is important because in the debriefing questions we ask which of the designs overall do users prefer.

The purpose of task 3.a.iv (Locate a video or videos using keyword search) is to analyze how educators perform keyword searches. In particular this task is focused on what teachers do to refine their search if the results are not optimal. In order to get educators to refine their search they will be asked if they had considered specific options for refining their search, such as starting over with different search terms or using one of the system options for narrowing their search results. This task is also designed to try and elicit from educators what makes them choose a specific video over another.

Full outline of tasks and questions for cognitive walkthrough

1. Browsing/exploration tasks
    a. Rationale -- According to the previous literature on educators' information seeking and use of educational information browsing is the primary way educators find information. The primary reason for including these tasks is to explore if the following three facets provide adequate browsing for teachers.
        i. Locate a video or videos using the top fifteen searches
            1. Do the terms in the top fifteen searches list make sense? (Are these terms related to STEM teaching and learning?)
            2. What do you believe the terms represent in the top fifteen searches list?
            3. What types of terms would you expect to be in the Top 15 searches for this video collection? Do you see those terms represented?
            4. Are any of the words in the top fifteen searches related to a course unit you will cover or have covered this semester? (If yes) what are they? Please select (one of) the word(s) and begin exploring the web site.
            5. (If not) please select "sun" and begin exploring the web site.
            6. Does this list of results fit with what you thought you might find given the term you clicked on?
            7. (If yes to probe 5) In what ways does it match?
            8. (If no to probe 5) In what ways does it not match?
            9. Are there any specific features or elements in the current display which may be useful to your browsing and/or selection of video at this stage?
            10. Did you notice you have the option to refine your search by grade level?
            11. Did you notice the three icons under the search box? What purpose do you think they serve?
            12. Did you notice the path which tells you where you are, this is also known as breadcrumbs navigation?
            13. Please click on the "home" link to return back to the main page.
        ii. Locate a video or videos using grade level

1. Let's continue exploring the web site. Please select your grade level and continue.
2. Are there any specific features or elements in the current display which may be useful to your browsing and/or selection of video at this stage?
3. What do you think about how the videos were divided by grade?
4. Are you satisfied with the grade level categories?
5. (If yes to probe 4) Please explain why you are satisfied.
6. (If no to probe 4) How could these categories be improved?
7. Did you notice you have the option to refine your search by subject?
8. How many results does the web site return? Would you ever want to change the default setting?
9. Explore the videos at this level. Did you notice the navigation between results?
10. Please identify a specific video on your current page which you think interesting and tell me why you think it is interesting.
11. Is there anything else you would want to know about this video before you use it?
12. Please select the video you identified,
13. Please click on the "home" link to return back to the main page.

iii. Locate a video or videos using subject headings

1. Please look at the subject categories, are any of the first level categories related to a topic you will cover or have covered this semester? Please select the category and continue exploring the web site.
2. (If not) please select the "Aeronautics" category.
3. Are there any specific features or elements in the current display which may be useful to your browsing and/or selection of video at this stage?
4. Looking at the second level, what do you think about how the videos were divided by subject?
5. Go back and try another subject heading, exploring the different sub categories. Do the subject categories make sense to you?
6. Are you satisfied with how the videos were divided by subject?
7. (If yes to probe 6) Please explain why you are satisfied.
8. (If no to probe 6) How could these categories be improved?
9. Please select a video from the current display which you are further interested in.
10. Did you notice that some of the videos have related content?
11. Did you notice that the videos are provided in different formats?
12. How do you interpret the different video formats that are provided?
13. What do you think about the storyboard preview?
14. Please click on the "home" link to return back to the main page.

2. Exploratory debriefing questions

a. The top fifteen searches list contains 3 large categories of searches: searches for specific topics, video titles and videos belonging to specific NASA programs. What do you think of this mixture of items in the list?
b. How might you represent the difference between these different searches?
c. This web site provides you with 4 ways to begin your exploration. They are by top fifteen searches, subject, grade level and NASA program, of these methods which one(s) would you be most likely to use? Are there any you don't think you'd be likely to use?
d. Other than the 4 ways provided here to begin your exploration (top fifteen searches, subject, grade level and NASA program), is there any other way you would like to start your exploration?
e. What about starting with a particular curriculum standard?
f. What about starting with things that have related content?

