ABSTRACT

Title of Dissertation: INFORMATION USE AND MEANINGFUL LEARNING

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This study investigates how high school students use information to learn. Conducted within the broad conceptual framework of a constructivist adaptation of learning theory, the study defines the "success" of students' information seeking as it relates to their meaningful learning experience as a whole.

In order to study students' information seeking as a meaningful learning experience, four foreshadowing questions were set out: 1) How do students initially understand information and information sources? 2) How do information structures of information sources affect students' understanding about their topics? 3) What strategies do students use for restructuring information? and 4) How is students' information use reflected in their products related to learning tasks?

Within the methodological framework of naturalistic inquiry, the study

used a combination of concept maps and interviews as a unique method for investigating changes in students' understanding based on their use of information. Twenty-one high school juniors in an honors class in persuasive speech were observed in their library media center while performing required learning tasks; eight of the students, their teacher, and the library media specialist were interviewed. Data were analyzed both manually and with the support of data management software.

Overall, the findings suggest that students' learning in an information-rich environment is dynamic and that students learn interactively and serendipitously. Several streams of analysis suggest more specific findings within these larger ones. To structure part of the analysis, Mayer's (1999) three processes for meaningful learning--selecting, organizing, and integrating--were extended to include two additional processes particularly important in information seeking: gathering and using. Findings suggest that all of these five processes are intertwined and dynamically related and the process of "using" information had a particular effect on students' understanding about their topics as they created their final products. Additionally, four types of changes were identified as students conducted their information seeking and created their final products: simple, analytic, organizational, and holistic. Analyzed within the framework of the revised Bloom's Taxonomy of Educational Objectives (Anderson and Krathwohl, 2001), the data revealed that students' learning progressed through all six levels of the taxonomy as they engaged with information.

INFORMATION USE AND MEANINGFUL LEARNING

by

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Chapter 1: Introduction

"Today's students face an increasing flood of information; they must somehow turn that flood into ideas and knowledge that they can use to better their own lives" (Pitts, 1994, p. 393). The development of information technology has offered us many new opportunities to use different types of information sources. In addition to traditional information sources, an increasing number of electronic sources are available. Most recently, the Internet has become a powerful information source available for public use. In addition, traditional print sources continue to be available.

Since the development of information technology is occurring so fast, it is not easy to keep up with the new learning environment it provides. Particularly with the great amount of information available in many different formats, both educators and students are in the process of figuring out how to make the most out of using a variety of information sources. Today's students, often called the "Net Generation" (Tapscott, 1999), are skillful in using many formats of information because they are growing up with home computers. The learning needs of these students are undoubtedly different from those of pre-Net generations.

Educators need to address these students' learning needs. Many students are enthusiastic and skillful in manipulating the information sources available online but far less capable at understanding, evaluating, and using the information these sources contain. In response to this concern, the school library media community emphasizes information literacy as one of the essential skills that students must acquire to achieve meaningful learning. Teaching and learning using information literacy skills in schools should be integrated into the curriculum so that the skills can be learned fully. As

research indicates, if information skills are integrated into instruction, student learning of content can be improved (Todd, 1995). The latest national guidelines, *Information Power: Building Partnerships for Learning* (American Library Association, 1998), argue for the importance of incorporating information literacy skills into the curriculum and describe nine *Information Literacy Standards for Student Learning* that set out specific information skills for students to master.

Although the national guidelines emphasizing information skills in a new information environment have been available for almost five years, little is known about how students learn by using information. As yet, we do not know very much about how students engage in the process of learning as they access, evaluate, and use information. If we can identify and describe how students use information to learn, we might be able to address their learning needs more effectively.

1.1. Need for the study

Learning should be the central emphasis when we consider students' information seeking and use in schools. The basic assumption of this research is that information sources influence learning in a way similar to the ways Kozma (1991) argued in his discussion of the influence of instructional media on learning: "Whether or not a medium's capabilities make a difference in learning depends on how they correspond to the particular learning situation." This research assumes that information sources correspond to particular learning situations for students during information seeking and use.

The field of information studies has built some knowledge of students' processes of information seeking and use. That body of knowledge is reflected in a relatively small number of studies. One of the crucial problems that research has identified is the fundamental difference between students' cognitive processes and knowledge structures and those inherent in information systems. Neuman diagnosed the problem in her study (1993) of high school students' searching of electronic databases: The "mismatch" between students' cognitive structures and the systems' knowledge structures was found to hinder more effective searching. Pitts (1994) asserted that information seeking and use are not easy processes for students to understand and to use to integrate new ideas into their personal understandings. McGregor (1993) indicated that high school students in a gifted and talented program were able to use higher-order thinking skills during their information seeking and use.

Although existing studies have significantly contributed to our understanding, they are not adequate to offer a complete picture of how students use information to learn. The piece in this puzzle that is the particular focus of this research is the relationship between learning and information seeking and use as two processes which move together. The growing usage of and reliance on electronic information sources today adds another dimension to the study that makes it different from previous studies. Information seeking itself is more dynamic and complex than in the past, challenging learners to integrate complex ideas quickly and to achieve learning that goes beyond simple mastery of facts and concepts. This study focuses on how students learn by using information during the process.

Many studies of information seeking in electronic resources tend to measure "success" by examining whether the information retrieved was relevant to search questions when a user inputs a search term into an information system. However, this view of "successful" information seeking is too simplistic, since information seeking is a holistic and dynamic process that cannot be measured against the number of results returned by a one-time search. Particularly with formal school-based assignments, "successful" information seeking must support meaningful learning.

This research uses the term *meaningful learning* to describe the kind of learning that goes beyond simple mastery of facts and concepts. As Novak (1998) stated, "meaningful learning results when the learner chooses to relate new information to ideas the learner already knows" (p. 17). Meaningful learning emphasizes students' use of a variety of cognitive skills while constructing knowledge with information.

The kinds of cognitive skills used for meaningful learning seem best delineated by Bloom in the original *Taxonomy of Educational Objectives* (1956) and by Anderson and Krathwohl in the revised version (2001). This revised taxonomy, which can serve as a framework for defining meaningful learning, lists six levels of learning from the lowest to the highest: *remember, understand, apply, analyze, evaluate,* and *create*. In this study, students' application of the cognitive skills identified in this taxonomy was used to describe how meaningful learning occurs during the course of seeking and using information.

Because meaningful learning is dynamic and because we do not know when and how it occurs during the processes of information seeking and use, the processes as a whole were examined. It is very difficult to pinpoint when learning occurs, because it is

constantly evolving throughout the processes of information seeking and use. Studying the process as a whole in relation to a learning task from the beginning of information seeking to the presentation of information in a final product has yielded significant understanding about successful information seeking and use.

1.2. Description of the study

The central research question that guided this research involved how students seek and use information as they pursue meaningful learning. In order to investigate the learning process as it occurs, the process of information seeking and use as a whole was selected as the focus of the research. However, it was impossible in a single study to investigate all the relevant issues. Determining the appropriate foci to provide the conceptual guidance for the study was thus the essential starting point. The following four sets of foreshadowing questions were developed to meet this purpose.

Major research question:

How does information seeking and use contribute to meaningful learning?

Foreshadowing questions:

1. How do students initially understand information and information sources?
    a. How do students plan information seeking and expect to access information and information sources?
    b. What do information and information sources mean to them for doing their assignments?

c. How do they understand 1) the ways in which information is structured in a source and 2) the processes used to retrieve the needed information from the source?

d. How does students' understanding about information and information sources change over time?

2. How do information structures of information sources affect students' understanding?

   a. How is the information structure of an information source similar to and different from students' initial understanding?

   b. How do the levels of vocabulary that students use match with the levels of vocabulary that a source presents?

   c. How do the existing curriculum categories and the given assignment of a class affect students' understanding of information sources?

   d. How do students' interactions with information sources change their understanding of the sources and the topics?

3. What strategies and activities do students use for restructuring information?

   a. What strategies do students use to gather, select, organize, and integrate information for their research?

   b. What activities do students demonstrate in gathering, selecting, organizing, and integrating information?

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   b. What activities do students demonstrate in gathering, selecting, organizing, and integrating information?

4. How is students' information use reflected in final products related to learning tasks?
    a. How is students' initial understanding of the topic changed or expanded?
    b. How is students' understanding of information represented in their products?

In addressing these questions, the progression of students' information seeking and use was explored from beginning to end as students finished an assignment during a two-week period.

The research context chosen was an assignment from a persuasive speech course in a public high school. Participants in the study were all twenty-one students from a junior honors class taking the course. The assignment was to do individual research on a topic and to give a speech to the class. The sources recommended to the students included three online databases, the Internet, and print sources. The teacher provided a range of tools to prepare students to conduct research efficiently on a topic, and the researcher added her own data-gathering instruments in consultation with the teacher. It was assumed that students worked to finish their assignment as directed using the tools that the teacher and the researcher provided.

The findings of this research are useful to researchers and practitioners in the library and information studies community as well as to systems designers. At its most basic level, the findings make targeted suggestions to each community. At a higher level, the findings provide grounded theoretical knowledge about student learning and information seeking and use. Ultimately, the study has brought us closer to a comprehensive understanding of student learning with information.

Chapter 2: Conceptual Framework

Although there are not many studies about how information is used for meaningful learning, two broad areas of research provided a rich conceptual background for this research: learning theory and information-seeking studies. Learning theories from cognitive psychology, constructivism, and pedagogy explained in relation to information seeking and use were integrated to provide a broad conceptual background. Studies of students' information seeking and use in school settings also contributed to the conceptual background for this research. Four key ideas are discussed in this chapter:

- Learning is a change in knowledge structure.
- Learning is an integration of new information into prior knowledge.
- Meaningful learning as opposed to rote learning involves knowledge construction that requires higher-order cognitive skills.
- Information systems and instruction should support learning.