3. Retrieval tasks
    a. Rationale -- Retrieval tasks will be important for advanced users of the digital video system and for users who would like to locate previously used resources very quickly. The primary reason for including the following tasks is to explore if educators can find information quickly and if the system matches their expectations
        i. Locate a video or videos using NASA program
            1. Now that you have completed a series of exploratory tasks, we would like you to search for specific videos. Using NASA program, please locate the NASA CONNECT™ video "Virtual Earth"
            2. Can you identify if this video has been segmented or divided into small chunks? Would segments be useful?
            3. What do you think of the way a video and their segments are currently shown in the system?
            4. Please click on the "home" link to return back to the main page.
        ii. Locate a video or videos using keyword search
            1. Are there any searches you would like to perform to see if the web site has videos which might be useful in your classroom setting? Please perform the search using the keyword search.
            2. (If not) please perform a search for "electricity"
            3. What are the next steps you would take?
            4. Had you considered narrowing your search by grade level?
            5. Had you considered thinking of similar terms?
            6. Do any of the videos look like good candidates to use in your classroom? How did you come to this conclusion?
        iii. Locate a video or videos using "Embedded Viewer" page – for the next two tasks imagine you are sea
            1. Please select "Embedded Viewer" from the left menu.
            2. Are there any specific features or elements in the current display which may be useful to your browsing and/or selection of video at this stage?

3. What would you expect to happen when you click on one of the videos in the video bar pane?
4. Did you notice that the search box says "Google Custom Search"?
5. Please perform a search for "boxes" on this page.
6. What do you notice about these results? Are these the types of results you would expect?
7. (If no to probe 6) What types of results did you expect?
8. Please click on one of the results. Did you expect this to happen?
9. (If no to probe 6) What types of results did you expect?
10. Return to the home page

iv. Locate a video or videos using “Google Video Search” page

1. Please select "Google Video Search" from the left menu.
2. Did you notice that the search box already has some information in it?
3. Please perform a search for "boxes" on this page.
4. What do you notice about these results? Are these the types of results you would expect?
5. Please click on one of the results. Did you expect this to happen?
6. Please click on the "home" link to return back to the main page.

4. Retrieval tasks debriefing questions
   a. On a scale of one to three how would you rate this site's ease of search? Where 1= Not easy to perform searches 2=Somewhat easy to perform searches and 3=Easy to perform searches) Why?
   b. On a scale of one to three how would you rate the relevance of the information you retrieved? Where 1= Not relevant, 2=Somewhat relevant and 3=Relevant) Why?
   c. In addition to the actual videos, did the web site provide sufficient resources related to the video content? Are there any additional resources you would like to see added?
   d. Did you prefer to use the "Embedded Viewer", the "Google Video Search", or the normal web site searching and browsing? Why?
5. Overall debriefing questions
   a. Would you use this web site in the future?
   b. Would you recommend this web site to a colleague? Why or why not?
   c. Where there any additional pieces of information which would have made your searching and browsing easier?
   d. Did you feel like you had adequate control of the system and information? (If no) what else would you have liked?
   e. Did you feel like you had a variety of representations for the video information? Are there other representations would you have liked to see?

Appendix J: Survey results for non-educator group

Table 1. Age distribution of non-educator group

Age Group	Number of Respondents
17 years or below	0
18-29	8
30-39	2
40-49	1
50-59	0
60 years and above	0
Total	**11**

Table 2. Occupations held by non-educator group

Occupation	Number of Respondents
Teacher	0
Teacher's Aide	0
Student	9
Student-Teacher	0
School Librarian	0
Home School Teacher	0
Professor	0
Other[13]	1

[13]The occupation listed in the other category was computer support.

Total	**10**

Table 3. Race or ethnicity held by non-educator group

Race or Ethnicity	**Number of Respondents**
American Indian or Alaskan Native	0
Asian or Pacific Islander	1
Black or African American	1
Hispanic, Latino or Spanish Origin	1
White	7
Mixed or multiple ethnicity	0
Some other race or ethnicity	0
Total	**10**

Table 4. Education levels held by non-educator group

Education Level	Number of Respondents
High school working towards Bachelor's	3
Bachelor's	3
Master's	1
Doctorate	0
Other[14]	3
Total	**10**

[14]The three participants who selected the other category gave their education levels as associates, high school and "studying".

Table 5. Favorite web resources mentioned by non-educator group

	Resource	Comments about the resource.
1	archive.org	The Internet Archive has a large amount of freely available video and film content, much of historical interest.
2	http://www.wikipedia.org	Looking up information on anything
3	www.vdb.org	The purpose of this website is to make accessible a range of video-artists work by listing these productions and providing short clips of some of such work.
4	www.digg.com	visitors to the site post links to news articles that interest them, viewers can rate how much they liked the article, so for every day you can see which news articles were most popular and pick which ones you would like to read based upon…
5	ask.com	search engine - it gives more relevent and informational results than google
6	Google.com	1. I use the google scholar search engine for researching educational topics as well as finding internet references for papers. 2. It is a search engine. 3. To find keywords and associated sites, relating to my search 4. Provides links that are identified via some (unknown) algorithm that uses most followed links from users 5. search for web pages that match the search criteria.

Table 6. Features non-educators valued in their favorite search engine or Web site

Feature	**Number of non-educators who valued this feature as their 1st choice**	**Combined Responses for 2nd and 3rd choice**
Easy to search	5	1
Multiple resources available	2	4
Usually has the most relevant information	2	3
Easy to find what I want	1	3
Easy to use	1	1
Well-known	0	3
From a reputable source	0	3
Resources are culturally / age / developmentally appropriate	0	2
Web site links are up to date	0	2
Downloads quickly	0	0
Limits search to the desired category	0	0
Resources easy to customize for my needs	0	0
Web site complements resources already used	0	0

Table 7. Non-educator use of Web based video

Question	Response	Number
Do you ever use downloadable or Web based video?	Yes[15]	10
	No	1

[15] These respondents used online video for the following reasons:

- Entertainment e.g. watching tv shows online, music videos, comedy or online homemade films (Youtube.com)
- News
- Research e.g. autism research
- School assignments, education
-

Appendix K: Demographic information of educator group

Table 1. Age distribution of educator group

Age Group	**Number of Respondents**
17 years or below	0
18-29	5
30-39	2
40-49	5
50-59	5
60 years and above	0
Total	**17**

Table 2. Occupations held by educator group

Occupation	**Number of Respondents**
Teacher	7
Teacher's Aide	0
Student	1
Student-Teacher	2
School Librarian	1
Home School Teacher	0
Professor	3
Other[16]	3
Total	**17**

[16]The occupations listed in the other category were teacher's assistant, technology specialist, and science coordinator.

Table 3. Race or ethnicity held by educator group

Race or Ethnicity	**Number of Respondents**
American Indian or Alaskan Native	0
Asian or Pacific Islander	0
Black or African American	2
Hispanic, Latino or Spanish Origin	0
White	15
Mixed or multiple ethnicity	0
Some other race or ethnicity	0
Total	**17**

Table 4. Education levels held by educator group

Education Level	Number of Respondents
High school working towards Bachelor's	2
Bachelor's	2
Master's	9
Doctorate	3
Other[17]	1
Total	**17**

Table 5. Years of teaching experience held by educator group

Years of Teaching Experience	Number of Respondents
1 year or less	2
2-3	1
4-6	4
7-10	2
11-20	4
21 years or more	4
Total	**17**

[17]The participant who selected the other category gave their education level as ABD.

Table 6. Number of years educators have been employed at current school

Years employed at current school	**Number of Respondents**
1 year or less	2
2-3	1
4-6	4
7-10	2
11-20	4
21 years or more	4
Total	**17**

Table 7. Courses taught by educator group

Course Taught	Number of Respondents
Science and Math	3
Science and Social Studies	1
Science and Health	1
Sociology	1
Music	1
English	1
Other courses taught[18]	9
Total	**17**

[18] The following responses were recorded in the other category for the courses educators taught:

- Science, especially space and elementary chemistry
- Ed Methods classes
- 5th grade
- Science, especially space and elementary chemistry
- Spanish linguistics. Cultural Studies in Spain
- Library / Technology
- Information & Library Science
- Technology Integration
- Science NASA Educator
-

Table 8. Setting of institution for educator group

Years of Experience	Number of Respondents
Rural location, Informal setting	0
Rural location, Formal setting	4
Suburban location. Informal setting	1
Suburban location. Formal setting	7
Urban location, Informal setting	0
Urban location, Formal setting	5
Total	**17**

Table 9. Grade levels taught by educator group

		Participant Number																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Total
Grade Taught	Prekindergarten		X									X							2
	K-5		X								X	X				X			4
	6-8	X	X	X	X			X				X			X		X	X	9
	9-12	X	X										X		X				4
	Undergraduate					X	X		X	X			X		X				6

Table 10. Distribution of students with special needs for educator group

Students with special needs at your school	**Number of Respondents**
Less than 25%	12
25-50%	1
50-75%	1
75-100%	1
Not Sure	1
Not Applicable, N/A	1
Total	**17**

Table 11. Percentage of students with IEPs for educator group

Students who receive IEPs	**Number of Respondents**
Less than 25%	9
25-50%	2
50-75%	0
75-100%	1
Not Sure	3
Not Applicable, N/A	2
Total	**17**