2.1. Learning theory

A fundamental difference exists between cognitive psychology and constructivism in approaching how to study human learning (Anderson, Reder, and Simon, 1998). Cognitive psychology explains how learning occurs in terms of its symbolic processes and representation, while constructivism considers the social framework of learning environments in which learning occurs. In other words, the fundamental difference between the two is that cognitive information-processing theory emphasizes internal representations of learning using symbolic processes, whereas constructivism puts more emphasis on external representations within learning environments that can facilitate meaningful learning based on the belief that students should actively construct their own knowledge.

Although these are two different perspectives on learning, both approaches are valid for studying learning (Anderson, Greeno, Reder and Simon, 2000). One needs both approaches to understand learning more fully, because neither is complete. We need to understand both internal and external representations of learning.

Researchers and theorists associated with both approaches take different positions on a continuum that describes the relative importance of each. Radical adherents to each view argue for its importance, while moderates are more willing to admit that the two views are complementary. This study takes the moderates' perspective: together, the information-processing and constructivist approaches provide a solid conceptual framework for exploring how learning occurs.

2.1.1. Learning is a change in knowledge structure: The cognitivist perspective

Cognitive psychology explains how learning occurs by explaining the ways in which the human cognitive system processes, stores, and retrieves information. Its most basic assumption is that "thinking is information processing" (Siegler, 1997, p. 64). It suggests that the human mind goes through the basic steps of the information-processing model in order to acquire information when external stimuli, such as new information, enter the cognitive system. The basic components of the information-processing system are the sensory register, short-term (or working) memory, and long-term memory.

For information entering short-term memory from the sensory register to be successfully stored in long-term memory, it must be processed in one's cognitive system the capacity of long-term memory and the period of retention of information are not fully understood. However, researchers have suggested a few types of knowledge that long-term memory holds: semantic, conceptual, schematic, procedural, and strategic knowledge (Mayer, 1981, 1992, 1999).

Semantic knowledge is factual, general knowledge about the world that we learn every day. Conceptual knowledge includes a person's representation of knowledge about major concepts. Schematic knowledge is a person's knowledge of problem types. Procedural knowledge includes the skills of using algorithms and procedures for particular situations. Strategic knowledge is a person's knowledge of how to learn and solve problems. This knowledge also includes metacognitive skills, which are also called cognitive strategies.

How do people use these kinds of knowledge to make inferences, solve problems, and cope with new learning situations? One of the powerful cognitive theories explaining this is schema theory. A schema is defined as "a data structure for representing the generic concepts stored in memory" (Driscoll, 1994). Schema theory explains how data structures are presented and used in particular domains in particular ways.

Learning can be characterized as a change in one's knowledge structure or schema. In that regard, information seeking can be seen as a learning process in which information seekers change their knowledge structures by making connections of new information with their existing knowledge, thus making new meanings. Mayer describes three necessary cognitive processes for meaningful learning: a learner *selects* relevant information from external stimuli, *organizes* it to build internal connections among incoming information, and *integrates* external connections to the newly organized information with existing relevant information (1999). Selecting, organizing, and integrating information ensure the transfer of one's acquired knowledge to different learning situations.

The processes of selecting, organizing, and integrating information require an ability to use semantic, conceptual, schematic, procedural, and strategic knowledge in a learning situation. The use of conceptual knowledge is particularly critical (Driscoll, 1994) because a change of one's knowledge structure involving concepts is the most central phenomenon when learning occurs in the course of interaction with new information (Glaser, 1994).

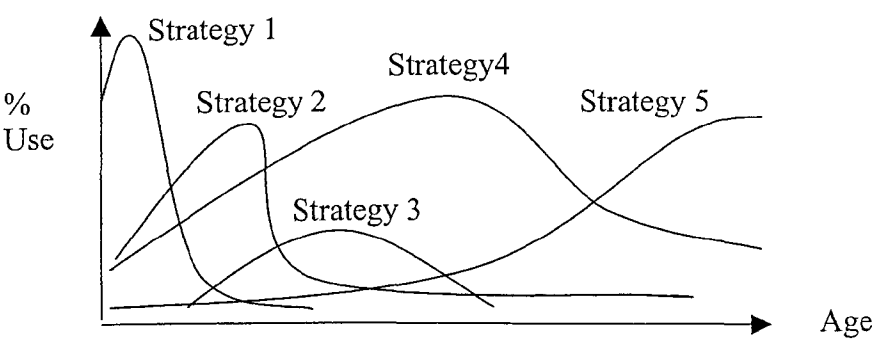
The basic mechanisms by which learning occurs are suggested by Piaget's original theory: *assimilation* and *accommodation*. If new information fits into the individual's existing schema, the information assimilates by becoming incorporated into the existing store of the information. However, if the new information does not fit into the existing schema, the structure of the schema changes to accommodate the new information so it can be incorporated. This means rebuilding the schema to accommodate the new information. Neo-Piagetian theorists such as Case accept Piaget's mechanism and combine information processing theories with Piaget's theory. Case asserts that *automatization* is the change mechanism that undergirds the process of structural reorganization and that this mechanism assumes the biological growth of working-memory capacity. Automatization suggests that cognitive operations become more efficient with practice or experience and that biological maturation enables cognitive operations to move to the next cognitive stage.

Modern cognitive psychologists, information-processing theorists in particular, try to analyze change mechanisms in more detail. Klahr and Wallace (1976) used self-modifying production systems, computer simulations with mechanisms that enable change in response to experience; here, the key change mechanism is termed generalization. Learners record details of features without knowing which are relevant and irrelevant. Then, when the system detects regularity, it produces generalizations about the regular features. Siegler describes encoding as another mechanism that is important in cognition. Encoding involves selecting meaningful features from events and objects and using them to form internal representations of information (Siegler, 1997).

Chunking is another important learning mechanism. It is generally accepted that chunking is a form of human information processing that facilitates knowledge acquisition. Experts or more experienced people in a domain have fewer chunks of knowledge than novices or inexperienced people, because they are able to process information more efficiently into meaningful chunks that are large enough to encompass many concepts and a variety of kinds of relationships among them (VanLehn, 1993).

When learning occurs, cognitive strategies are used to adapt incoming new information so that it can be incorporated into schemata. Siegler's Overlapping Waves Approach Model (1997, p. 92. see figure 1) explains how people adapt cognitive strategies as they get more experienced. Siegler assumes that there are many strategies that people can use (e.g., strategy 1, 2, 3, 4, 5); however, the strategies that are used most frequently become prevalent (e.g., strategy 4 or 5). Glaser also emphasizes the importance of the implicit and explicit generative cognitive strategies that learners bring to constructing knowledge (1994). The development of cognitive skills largely depends on the use and development of cognitive strategies for learning.

<Figure 1: Siegler's Overlapping Waves Approach Model>



2.1.2. Learning is an integration of new information into prior knowledge: The constructivist perspective

Cognitive psychologists and constructivists agree that learners' active interpretation of new information related to their prior knowledge and experience is essential for meaningful learning (Anderson, Reder, and Simon, 1998). Beyond this basic agreement, however, there are many disagreements between some modern cognitive psychologists and the so-called "radical constructivists." Despite the fact that constructivists assert that their theoretical background has its bases in cognitive psychology, the disagreements between the two camps have had a significant impact on contemporary discussions of learning theory and classroom practice.

Cognitive psychologists study human cognition and learning from the perspective of information-processing theory, which presents models of cognitive processing that use symbols as their representational tools. Some radical constructivists, however, focusing on the theory of situated learning, believe that there are nonlinear, nonverbal, nonlogical, and intuitive forms of cognition or knowledge that cannot be represented with symbols (Anderson, Reder, and Simon, 1998; Greeno, and Moore, 1993). Cognitive psychologists counter by pointing out that cognitive competence depends on the availability of symbolic representations that allow the transforming of external representations into internal representations.

A related controversy between radical constructivism and cognitive psychology lies in the difference in learning environments that each supports. Radical constructivists believe that knowledge does not transfer from the classroom to authentic situations because classroom instruction is too simple to encompass the knowledge

required in "real-life" situations. With this view, some moderate constructivists promote creating learning environments that resemble authentic environments using instructional technology, since de-contexualized and simplified knowledge promotes learning that is rigid and incomplete (e.g. Duffy and Jonassen, 1992; Choi and Hannafin, 1995; Land and Hannafin, 1996; Wilson, 1996; Jonassen, Peck, and Wilson, 1999). Cognitive psychologists, however, argue that students are easily overwhelmed by complex, "real-life" situations and that abstract tools have long been used in instruction and are a powerful method for fostering learning. Cognitive psychologists believe that instruction should emphasize engaging students in cognitive processes that will enable them to transfer knowledge to authentic situations.

In keeping with the claim that both approaches are fundamentally important in education (Anderson, Greeno, Reder, and Simon, 2000), this study incorporates both theoretical perspectives into its conceptual base. The study assumes a moderate constructivist belief and emphasizes the cognitive perspective in its attempt to identify learners' processes in using information to learn. The study borrows from constructivist assumptions that people do not learn passively but actively interpret new information with the help of prior knowledge and experience. In other words, this study is grounded in the cognitivists' claim that learning occurs internally from individual experiences and is in turn concerned with the constructivists' focus on how we construct knowledge in specific contexts. It characterizes learning as an active process that integrates new experience into one's existing cognitive structures -- which are called schemata, mental models, or mental representations by different cognitive psychologists. This characterization of learning as an active process is supported by the constructivist belief

that knowledge grows internally as the learner actively constructs individual interpretations from experiences.

Constructivism supports an alternative paradigm of teaching and learning that challenges the traditional behaviorist paradigm, still apparent in schools, which is based on the belief that learning is the passive transmission of ideas through instruction. Current efforts to understand new information environments and information seeking can be very well nested in constructivism, because individuals' processes in seeking information are closely related to learners' active processes in pursuit of meaning. From the constructivist perspective, learners' active involvement in learning is crucial for meaningful learning: the learner constructs his/her own knowledge through the process. *Information Power: Building Partnerships for Learning* (American Library Association, 1998) recognizes and employs constructivism as its underlying philosophy for achieving information literacy skills.

Several studies of children's information seeking emphasize information seeking as process oriented -- for example, Kuhlthau (1993), McGregor (1993), and Pitts (1995). Cognitive and constructivist ideas were the premises underlying these studies, which focused on what happens in users' minds during the information-seeking process. Kuhlthau explicitly stated that constructivism was a background framework for her studies (1993). Although she recognizes that individuals go through the information-seeking process differently, her Information Search Process model identifies the common pattern of how individuals' information seeking progresses according to cognitive, affective, and behavioral perspectives.

By applying constructivist concepts and ideas to information seeking and learning, Kuhlthau's studies reveal how information seeking proceeds and how individuals are involved with the steps of the process as they make meaning from the information they find. From a constructivist perspective, seeing the information-seeking process as a component of meaningful learning becomes clearer. This research accepts the basic principles of the cognitive/constructivist view of learning and sees information seeking and use as the active process by which an individual learner constructs knowledge from new information.

2.1.3. Meaningful learning involves knowledge construction that requires higher-order cognitive skills: The pedagogical perspective

The theoretical foundation of modern pedagogy is largely influenced by both the cognitive and the constructivist perspectives. Novak's notion of meaningful learning (1998), Mayer's three external conditions for meaningful learning (1999), and the revised Bloom's taxonomy (Anderson and Krathwohl, 2001) all contribute to the understanding of meaningful learning that underlies this study.

Pedagogy attempts to understand what meaningful learning is, how it is achieved, and how classroom instruction can mediate it. Pedagogy often explains meaningful learning in comparison with rote learning, and many theorists argue that too many learning activities in today's schools are still in rote mode. According to Novak (1998), "learning is too often by rote," even in settings "in which the underlying reasons for rules need to be explained" (p. 58). The knowledge obtained by rote learning is often not retained long and does not necessarily transfer to other knowledge domains.

Novak (1998) identified three requirements for meaningful learning, all of which fit well with the idea of meaningful learning in the context of information seeking and use: (1) relevant prior knowledge, (2) meaningful materials, and (3) the learner's intention to learn meaningfully. Although there may be some variations in the third element - the learner's choice to learn meaningfully – it is clear that all students build upon their prior knowledge to gain more understanding as they access, evaluate, and use information.

Mayer's (1999) three external conditions for meaningful learning in instructional settings also provide the rationale for understanding how students achieve meaningful learning through information seeking and use: 1) meaningful learning materials, 2) help for the learner, and 3) the evaluation of meaningful learning. In classroom settings, teachers have some degree of control and responsibility for students' achievement of meaningful learning. Teachers should prepare meaningful learning materials before instruction because "a random list of unconnected facts" is not understandable for learners (Mayer, 1999, p. 20) and does not lead to meaningful learning. Teachers should provide help for learners as they select, organize, and integrate information in a lesson; and they should evaluate student learning using techniques that do not just measure students' simple mastery of facts and concepts. In the context of information seeking and use, both teachers and students have more challenges under this approach. Students are expected to access, understand, select, and connect the facts on their own for their understanding; they must make their own organization, since organized learning materials such as textbooks are not provided. Students are expected to pursue help actively during the process, and the final outcomes

of their information seeking are often evaluated without considering the processes that led to the outcomes.

Rote learning requires only low levels of cognitive skills, such as memorizing simple facts and concepts, while meaningful learning requires higher levels of cognitive skills that accompany greater cognitive effort. One of the ways to overcome the learning challenges in information seeking and use is to provide appropriate instructional guidance for students by using an appropriate framework that describes the underlying processes students must use to attain these higher levels. The different levels of cognitive skills involved throughout the learning process are described well in *A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives* (Anderson and Krathwohl, 2001). The taxonomy identifies six levels of learning according to the cognitive skills required for particular learning tasks.

The revised taxonomy can help teachers design instructional objectives more effectively for student learning in relation to a learning task, and it also serves well as a framework to delineate the kinds of cognitive skills needed to achieve different levels of learning. For example, the lowest level in the revised taxonomy is remember, which is often the sole cognitive activity required for rote learning. The outcome of this activity would involve simply recalling some facts from memory. The highest level is create, which involves a collection of more advanced cognitive activities. The outcome of this activity would involve accessing, evaluating, and using information in new and often unpredictable ways.

Students are responsible for accessing, evaluating, and using information from a variety of sources in the context of information seeking and use. Therefore, it is clear

that higher levels of cognitive skills are integrated to achieving meaningful learning. Information seeking and use thus involves an authentic learning task that requires both appropriate understanding of the task and application of the necessary cognitive skills to accomplish the task. Developing instructional strategies that facilitate student learning is a key to students' successful information seeking and use. Many issues remain, as we do not yet know enough about how we seek and use information to learn meaningfully.

2.2. Information systems and instruction should support learning: Information seeking studies

There exists only a small body of significant work that addresses how students seek and use information in support of learning. Although these studies do not fully explain how students seek and use information to learn meaningfully, they explain the phenomenon itself, what difficulties students encounter during the process, how they use particular types of information resources, and how they need to be guided instructionally. Summarizing all the studies on information seeking is certainly difficult - due to their variety of foci: differences in users, in information resources used, and in other environmental factors involved in the studies – but several key concepts from this literature undergird this study.

2.2.1. Knowledge support for learning

One of the earliest studies of information seeking that sheds light on information seeking and learning was conducted by Joyce and Joyce (1970). They developed an information system for children about a Pueblo culture of the southwestern United

States and investigated how elementary school children used the system. In their "free-inquiry study," they studied how children used the system under unstructured conditions. Children were free to ask questions and to describe the culture. Then, the researchers developed a new classification system designed around children's questions, which had fewer categories of themes than the original classification scheme. Joyce and Joyce found that children with high intelligence (measured by the matches between IQ and academic achievement) generated more categories of themes and used more categories of the original classification system with its more refined categories than did children with average and low intelligence; these children used a new classification system containing fewer categories quite well. Joyce and Joyce also investigated how learner-directed learning and system-directed learning had different results. The learner-directed group was free to ask questions without any given structure or materials, and the system-directed group was given materials about the culture. The students in both groups produced output tapes describing what they learned. The results show that the system-directed group generated more themes than the learner-directed group. The key feature of the study relevant to this study was the use of the number of themes that children generated as a way to measure how elementary school children learned from a set of information provided for them.

In his extensive qualitative study of elementary school children's use of an Online Public Access Catalog (OPAC), Solomon (1993) found patterns of success and breakdown in using this OPAC in a school library media center. Three patterns that contributed to success were:

(1) efforts on the part of some children to seek assistance;

(2) the application of OPAC control strategies to overcome some impasses; and

(3) the tendency of children to express their information needs with simple, concrete search terms.

Patterns of breakdowns occurred at three levels:

(1) knowledge breakdowns about the processing of the OPAC, its content, and mismatches between search terms and Library of Congress Subject Headings (LCSH);

(2) rule breakdowns in syntax, query form, and focus; and

(3) skill breakdowns in reading, spelling, and keyboarding.

Among these levels of breakdown, the "knowledge" reasons for breakdown suggest important considerations for this research because they underscore the fundamental problem between a controlled-vocabulary system and children's use of their natural vocabulary in expressing their needs. Solomon found that the children's subject knowledge structures and vocabulary did not match with knowledge represented in that of the OPAC and LCSH.

Neuman (1993) provided another important piece of evidence in the "knowledge" breakdowns in high school students' use of electronic databases. In her extensive qualitative study of high school students' use of online and CD-ROM databases, Neuman (1993) found that these databases do not accommodate high school students' needs in the ways the databases structure information and present their interfaces. She reported a lack of students' ability to access information using online bibliographic databases, concluding that students need much more support in accessing

information not only from human intervention but also from the information systems themselves. She indicated that the conceptual as well as the linguistic gaps between students' knowledge structures and those of the systems were significant. As a result, students had difficulties in accessing information. She suggested that applying principles from instructional design would lead to systems that would greatly help students in accessing information.

Using a four-round the Delphi study with 25 library media specialists from 22 high schools, Neuman (1995) investigated the important issues that should be considered in high school students' use of databases. She designed her instruments in nine categories of statements: five categories adapted from Fleming (1981) and four generated from her previous studies (1991b, 1993). The study's major findings on students' problems in using electronic sources included generating search terms, designing effective search strategies, and overcoming mismatches between students' ideas of information organization and systems' actual organization of information. Some design issues found important were using standardized vocabulary, adapting automatic mechanisms for broadening and narrowing searches, and using more directions to guide students' searches. The study's major findings on curriculum were to emphasize students' understanding of the nature of research and of searching, their understanding of how to make relevance judgments, and their understanding of effective search strategies. The findings on instructional strategies for these areas that were identified were individualized instruction, collaborative searching with a library media specialist and students, and peer tutoring. Major policy issues related to using

electronic sources included setting priorities on mastering higher-order thinking skills, and gaining familiarity with using these sources.

Todd (1995) found that instructional support that includes information skills instruction was significant in achieving learning outcomes. He investigated how high school students' information seeking skills affect learning and found an encouraging result. Using a posttest-only, comparison group experimental design, he reported that students who had had integrated information skills instruction built into their science class attained a higher mastery of science content than did students whose science class did not include information skills instruction. This result suggests that information seeking does in fact affect student learning.

In designing the interface of *ARTEMIS* for middle and high school students using the framework of Learner- Centered Design, Wallace *et al.* (1998) identified the different types of knowledge areas required for these learners as well as the problematic areas they encounter in information seeking. They identified five knowledge dimensions: domain, technology, strategy, metacognitive knowledge, and motivation. The problematic areas in the information seeking of sixth and ninth graders were identified as engaging in a process, generating search terms, staying on task, and evaluating information. The tools provided in the interface of *ARTEMIS* address these dimensions of learner needs. The tools are designed primarily for learners "to accomplish multiple tasks in a single computer environment so that their work does not become fragmented" (p. 198). The tools enable students to continue their work over a period of time and consist of a series of functions that allow them to focus on each of five knowledge types as well as those problematic areas.