Table 12. Distribution of students who receive free or reduced price lunch for educator group

Students who receive free or reduced price lunch at your school	**Number of Respondents**
Less than 25%	3
25-50%	2
50-75%	1
75-100%	3
Not Sure	3
Not Applicable, N/A	5
Total	**17**

Table 13. Percentage of talented or gifted students for educator group

Talented or Gifted Students at your school	**Number of Respondents**
Less than 25%	8
25-50%	2
50-75%	0
75-100%	0
Not Sure	4
Not Applicable, N/A	3
Total	**17**

Appendix L: Other favorite Web resources mentioned by educators

	Resource	Comments about resource
1	http://nlvm.usu.edu/en/nav/vlibrary.html	Library or virtual manipulatives, mathematics resources, mostly java applets, listed by grade and subject category
2	brainpop.com	this is a great site that offers a large variety of material. the site not only offers instructinal information, but it is persented in a manner the students enjoy. in addtion the site is student friendly, interactive, and is visually stimulating.
3	Virginia Department of Education Standards	
4	www.grovemusic.org	online version of Grove Dictionary of Music and Musicians. Used to obtain basic biographical data, chronology of compositions/recordings.
5	www.allmusic.com	performer biographies, discographies.
6	The Online Writing Lab at Purdue University	has wonderful handouts and explanations of writing issues.
7	learnnc.org	use it to find resources directly related to specific

		goals and objectives
8	**archive.org**	**The Internet Archive has a large amount of freely available video and film content, much of historical interest.**
9	**http://www.wikipedia.org**	**Looking up information on anything**
10	**www.vdb.org**	**The purpose of this website is to make accessible a range of video-artists work by listing these productions and providing short clips of some of such work.**
11	**www.digg.com**	**visitors to the site post links to news articles that interest them, viewers can rate how much they liked the article, so for every day you can see which news articles were most popular and pick which ones you would like to read based upon…**
12	**ALISE Web site**	
13	**ACM Digital Library and campus e journals**	
14	**http://thegateway.org**	**GEM The Gateway**
15	**http://memory.loc.gov/ammem/ndlpedu/index.html**	**American Memory Lesson Page**
16	**http://www.bbc.co.uk/schools/**	**BBC Schools**
17	**http://www.kn.pacbell.com/wired/bluewebn**	**Blue Web'n**
18	**http://www.cybersmartcurriculum.org/home/**	**CyberSmart Curriculum**
19	**http://www.nytimes.com/learning/teachers/index.html**	**New York Times Teacher Connections**
20	**http://www.nytimes.com/learning/**	**New York Times Learning Network**
21	**http://7-12educators.about.com/**	**About.com**

		Secondary
22	http://k-6educators.about.com/	About.com Elementary Educators
23	http://www.educationworld.com/	Education World Teacher Resources
24	http://school.discovery.com/lessonplans/	Discovery School Lesson Plan Library
25	http://school.discovery.com/teachingtools/teachingtools.html	Discovery School Teacher Tools
26	http://www.edhelper.com	edHelper.com (lessons, webquests, worksheets)
27	http://www.ed.gov/free	FREE: Federal Resources for Educational Excellence
28	http://discoveryschool.com/schrockguide/	Kathy Schrock's Guide for Educators
29	http://www.marcopolo-education.org/	Marco Polo
30	http://mathforum.org/	Math Forum
31	http://www.archives.gov/digital_classroom/index.html	NARA Digital Classroom
32	http://nsdl.org	National Science Digital Library
33	http://www.nationalgeographic.com/education/	National Geographic Education
34	http://www.pbs.org/wgbh/nova/hslibrary.html	NOVA Online Activities (science)
35	http://www.pbs.org/teachersource/	PBS TeacherSource
36	http://www.cagle.com/teacher/	Professional Cartoonist (Editorial Cartoons with lesson plans)
37	http://wwww.readwritethink.org/	Read Write Think (NCTE)
38	http://www.sdcoe.k12.ca.us/score/cyberguide.html	S.C.O.R.E. Cyberguides
39	http://socialstudies.com/c/@9crDOmMTkGTpA/Pages/activities.html	Social Studies School Service Online Activities
40	http://teachwithmovies.org/	Teach With Movies: A New Tool for Parents and Teachers
41	http://www.spartacus.schoolnet.co.uk/history.htm	Teaching History