Gordon (2000) tested the effectiveness of concept mapping as a useful technique for formulating concepts in searching with 10th grade students. Using both quantitative and qualitative methods, she found that:

· concept mappers used print sources more than electronic sources,

· they spent less time searching and used fewer sessions for searching,

· they used SIRS (Social Issues Resources Series) longer than the OPAC, and

· they used subject headings more often than keyword searches.

Concept mappers were able to use a larger number of search words; a greater variety of search terms; and more frequent opening moves, query reformulations, and search operations. They also performed "depth" and "breadth" searching more frequently (indicated by more conceptually "vertical" as well as "lateral" moves) than non-concept mappers. The results of the study have implications for information literacy instruction, since they demonstrate that concept mapping is a useful technique for forming conceptual skills that are critical in searching.

Neuman (2002) investigated what learning tasks, instructional strategies, and learning strategies should be used by students, teachers, and library media specialists in an information-rich environment. This qualitative study involved the library media specialist, five teachers, and 140 students in sixth and seventh grades in a middle school. In reporting her preliminary results, she reported that teachers put much effort into "orchestrating" their planning for each session in advance of their classes, considering the breakdown of technology. The other major theme found in her study was the issue of "structure." She reported that students do not have appropriate skills to structure information that is diverse and unrelated, such as that found on Web.

Therefore, providing structure is important for students, particularly for less-advanced ones.

2.2.2. Search behavior with text information

In most cases, the mode of information delivery in learning is textual, although more and more information systems, including the Internet, have multimedia capabilities. Students' searching of text information has been more thoroughly researched than has their searching of multimedia information. This body of literature also sheds light on information seeking and learning, although its focus is mostly on exploring search behavior *per se* and identifying the difficulties children go through in searching text information. Marchionini (1989) reported that 28 third and fourth graders and 24 sixth graders, in general, could successfully use a full-text CD-ROM encyclopedia. Children were equally successful in both an open (to find specific facts) and a closed task (to find information about a topic), although the open task took longer to finish and needed more moves. However, older children were faster and more successful on both kinds of tasks. He also found that children's search strategies were more highly interactive than planned. When they searched, they used sentences and phrases as queries, indicating that they had ill-defined mental models of the encyclopedia.

Large *et al.* (1994) compared 48 sixth graders' search behavior on the print and versions of an encyclopedia. The results indicated a significant difference of retrieval speeds depending on the query's complexity – measured by the number of search terms

in a query - although there was no evidence of difference of retrieval times between the print and CD-ROM versions for questions at the same level of complexity.

A series of studies based on the Science Library Catalog (SLC) investigated how elementary school children used its four successive versions. Borgman *et al.* (1995) reported a comprehensive review of the findings of three years of these studies. A Dewey-Decimal based hierarchical browsing system without keyword function, the SLC was developed by the researchers so that children were able to use it without prior training and the technical skills that are required to use keyword OPAC systems. The authors found that there is a relationship between search topics and system structures. Since the SLC is based on the Dewey hierarchy, it was suitable when children had topics that were open-ended or difficult to spell. The hierarchical structure of the Dewey Decimal System provided context for these topics, allowing children to learn about them by exploring within the subject domain. The keyword OPAC systems were more suitable for direct access to records and for tasks in which students were given terms to search.

In the latest study in the Science Library Catalog series, Hirsh (1998) found that task complexity and amount of knowledge about the search topic affect elementary school children's performance in information seeking. She employed two measures of task complexity, browsing-task complexity and keyword-task complexity. The measure for browsing-task complexity was designed to find out the influence of providing search terms that match the catalog's vocabulary: simple browsing tasks contained words matched to the bookshelf or Dewey topic headings, and complex browsing tasks did not contain such matches. The measure for keyword-task complexity was designed

to find out if the size of the search result set affects information seeking, based on the number of topic headings appearing in the search result sets. Children were successful in finding information when the search terms were provided but not successful when they were not provided. However, the size of search result sets was not found to affect the success of the children's information seeking. In addition, Hirsh found that children with high domain knowledge were more successful than children with low domain knowledge.

Chen (1993) identified high school students' difficulties in using an online catalog that confirmed the Neuman's findings (1991b, 1993). The difficulties that 35 eleventh grade students had included typographical and spelling errors, errors in using the system, errors in generating search terms, and errors in recording search results. Chen operationalized each student's success rate by dividing the number of correct items by the total number of items and reported that students had their highest success rates with author searches. Her study suggests that high school students have not only mechanical difficulties in using the system but also conceptual difficulties in searching.

There is a body of literature that not only addresses children's search behavior but also attempts to investigate their assessment of information. Hirsh's study of elementary school children's relevance criteria and search strategies using electronic sources (1999) revealed that 10 fifth grade children determined the relevance of information primarily on the topicality of textual information and on their own interest and paid little attention to the authority of textual and graphical information. She also found that, while children tended to use "topicality" of information as a relevance criterion at an early stage, they used "interesting" as a criterion as they moved along in

the process. This finding suggested to her that the children filled their knowledge gaps at an early stage and then tried to find discriminating information. For graphical information, children tended to spend much time finding their favorite graphics in the system.

2.2.3. Search behavior with multimedia information

There is a small body of studies that deal with children's use of multimedia information. Oliver and Perzylo (1994) built on their earlier work (Perzylo and Oliver, 1992) when they studied 27 twelve-year-old children's use of multimedia information in a CD-ROM encyclopedia. From the previous study, they realized that children tended to extract only textual information for their project assignments, although they accessed and used video, sound, and graphical images. So the researchers investigated the extent to which children extracted descriptive information from multimedia sources. They found that, with appropriate instruction and direction, young children were well able to extract information from multimedia. This suggests the importance of instructional support in using multimedia information sources.

Small and Ferreira (1994) investigated middle school children's and adults' information location and use from multimedia and print sources as well as the subjects' motivation and learning patterns related to these sources. One group of children used a laserdisk source, and the other group used a book source on the same subject. An adult group using the multimedia source was included to compare with the children's multimedia group. Results show that the "book" group used more extracting activities -- note-taking -- than the "multimedia" group and that the "multimedia" group used more

finding activities - locating desired information either through an index or browsing, sequential or random - and engaging activities - viewing, reading, and/or listening - than the "book" group. The "multimedia" group used three times as much nontext information as text information, whereas the "book" group used about the same amount of text and nontext information. Also, "multimedia" group children had higher motivation toward the multimedia source than either the adult group or the "book" children. Learning patterns among the groups were different in that the "multimedia" children used a greater percentage of single words from the source, while the "book" children used more phrases and sentences. The authors explained that the "multimedia" children "may have experienced more fragmented engagement of information, since those children tended to do more browsing, reading, and viewing" (p. 270). This study is especially interesting because it provided an important piece of evidence that children using a multimedia source learn differently from children using print sources.

Large, Beheshti, and Breuleux (1998) investigated how sixth graders used three multimedia CD-ROMs (*Encarta*, *Castle Explore*, and *Exploring Castle*) in order to do their class projects. The researchers reported that children are a distinct user group in regard to information systems. They tend to be confident, enthusiastic, and dexterous in manipulating the interface but to lack search strategy formulation and sophistication in language use. Sixth graders were able to distinguish between an interface that was interesting and one that had the information they needed. For example, their enthusiasm was greater for *Castle Explore*, but they relied heavily on *Encarta* to extract information. Large *et al.* suggested that class projects need to be redesigned for students to benefit fully from multimedia information sources: current class projects often

require students to select individual pieces of textual and factual information rather than using multimedia information fully.

2.2.4. Search behavior with the Web

The Web allows multimedia capabilities without time and geographic constraints. Overall, two groups of studies have involved children's use of the Web: one looks at information behavior of students using the Web to shed light on teaching and learning with the Web (e.g., Wallace and Kupperman, 1997; Schacter, Chung, and Dorr, 1998; Fidel *et al.*, 1999; Watson, 1999; Large and Beheshti, 2000; Bowler, Large, and Rejskind, 2001; Neuman, 2001, 2002); and the other looks at the usability of some of the popular Web search engines (e.g., Large, Beheshti, and Moukdad, 1999; Bilal, 1999, 2000; Large, Beheshti, and Rahman, 2002).

In a classroom setting, Wallace and Kupperman (1997) reported how 8 sixth grade children used the Web, how they made decisions about what information was valuable, and how they used it for their science class tasks. The findings, summarized in four themes, suggest the characteristics of children's use of the Web.

(1) Children did not explore the content of the visited sites enough and tended to go back to the hit lists quickly after looking at one or two pages.

(2) Children often rushed to find answers to the tasks rather than trying to understand information during the search process.

(3) Reflecting the developmental aspects of children in sixth grade, students often thought the source was valuable to their task if they found the specific words that they had sought.

(4) Children used the Web tools naively, although they learned to use them very easily. For example, naive uses of the tools were indicated by children's frequent use of the "back" button as a primary means of navigating and by repetitive use of keywords for searching. Many of the findings of this study were confirmed by the subsequent studies.

Schacter, Chung, and Dorr (1998) conducted one of the earliest studies, which yielded findings that led to many research questions for subsequent studies of students' use of the Web. The study investigated the relationships between different task structures and 32 fifth and sixth grade elementary school children's performance on the Web judged by both adults and the children themselves. Schacter *et al.* reported that children performed better with an ill-defined problem (to find information on topics) than a well-defined problem (to find specific facts). Children generally used a browsing strategy over an analytic search strategy. However, the children used more analytic search strategies to find answers for the well-defined task than for the ill-defined task. The researchers concluded that the structure of the well-defined task might provide a more concrete set of concepts to use in keyword searching. One puzzling finding, as the researchers noted, was that children and adult raters disagreed on the quality of the children's relevance judgments for the well-defined task but had higher agreement in regard to the ill-defined task.

In her phenomenological study, Watson (1998) investigated 9 eighth graders' perceptions of using technology, especially the World Wide Web. She concluded that children perceive that self-confidence, resilience, and openness to learning about the new technology are necessary for using it. Skills in reading the Web and in managing

information are perceived as important by children, and the author suggests that our education should address those skills. Although Watson used only interview data for this study, her study is notable for its report of children's perceptions of using Web technology.

Using a case study method, Fidel *et al.* (1999) investigated how eight high school students search the Internet for their school assignments. Students' searches were highly focused, and students were able to make quick decisions and to move swiftly and search flexibly on the Web. They used their own "landmarks" - for example, lists of search result sets - so they could always go back and start a new search until all the landmarks had been exhausted. Students always asked for help when needed. The students liked using the Web because it contains multimedia information, including pictures, and because it is easy to use for accessing information. The researchers suggested improvements to system design that would accommodate the users' searching behavior.

More recently, Large and Beheshti (2000) reported the importance of teachers' approaches to the use of the Web as an information source for learning activities. They investigated how sixth grade students in a primary school in Canada reacted to the use of the Web in their classroom:

· how students saw the Web as an information source *vis a vis* other sources,

· how they decided which sites to consult for school projects, and

· what problems they encountered while exploring Web sources.

The assignment was to create an individual poster to provide textual information about students' topics with images. The researchers interviewed fifty students who

completed the poster. Three groups of students were identified: technophiles, traditionalists, and pragmatists. Technophiles favored the Web over other print sources available, traditionalists preferred the print encyclopedia and reference books in the library, and pragmatists saw the Web as a complementary source with other sources available and believed that their decision to search for information depended on the kinds of information which they sought. It was frustrating for many of them to find exactly the same information on the Web as they do in the print sources. The researchers suggest that the use of the Web as an information source should be approached differently from the use of print sources. Class projects and teachers' approaches which work well in the print environment do not work as well in the Web environment.

Bowler, Large, and Rejskind (2001) reported how three sixth grade students in Canada accessed, interpreted, and used information to complete their assignments when the Web was a primary source. Some of their findings echo the findings and problems diagnosed by many previous studies using electronic sources. However, the issues raised in this study reflect the current usage of the Web in schools: neither teacher nor students know how to derive the use of full benefits of the Web as a learning tool. Students did not understand that the Web is a different learning environment from the print world. The assignment given by the teacher was not different from ones that require information in print, although students needed more guidance in accessing, interpreting, and using information. The study identified the importance of formulating instructional strategies for using the Web as a learning tool.

Focusing on the Web as a learning environment, Neuman identified teaching and learning strategies that are helpful in this environment. In her extensive naturalistic case study, Neuman (2001, 2002) reported how middle school students used the Web and what instructional strategies were used to guide that use. Her findings suggest that the Web is not used fully as a learning tool because much of the emphasis is on access, not on "the steps related to deep and meaningful learning" (2001). She argues that "looking for facts" is a frequent model of the usage in school and that providing structures to organize these facts is crucial for students' achievement of meaningful learning.

The studies on children's usability of the Web identify aspects of children's behavior using the available functions on Web browsers and search engines and suggest ways systems can be improved to accommodate children's behavior. Bilal (1999) conducted comparisons among three search engines - *Yahooligans!*, *Ask Jeeves for Kids*, and *Super Snooper* - used by 22 students in seventh grade. The retrieval performance for each of these -- measured by retrieval output, relevance, overlap, and redundancy -- were compared to identify the strengths and weaknesses of each engine.

Bilal (2000) chose *Yahooligans!* to investigate further with 22 seventh grade children. Using a measure she developed called the "Web Traversal Measure," she calculated children's traversal effectiveness, efficiency, and quality. She found that children use both keyword searching and browsing subject categories to find relevant information. However, children often switched between and among keyword searching, browsing subject categories, and visiting sites -- reflecting their disorientation on their task or their cognitive overload from the information presented. Children frequently

demonstrated looping and backtracking, which made their searches less efficient. Bilal identified three groups – linear, nonlinear, and looped – according to their search behavior. Children with the linear style were most successful because they found and clicked the target sites and scrolled down to locate the relevant information. Children with the nonlinear style found and clicked the appropriate sites but did not examine the pages to locate the information. They backtracked, searched under new terms, or browsed different categories. Children with the looped style were the most unsuccessful group. They found a target site but did not click it. Instead, they browsed, searched with different terms, backtracked, or looped.

In a follow-up study, Bilal (2001) reported how 17 seventh-grade children used *Yahooligans!* with research tasks. Consistent with other studies, all children tried to find specific answers to the research questions. In the study, 31 % of the children failed to find the relevant information about the questions because they did not use their topic knowledge in locating such information. These children printed the text from the first page they encountered as relevant information without examining the rest of the pages. Children also demonstrated more keyword searches at their initial moves and showed good search skills in manipulating concepts. Successful and partially successful children demonstrated better search skills using relevant concepts than did unsuccessful children. The "back" button was the most frequently used function in the browser, leading to more unsuccessful searches due to the obvious ineffectiveness of such a search strategy.

Large, Beheshti, and Moukdad (1999) reported sixth grade children's habits of information seeking. The findings - based on data collected from 53 children searching

for information on the Winter Olympics - show that children prefer browsing to keyword searches, even though the children were able to formulate keyword searches. Descriptive statistics of children's moves show that the "back" button and hypertext links were the most highly used functions on the Web browser and that the online help was the least-used function.

Large, Beheshti, and Rahman (2002) reported how 23 children from 10 to 13 years of age evaluated the usability of four children's Web portals: *Ask Jeeves for Kids*, *KidsClick*, *Lycos Zone*, and *Yahooligans!* Focus groups of the children indicated that students preferred to have entertaining as well as educational aspects on Web portals. In addition to attractive screen design using colors and graphics, the children wanted to be able to change colors and graphics to accommodate their own preferences and to have both browsing and keyword-search capabilities.

2.2.5. Information seeking and use

How students go through the information-seeking process has been identified by several studies and particularly by Kuhlthau (1993), Pitts (1994), McGregor (1993), McGregor and Streitenberger (1998), and Todd (1999). Kuhlthau delineated six stages in the information search process - task initiation, topic selection, exploration, formulation, collection, and presentation - and addressed each from the cognitive, affective, and physical perspectives. She found that students' thoughts, feelings, and physical actions are different from stage to stage. She reported that students' information-seeking behaviors are largely dependent on the stage at which they are working.

Pitts (1994) examined the cognitive aspects of why high school students make different decisions as the process moves along. Using the concept of personal understanding and mental-model theory as her conceptual framework, Pitts found that students make decisions based on their prior learning experiences, which are reflected in a variety of intertwined "learning strands." The study indicates that students switched from one strand to another as they experienced difficulties. Another important finding is that students used little information from libraries and other information systems because they did not know how to access information that could meet their information needs.

In Alberta, Canada, McGregor (1993) focused on the higher-order thinking skills used by high school students during the research process. This study revealed that the students' cognitive operations were carried out intuitively. All three higher levels of thinking skills identified in the Bloom's taxonomy were used by the eleventh grade students in a gifted program, whether those skills were used in the organization of information or in the writing stage. She also reported that the nature of the task affected students' use of higher-order thinking skills: an analytical question encouraged more uses of higher-order thinking skills and wider ranges of skills. However, at any task, students were more focused on finishing the product than on the process of thinking.

McGregor and Streitenberger (1998) studied how eleventh grade students in Texas used information by comparing their final papers with the sources cited and compared their findings with McGregor's study (1993). They found that students in both studies showed high rate of copying, indicating that students were more oriented to fulfill a requirement and did not focus on synthesizing the information for their topics.

McGregor and Streitenberger (1998) reported many citing errors in which students did not have the quotation marks with the passages, although they had reference information in parentheses. Compared with the McGregor study (1993), the students showed less direct copying of information. The researchers speculated that the teacher's intervention affected the degree of copying because she had emphasized correct citing as a way to avoid plagiarism.

Todd (1999) studied the use of information by high school students, focusing on how students make cognitive changes as a result of information use. Using a quasi-experimental research design, Todd first investigated the perceived effects of exposures to heroin information on four adolescent girls' knowledge structures and then established patterns in relation to the changes. He interviewed the girls after each of three exposures to information and mapped the data using Conceptual Graphical Structures (Graesser and Clark, 1985). He found five perceived effects of exposure to information: get a complete picture, get a changed picture, get a verified picture, get a clearer picture, and get a position in a picture. The major cognitive strategies employed by these girls to change their knowledge structures were appending, inserting, and deleting. He reported that, in general, the girls' knowledge structures were changed with the elaboration of general ideas into more specific information as the girls were exposed to more information. He found that their existing knowledge became the basis for further information seeking and use.

2.3. Issues related to the study

The studies reviewed provided a good starting point to explore how students use information to learn. Learning theories from different disciplines provide one component of the framework for this research. The findings of information-seeking-and-use studies provide a second conceptual basis. From this broad conceptual background, the particular issues that guided this study are presented here.

Although our knowledge of students' information seeking and use is growing, the current understanding is far from complete. As we recognize the role of information in learning, this knowledge will continue to grow. For example, current researchers are trying to keep up with uses of the Web for teaching and learning. Because its emergence occurred less than ten years ago and because it continues to develop quickly, studies of the Web as a learning environment will continue to be important. The studies reviewed for this study reveal that the patterns of students' uses of the Web are certainly different from the patterns they demonstrate using print sources (e.g. Large *et al.*, 1994; Large and Beheshti, 2000; Neuman, 2001, 2002; Small and Ferriera, 1994).

Researchers in the field assume that information seeking is a key component of the learning process. But how do information seeking and use help students learn? Some existing studies (Neuman, 1991b, 1993; Solomon, 1991, 1993) have identified a gap between students' cognitive knowledge bases and the existing conceptual structure of the information resources in online bibliographic databases. These studies support the idea that students' information seeking can benefit from improved information structures for information resources, such as those suggested from instructional design. Because the structures of information resources not only are not designed for students'

use but are also all different from one another, determining what information structures are suitable for student learning is a critical need. New challenges to this "gap" problem are emerging, as the Web has become a popular source for information in schools. The Web contains unstructured information without controlled vocabulary. Students must access and retrieve the information they need using the search engines on the Web and many electronic information systems available online.