		Online (lots of simulations)
42	**http://www.edteck.com/dbq/**	**Teaching With Documents**
43	**http://bestwebquests.com/**	**Tom March's New Best WebQuests**
44	**http://webquest.org/**	**WebQuest**
45	**http://www.webenglishteacher.com**	**WebEnglish Teacher.com**

Appendix M: Demographic information of interview and cognitive walkthrough participants

Table 1. Age distribution of interview and cognitive walkthrough participants

Age Group	**Number of Respondents**
17 years or below	0
18-29	1
30-39	3
40-49	2
50-59	5
60 years and above	1
Total	**12**

Table 2. Occupations held by interview and cognitive walkthrough participants

Occupation	Number of Respondents
Teacher	12
Teacher's Aide	0
Student	0
Student-Teacher	0
School Librarian	0
Home School Teacher	0
Professor	0
Other[19]	1
Total	**13**

[19]One respondent was both a teacher and a planetarium director.

Table 3. Race or ethnicity held by interview and cognitive walkthrough participants

Race or Ethnicity	**Number of Respondents**
American Indian or Alaskan Native	0
Asian or Pacific Islander	1
Black or African American	2
Hispanic, Latino or Spanish Origin	0
White	7
Mixed or multiple ethnicity	2
Some other race or ethnicity	0
Total	**12**

Table 4. Education levels held by interview and cognitive walkthrough participants

Education Level	**Number of Respondents**
High school working towards Bachelor's	0
Bachelor's	2
Master's	8
Doctorate	0
Other[20]	2
Total	**12**

Table 5. Years of teaching experience held by interview and cognitive walkthrough participants

Years of Teaching Experience	**Number of Respondents**
1 year or less	1
2-3	0
4-6	1
7-10	2
11-20	3
21 years or more	5
Total	**12**

[20]One participant indicated they had a Master's degree and an additional Bachelor's degree. The other participant reported they had two Master's degrees.

Table 6. Number of years interview and cognitive walkthrough participants have been employed at current school

Years employed at current school	**Number of Respondents**
1 year or less	2
2-3	2
4-6	0
7-10	3
11-20	0
21 years or more	5
Total	**12**

Table 7. Courses taught by interview and cognitive walkthrough participants

Course Taught	Number of Total Courses for 12 respondents
Earth Science	5
Life Science	2
Chemistry	2
Physical Science	2
Astronomy	2
Other courses taught[21]	15
Total	**29**

[21] The following responses were recorded in the other category:

- Integrated Physics and Chemistry
- Environmental Research
- Space Science
- General Science
- Environmental Science
- Science and Technology
- Math / Science / Technology
- Environmental Field Studies
- Geology
- Meteorology
- Oceanography
- Grade 6 science and social studies

Table 8. Setting of institution for interview and cognitive walkthrough participants

Years of Experience	**Number of Respondents**
Rural location, Informal setting	0
Rural location, Formal setting	4
Suburban location. Informal setting[22]	1
Suburban location. Formal setting	7
Urban location, Informal setting	0
Urban location, Formal setting	1
Total	**13**

[22]This setting and location refers to the teacher who was also a planetarium director.

Table 9. Grade levels taught by interview and cognitive walkthrough participants

Grade Level	Number of Respondents
Prekindergarten, Daycare	0
K-5	4
6-8	7
9-12[23]	5
Undergraduate / Graduate	0
Not Applicable, N/A	0
Total	**16**

[23] The respondent who was the planetarium director also noted in the grade level of planetarium students varied.

Table 10. Distribution of students with special needs for interview and cognitive walkthrough participants

Students with special needs at your school	**Number of Respondents**
Less than 25%	9
25-50%	3
50-75%	0
75-100%	0
Not Sure	0
Not Applicable, N/A	0
Total	**12**

Table 11. Percentage of students with IEPs for interview and cognitive walkthrough participants

Students who receive IEPs	**Number of Respondents**
Less than 25%	9
25-50%	3
50-75%	0
75-100%	0
Not Sure	0
Not Applicable, N/A	0
Total	**12**

Table 12. Distribution of students who receive free or reduced price lunch for interview and cognitive walkthrough participants

Students who receive free or reduced price lunch at your school	**Number of Respondents**
Less than 25%	4
25-50%	3
50-75%	3
75-100%	1
Not Sure	1
Not Applicable, N/A	0
Total	**12**

Table 13. Percentage of talented or gifted students for interview and cognitive walkthrough participants

Talented or Gifted Students at your school	**Number of Respondents**
Less than 25%	10
25-50%	2
50-75%	0
75-100%	0
Not Sure	0
Not Applicable, N/A	0
Total	**12**

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