The nature of this "unstructured" information points to the importance of the instructional strategies used to support learning. (Bowler *et al.*, 2001; Neuman, 2001, 2002; Large and Beheshti, 2000). Because teachers and library media specialists teach information skills through information seeking and use, how teachers and library media specialists design their assignments as well as their instruction is critical. Even good students often do not try to do more than what is assigned (McGregor, 1993). Providing carefully designed tools for students in using information to learn is therefore important, as research suggests (Neuman, 2001, 2002). Other research indicates that school assignments requiring research often do not benefit from what is easily available on the Web and other electronic information sources containing all types of multimedia information (Small and Ferriera, 1994; Bowler *et al.*, 2001: Large and Beheshti, 2000).

Understanding how students understand their process of information seeking is important if we are to learn how students use information for learning. If students do not recognize that learning is the goal of their information seeking and think that the tools provided by teachers are merely the kinds of discrete sub-components of an assignment rather than steps to learning, they will not get much benefit from them. This is particularly important with research assignments, which require students to find an

array of information independently on particular topics and then construct the knowledge they gain according to the form required by the assignment.

Understanding students' understandings about information and information sources is also important because these understandings affect their experiences of information seeking and use for learning. Students' initial understandings of information and information resources are often determined by their past and related information-seeking experiences. If students do not have an adequate understanding of information and information sources, their information seeking will be constrained; therefore, their learning will not be facilitated fully. Understandings about their initial plans for information seeking for their assignments, about their expectations of information and information sources, and about their understandings of information storage and retrieval will give some valuable indications of how students go about seeking and using information.

Understanding students' use of learning strategies is crucial. When students find information and make an effort to fit it into their existing knowledge, the new information has to be assimilated or accommodated into their knowledge structures or it will be lost. As Mayer (1999) noted, students need help to go through meaningful learning processes – selecting, organizing, and integrating information. Students' strategies for learning can explain how they make a cognitive effort to understand and use information for learning as they use a variety of cognitive skills as described in the revised version of the Bloom's taxonomy (Anderson and Krathwohl, 2001).

Understanding how students learn with information is another crucial issue that needs more attention. Although information directly influences personal knowledge

growth, little is known about how it occurs. Todd (1999) developed a methodology that can be used to measure how learning occurs. His concept of "information utilization" suggests how adolescent girls changed their knowledge structures as they used information. When students produce learning products from information, their process as well as their products reflect how they use the information collected. Studies of all these issues should yield an understanding of how information plays a role in meaningful learning.

Chapter3: Methodology

The purpose of this chapter is to describe the research setting and participants as well as the procedures for data collection and data analysis used to conduct this study. The chapter discusses why particular procedures were used for the research: the selection of the research setting and participants, the procedures followed to address ethical concerns with participants, the methods used for collecting data, the processes of analyzing data, the procedures and techniques used to ensure the validity of the study, and the limitations of the study.

Two particular techniques used for data collection are discussed in detail: concept mapping and interviews. Although concept mapping has been widely used to assess students' mastery of subject content in classroom settings, this study's use of the technique as a methodological tool to identify changes in students' knowledge that occurred during information seeking and use is unique. Here, the researcher combined concept mapping and interviewing to create and explore a new tool for understanding a key outcome of students' information behavior in relation to their learning tasks. The chapter explains the use of concept maps as an assessment tool for students' knowledge in existing studies and explores the methodological considerations that led to the use of the technique for this research.

3.1. Qualitative inquiry as a methodological framework

"There have been so many paradigms, strategies of inquiry, or methods of analysis to draw upon" (Denzin and Lincoln, 1998a, 1998b, 1998c, p. 22). For this study, qualitative inquiry grounded in constructivist paradigm - naturalistic inquiry in its original terms - as described by Guba (1981), Guba and Lincoln (1982), Lincoln and Guba (1985), and Guba and Lincoln (1998) was used as the methodological framework. More specifically, a form of case study was employed. Because this research was exploratory, it required a methodology that allows the researcher maximum flexibility to address emergent understandings and concerns. Qualitative inquiry in a form of case study was appropriate for three reasons: the study's research questions – "hows" – were best answered by this method; the researcher had little control over the events in the research setting; and the purpose of the research was to investigate authentic experiences related to students' information seeking and use. These conditions are basic to all qualitative inquiries in general and to case studies in particular (Yin, 1994).

The research question lent itself to qualitative research: How does information seeking and use contribute to students' meaningful learning experiences? The study addressed "causal connections" (Maxwell, 1996) between information seeking and use and learning. Investigating causal relationships in qualitative studies is different from establishing similar relationships in quantitative studies. In qualitative research, actual events and processes involved in leading to specific outcomes are considered causal relationships (Maxwell, 1996). This kind of causal relationship is explained by Miles and Huberman (1994) as "local causality." The research explored local causality by investigating how aspects of students' information seeking play a role in learning.

Qualitative methods were also appropriate because they are ideal for investigating processes as they occur naturally, and information seeking is essentially a process-oriented learning activity in authentic contexts. Some pioneering studies (Neuman, 1991a, 1991b, 1993) that used qualitative methods in exploring the processes of information seeking and learning have proven its appropriateness for addressing the processes of information seeking. Since those earlier studies, many studies that have investigated information seeking with an emphasis on users' understanding and experiences during information seeking have employed qualitative research methods to explore the processes that are difficult to control and measure. This research is essentially process oriented in that it attempts to understand not only the meaning of the physical events and situations of the information-seeking process but also the details of how learners understand and make sense of the information during the process.

The theory of constructivism also provides a rationale for using qualitative methods. Constructivism argues that each learner actively constructs meaning with new information based on his/her prior knowledge. In order to investigate the learner's "active engagement" in seeking and using information, examination of these processes is crucial. Particularly, this research asks "how" questions to explore the phenomena of information seeking and use to learn how students are actively involved with information to learn.

When a learner constructs meanings, that learner's internal knowledge structure changes. However, it is not easy to pinpoint exactly when and how this change happens because of the complexity and dynamism of the learner's experiences. Thus, changes in

internal knowledge structures need to be explored through studying the processes of change that participants demonstrate in authentic contexts.

The relatively small body of literature related to students' information seeking also supports the use of qualitative research methods. (e.g., Fidel, 1999; Hirsh, 1999; Kuhlthau, 1991; Large and Beheshti, 2000; McGregor, 1993, 1998; Neuman, 1991b, 1993, 2002; Oliver and Perzylo, 1994; Perzylo and Oliver, 1992; Pitts, 1994; Solomon, 1991, 1993; Wallace and Kupperman, 1997; Watson, 1998). Only bits and pieces of phenomena and factors related to children's information seeking, use, and learning have been reported in the literature, because information seeking and learning are so context bound that complex and unexpected behaviors often occur. This research takes the stance of the qualitative study to investigate students' information seeking, use, and learning to yield insightful and realistic research outcomes related to participants' experiences in a naturalistic learning environment.

3.2. Concept maps and interviews as research tools: Methodological discussion

This research used concept mapping in conjunction with interviews as the primary methodological tools for identifying students' understanding[1] of their chosen topics as these changes related to information encountered during searches of print and electronic resources. While many studies that employ concept maps focus on them as an assessment tool to measure students' mastery of concepts in a specific knowledge domain, this study used them as a means to capture students' changing understanding of

[1] In this study, three expressions - changes in students' understanding of their topics, changes in students' knowledge of their topics, and students' conceptual changes of their topics - all are used interchangeably to indicate the changes in students' knowledge representation reflected in their documents.

their topics based on the information found in the course of information seeking and use. The interviews with individual students were then used to identify how the changes of understanding occurred over time. This section focuses on the theoretical assumptions about learning reflected in concept maps and on the concept map as an assessment tool in order to provide the conceptual background for the particular use of concept maps for this study.

Concept mapping is designed to facilitate the process of understanding by identifying key concepts and their interrelationships. Teachers can use concept mapping as a tool for planning their instruction, for assessing of learners' knowledge, and for further diagnosis of learners' understanding or misunderstanding. Recently, concept maps have been used for modeling the knowledge bases of information systems, such as expert systems and hypertext systems (Jonassen, 2000; Plotnick, 1997).

Concept mapping is a powerful way to document students' intellectual journey of knowledge construction (Wallace and Mintzes, 1990). Although specific understandings of concept mapping vary from scholar to scholar, the assumption common to all is that concept mapping is useful as a representational tool for one's knowledge structure at a given time. Concept maps are representations of "semantic network" and "cognitive maps" (Jonassen, 2000). Concept maps like flowcharts, relational diagrams, and one-dimensional models can also represent mental models of systems (Mayer, 1989).

Numerous studies have been published on the usefulness of concept mapping for different purposes. At the most basic level, concept maps help learners move away from rote learning to more meaningful learning by giving them a mechanism to identify key

concepts and relationships between and among them (Novak, 1998). Particularly, concept mapping is thought to be useful "for students to overcome the challenges they identified in understanding concepts, principles, and theories within two different paradigms, each of which is based on different notions of information: information as an object and information as sense-making" (Todd and Kirk, 1995, p. 335).

Research on the usefulness of concept maps as an assessment tool in classroom settings is led by Novak, who was largely influenced by Ausubel's (1963) theoretical framework of meaningful learning. The original theoretical framework for concept mapping - Ausubel's assimilation theory of learning (1963) – and its reinterpretation by Ausubel, Novak, and Hanasian (1978) and Novak (1998) gave a starting point for the decision to use concept mapping for this study. According to Novak's interpretation (1998), Ausubel *et al.* (1978) characterized four types of learning: subsuming concepts, progressive differentiation, integrative reconciliation, and superordinate learning.

"Subsuming concepts" refers to linking new concepts to existing knowledge represented by more general concepts. Often, new concepts are less inclusive, so they can be readily subsumed under a general concept in a student's existing knowledge structure. In the process, the subsumed concept as well as the existing concept might be slightly modified, since the process is interactive. "Progressive differentiation" explains the situation in which a general concept is referred with more detailed and specific concepts. "Integrative reconciliation" indicates qualitative changes in knowledge construction, which occur when new relationships between and among concepts emerge during the process of learning and the new concept and the old information are reconciled. "Superordinate learning" is a change in knowledge at a macro level; it refers

to learning that occurs when existing concepts are pulled together into a larger domain. This process involves the learner's developing a different way of organizing the concepts and thus making new meanings from the reorganization.

Assessment measures using concept maps involve (1) creating scoring systems to calculate scores on the components students include in their maps (Heinze-Fry and Novak, 1990; Lay-Dopyera and Beyerbach, 1983; McClure and Bell, 1990; Markham and Mintzes, 1994; Schreiber and Abegg, 1991; Wallace and Mintzes, 1990); (2) comparing students with a criterion map created by a teacher or an expert (Acton, Johnson, and Goldsmith, 1994; Lomask, Baron, Greig, and Harrison, 1992); and (3) using both scoring systems and comparisons in combination (Barenholz and Tamir, 1992; Novak, Gowin, and Johansen, 1983).

Scoring methods are one common way to evaluate students' knowledge construction. Novak and Gowin's scoring system (1984) is the most comprehensive system for scoring the components of maps numerically (Ruiz-Primo and Shavelson, 1996). This scoring method is designed to evaluate and calculate scores on four components of concept learning from instruction:

<Table 1: Novak and Gowin's Scoring System>

Components	Description	Score
Relationships	Is it valid?	1 point for each meaningful, valid proposition
Hierarchy	Does the map show hierarchy?	5 points for each valid level of hierarchy
Crosslinks	Does the map show meaningful relationships between one node of the hierarchy and another node?	10 points for each valid and significant link 2 points for each crosslink
Examples	Is it valid?	1 point for each example

Table made based on the information from Novak and Gowin (1984, pp. 36)

Stuart (1985) modified the scoring system developed by Novak and Gowin (1984) to evaluate six components of student-generated concept maps to see the

knowledge changes in one learner between a pre-test and post-test and to detect differences between maps developed by learners in the testing situation. While Novak and Gowin (1984)'s scoring system aggregates the total score from four different components to evaluate one map, Stuart (1985) found that most components of maps did not correlate significantly with one another, indicating each component needs to be treated separately for more careful evaluation. However, even with the separate analysis of each component, Stuart questioned the qualitative differences of two students' maps that received similar scores on each component and suggested the need for qualitative analysis of these differences.

<Table 2: Stuart's Scoring System>

Components	Description	Scores
Branching	Every concept node was counted including the topic word or phrase	1 point for every node
General to specific	A rating illustrates a pattern and requires a judgment of the scorer.	0-10% of concepts show a movement from general to specific = 0 point 11-29% = 1 point 30-49% = 2 points 50-69% = 3 points 70-89% = 4 points 90-100% = 5 points
Closed units	It indicates the degree of integration of concepts	1 point for each closed unit
Technical terminology	Is it used correctly?	0-10% of terms show correct usages = 0 point 11-29% = 1 point 30-49% =2 points 50-69% =3 points 70-89% = 4 points 90-100% = 5points
Relationships	Is it correct?	1 point for each correct relationship; do not count the same relationship if it is repeated.
Hierarchy	Levels of hierarchy	1 point for each level

Table made based on the information from Stuart (1985, pp. 75- 77)

More recently, Jonassen (2000) reviewed the criteria for assessing students' concept maps reflected in existing studies and suggested using a variety of measures that are appropriate for teachers to evaluate students' concept maps. Examples of some commonly used criteria include:

- "The number of nodes indicates the breadth of net [knowledge]." (p. 74)
- "The number of distinct propositions (node – link – node combinations) indicates completeness." (p. 74)
- "The ratio of instances to concepts is an indicator of how well integrated the concepts in the domain are (also known as 'embeddedness')." (p. 75)
- "The centrality of each node is indicated by its number of direct links and indirect links. Centrality is a measure of the importance of concepts in a domain." (p. 75)

Another method for evaluating students' concept maps involves comparing these with an expert's criterion map and determining a score according to the amount of overlap between them (Ruiz-Primo and Shavelson, 1996). Science is often the knowledge domain in which this approach is used because of the assumption that science provides a relatively correct knowledge structure by which to evaluate students' knowledge structures represented in maps.

For example, Lomask, Baron, Greig, and Harrison (1992) scored terms and links in a student map as proportions of the student's terms and links in an expert's map. The proportion for terms was calculated as complete (100%), substantial (99%-67%), partial (66%-33%), small (32%-1%), or none; the strength of links was scaled as strong (100%), medium (99%-50%), weak (49%-1%), and none (0%).

Another method involves combining scoring components and a criterion map. For example, Novak and Gowin (1984) suggested adding another rule to their four components in Table 1 - comparison - for their scoring system. After scoring the criterion map with their scoring system with four components, a score of a student's map evaluated with the four components in Table 6 was divided by the scores of the criterion map. The result showed the percentage of the overlap between the criterion map and the student map. Using this method, it is possible that some students may score more than 100% when they do better than the criterion map.

While these quantitative measures used in the existing studies demonstrate the usefulness of concept maps as an efficient tool for assessing students' concept learning, the question of how conceptual changes occur cannot be explained with numbers. In fact, studies suggest the further exploration of qualitative analysis for future studies of concept mapping (Markham and Mintzes, 1994; Stuart, 1985).

According to Markow and Lonning (1998), qualitative analysis is particularly needed for evaluating students' self-constructed maps. These authors note that concept maps are generated by students with lists of given concepts, by researchers with interview data, or by students without any given concepts. The first two cases lead to less complexity in analyzing conceptual changes than the third case because the first two are generated in controlled settings. When the maps are self-constructed by students from scratch, more complex issues exist because self-constructed maps allow students more freedom to describe their thoughts in their own ways. The issues include large variations among concepts used in a knowledge domain and the effects of instruction and training for concept mapping.

Little is known about the measures for identifying qualitative changes in self-constructed maps, but Enger (1998) identified aspects of qualitative changes from students' perspectives. Elements of her qualitative examinations of students' concept maps generated before and after instruction on the respiratory system were reorganizations of pre-maps and post-maps, changes in vocabulary usage, the nature of new knowledge representations, and the presence of misperceptions. She found that only six of 22 seventh grade students retained much of the original structure from their pre-maps to their post-maps and that these six students seemed to have greater conceptual understanding of the subject content. Enger also reported that students tended "to omit the linking words whether from lack of understanding or lack of attention to detail in writing." (Methodology, para. 8)

Investigating substantive changes, however, requires more than the qualitative analysis of the concept maps themselves. Some researchers suggest interviews in addition to concept maps to yield more meaningful results (Wallace and Mintzes, 1990). Understanding qualitative changes in students' knowledge as they access information challenges the researcher to gain access to students' thoughts, particularly in the context of information seeking and use. Todd (1999) developed a methodological technique to capture four adolescent girls' knowledge as they were exposed to information, although he did not use concept mapping as a tool for data collection. Rather, he qualitatively analyzed his data from interviews with the girls after three different exposures to information about heroin and translated the data into a Conceptual Graph Structure (Glaesser and Clark, 1985). He found that the girls had five different types of knowledge changes after their exposures to the information: get a complete picture, get

a changed picture, get a clearer picture, get a verified picture, and get a position in a picture. Todd's study, however, did not examine how the information affected the changes.

Several common aspects in these studies of using concept maps to assess students' concept learning are not relevant to the present study. First, the studies were done mainly within "conceptually rich" areas - such as mathematics, biology, physics, chemistry, and geology – in which relatively systematic knowledge structures are established. Second, the context of these studies was the classroom; students' concept maps constructed before instruction were compared with their maps generated after instruction. Third, the studies were conducted in experimental settings using quantitative measures to evaluate concept maps. While these aspects are not directly related to the current research, they suggest that concept maps as an assessment tool are useful to identify and assess what students have learned as a result of some particular learning process.

How information led to such changes in knowledge was one of the key aspects of this study, and pairs of concept maps were used as tools to explore that phenomenon. The context for concept mapping - information seeking and use - was more dynamic than the context of science classrooms in an instructional setting. The nature of the students' task encouraged free exploration of knowledge in a set of searchable information sources that provided no structures of knowledge in particular knowledge domains. The students' assignment did not require a systematic, structured knowledge background, and their specific topics did not reflect curricular topics that provide familiar knowledge models for students. Rather, the assignment asked students to build

their own knowledge from the process of information seeking and use. Students independently sought and used relevant information on their own topics and made decisions on what information to select from arrays of information presented by the sources recommended to them.

The purpose of using concept maps for this research was thus to identify changes in students' knowledge related to the information they encountered, with an assumption that students learn from the process of information seeking and use. Because the focus of this study was not on assessing the students' mastery of a subject area but on identifying their conceptual changes during the process of information seeking and use in a naturalistic setting, more qualitative methods for evaluating students' understanding as represented in their maps were used. These methods involved analyzing the changes that occurred because of the information and the changes in students' knowledge that these changes in their maps represented. Thus, the analysis of concept maps was led by the individual interviews with students, in which they identified key concepts that reflected changes in their original ideas stemming from the information encountered.

3.3. Research context

3.3.1. Background

The site for this research was Arundel High School, a public school located in Gambrills, Maryland. Arundel High School is in a suburban setting. Although the school does not maintain detailed records of individual students' socioeconomic backgrounds, the student body comes from mostly average, middle-class homes,

according to the library media specialist and the assistant principal. Every year, approximately forty percent of the graduates go to four-year colleges, and another forty percent attend two-year colleges.

At the time of the fieldwork for this research - that is, spring semester of 2001 - the student enrollment was 1,831 from 9th grade through 12th grade (see table 3). The ethnic background of the student body was predominantly White American followed by African American, Asian American, Hispanic American, and Native American in that order (see table 4). The number of teachers was 71, including the library media specialist (see table 5).

The library media program at Arundel High School operates on a flexible schedule; students with teacher-provided passes could come and use the library resources at any time. In addition, the library media specialist teaches with teachers who schedule classes in the library for research or for literature exploration. Each day, two classes can be scheduled to use the library media center. The staff includes one library media specialist, two library assistants, one audio-visual assistant, and one secretary.

The collection of the library media center includes over 17,000 fiction, non-fiction, and reference materials; 120 periodicals; and four newspaper subscriptions. The electronic sources include five online database subscriptions, CD-ROMs, and many links to recommended websites for students and teachers. The media center has over 1,500 videos and other audio-visual materials in addition to the print and electronic sources. Unlimited check-out is permitted for teachers. Sixteen computers are available for students in the library media center. All but three are on LAN support connected to the Anne Arundel County Public Schools network with a T3 connection. The other

three are on cable connections. Students could access any online databases, including the Internet, with these computers.

<Table 3: Number of Students by Grade>

(Source: Arundel High School, 2001)

Grade	Number of Students
9th Grade	565
10th Grade	448
11th Grade	443
12th Grade	375
Total	1,831

<Table 4: Number of Students by Ethnic Group>

(Source: Arundel High School, 2001)

Ethnic Groups	Number of Students
White	1,279
African Americans	406
Asians	87
Hispanic	55
American Indians	4
Total	1,831

<Table 5: Number of Teachers by Department>

(Source: Arundel High School, 2001)

Departments	Number of Teachers
Art	4
Business	5
Family and Consumer Science	2
Foreign Language	7
Math	14
Technology Education	1
Music	2
Physical Education	9
Science	12
Special Education	14
Library Media Specialist	1
Total	71

3.3.2. Process of involvement

The Anne Arundel County Public Schools showed their willingness to be involved in this research. The school was recommended by the Director of Library Media and Instructional Technology in the school district, and the particular school was

selected by the researcher as a site because it had a good library media program with a moderate level of technology available.

The director informed the principal and the library media specialist of the school that the researcher had selected and suggested a meeting with teachers who expressed an interest in participating in the research. The proposal for the research was sent to the library media specialist in order for her to understand the study and to invite teachers to participate. The library media specialist served as the coordinator of the first meeting with teachers.

At that first meeting in November 2000, the library media specialist, the assistant principal, and the researcher joined with five teachers who had expressed initial interest in discussing the research and had described assignments that might be appropriate for the study. The researcher described the study briefly, and the teachers asked questions about the research and data collection methods. Since they did not have an extensive understanding of a qualitative research, the teachers asked many questions and expressed their worries about how their class schedules would have to be altered to accommodate the data collection methods, particularly individual interviews with students and administering instruments. At the end, most of the teachers declined; a persuasive speech class of junior honors students remained as the sole group.

Subsequently, numerous email discussions occurred between the teacher and the researcher regarding possible assignments. The teacher wanted to know more about the specific instruments and the schedule for data collection, and the researcher had to establish that the class assignment suggested would be appropriate. As a result of these

communications, the teacher and the researcher were able to choose an assignment that was most appropriate for the purpose of this research.

In a second meeting with the teacher in January 2001, the researcher and the teacher discussed getting parental permission from the students. The teacher agreed to distribute the informed consent form with a cover letter explaining the purpose of this research; the form had been approved by the Institutional Review Board for Human Subjects at the University of Maryland (see appendix A). All the forms were returned on the day of the researcher's first visit to the class except for those from a few students who returned the forms on the following day. Collecting the consent forms from all students in the class was not a surprise for the teacher because "they are bright kids and pretty responsible." At the same time, permission from the Anne Arundel Public Schools was pursued and obtained (see appendix B). The researcher not only had verbal permission from the Director of Library Media and Instructional Technology in the Anne Arundel Public Schools but also formal written permission from the district.

Another agenda item for the second meeting was discussing the details of the assignment and the research instruments, including several additional components which the researcher had designed. After reviewing each concept mapping instruction sheet (see appendix C) and a form for students' research journals (see appendix D), the teacher agreed they were appropriate for the students in terms of vocabulary and conceptual complexity.

3.3.3. Participants

Purposeful sampling (Patton, 1990; cited by Maxwell, 1996), also known as criterion-based selection (LeCompte and Preissle, 1993,) was used for this study. It is the technique "in which particular settings, persons, or events are selected deliberately in order to provide important information that can't be gotten as well from other choices" (Maxwell, 1996. p. 70).

Participants were 21 junior honors students in a persuasive speech class. Because all the students returned their parental permission forms and stated their willingness to participate, the researcher was able to collect all the documents produced by all the students and to observe all of them in the library media center and the classroom during the period of the assignment.

For individual interviews, eight students were carefully selected by the teacher according to the researcher's request to select those who were especially good at expressing their thoughts and opinions in detail. To select the students, the teacher consulted with the teacher who had taught these students the previous semester. Ultimately, the teacher selected four males and four females, including all the male students in the class. As the assignment proceeded, although both the teacher and the researcher realized that one of the eight students was less detail-oriented than the others, he remained in the interview group.

Throughout this report, the 21 student participants are indicated by codes assigned according to the alphabetical order of their last names. Thus, S1 to S21 were used as the assigned codes. The eight students in the interview group were S2, S4, S5, S8, S14, S16, S17, and S19.

3.3.4. Tasks for participants: components of the assignment

The assignment used for this research required students to complete a series of components including a final product: a five-to-seven-minute speech on a self chosen topic. Other components included two concept maps, each with a paragraph describing the topic; an outline based on a teacher-generated form; a research journal; note cards; a rough-draft outline; and a packet through which students could describe access to individual information sources to get extra credit. The concept maps and research journal were added by the researcher for the purpose of the research.

Three electronic sources as well as the Internet were recommended to students for this assignment: *Electronic Library*, *Ebsco Host*, and the Anne Arundel County Public Library databases. Students were required to use at least five references from these sources for their speeches. The teacher's requirement that students use the databases ensured that the class accessed reliable sources, not just random sources on the Web.

The researcher concluded that the "extra-credit" packet, the rough-draft outline, and note cards were not useful for her analysis. The information in the packet was not significant to the research questions. The rough-draft outlines did not contain any significant additions to students' final maps because they were due only one day after final concept maps were collected. Many of them were preliminary and not complete. Many of students' note cards were not reflective to their topics; the teacher permitted students to submit the cards with information and bibliographic data on subjects other than their topics.

- Concept maps

Concept maps were added to the original assignment for this research. The teacher was not aware of concept mapping but quickly understood it during the first meeting with other teachers. Several teachers who were in the first meeting mentioned that they had used it in their instruction for students to organize what they had learned in terms of concepts and relationships. This indicated that some of the students in the persuasive speech class might have experience drawing concept maps in other classes.

In order to make sure that every student knew how to draw a concept map, on the first day the assignment was given, the teacher delivered a 10-minute instructional session designed by the researcher. The instruction included specific steps that students should follow in drawing a concept map and the examples of relationships most commonly used by students (see appendix C). The main emphasis of the instruction was to have each student name a topic, identify the concepts around the topic, and connect the concepts by labeling the relationships between and among them. Students received handouts including these steps and examples for future reference.

Students were told to submit one-paragraph descriptions of their topic areas along with their concept maps. These descriptions were used to provide more explanation of the ideas represented in the concept maps, in case the maps were not self-explanatory.

The first concept map and the paragraph were assigned on day one, after the assignment had been given and the topic chosen. Students were asked to submit their initial ideas in these formats on the following day prior to doing any research. Final concept maps were assigned around the time students finished the rough drafts of their

outlines. Students were expected to have more knowledge of their individual topics represented in wider maps with more links. Examples of students' concept maps are shown in appendix E.

One expected event in the students' research was the change of topics. In fact, not all the students kept their initial topics for their final speeches. Each time a topic was changed, the teacher asked the student to do another initial concept map for the new topic.

- Outline

The outline template (see figure 2) was provided by the teacher, and the students were expected to use it for their outlines and for their speeches. The teacher adapted the mnemonic "AREST" for the outline: Assertion, Reason, Evidence, Summary, and Transition. This mnemonic was used as a structural framework into which students inserted their ideas and information for their outlines and speeches. The teacher scheduled a class session to explain the outline template to students in a computer lab, where everyone could use a computer. The form was preloaded in the computer in Word format so that students could copy the file from the computer to their own disks. The teacher went over each line and provided an example for it. At the end of the class period, each student could obtain the printout of his/her own outline form with examples. Because there was no written version of the speech required, the outline served as the only final written document of a student's speech.

<Figure 2: Outline Template>

Specific Purpose: To persuade the audience to organize their speech DON'T SAY THIS

Introduction:

I. Attention material (none of these words will appear in the outline)
   - A. Humor
   - B. Anecdote
   - C. Common ground technique
   - D. Shock technique
   - E. Suspense
   - F. Quotation

II. Background material, adaptation to audience

III. Forecast of theme and/or major points

Body

I. An assertion goes here.
   - A. A major reason goes here.
     - 1. A supporting reason goes here.
       - a. Evidence goes here.
         - (1) source (who, when, where)
     - 2. another supporting reason
       - a. a subordinate reason goes here.
         - (1) evidence goes here
           - (a) source
   - B. major reason
     - 1. evidence
       - a. source
   - C. a summary, transition....goes here.

II. An assertion goes here,
   - A. _____
     - 1. _____
   - B. _____
     - 1. _____
       - a. _____
   - C. _____(etc. as needed)

Conclusion:

I. Summary

II. Restimulate attention {Quotation, dramatic statement}

III. Clincher {rhetorical question, repeated theme
See also attention techniques above}

None of these words in the conclusion are in the outline.

- Final speech

The final product was a short speech on a chosen topic. The duration of time - five to seven minutes - was considered a critical element. The teacher reminded students of this criterion before they gave their speeches and warned them that she would stop a speech if it exceeded the time limit. The teacher also emphasized delivering the speech in a conversational manner, so that the audience could enjoy it. She mentioned she would penalize any student who read from notes or an outline.

Students' speeches were video-and audio-taped. After each speech, the student who gave the speech was sent to the audiovisual room next to the classroom to see him- or herself give the speech. The purpose of this activity was to give students an opportunity to observe themselves so they could improve future speeches.

- Research journals

Because the researcher could not observe every student's searches during the period, she designed a research journal to enable students to keep track of their searches and results each time they used information sources. The students' journals provided important records of their searches for the researcher, particularly with the remote access of databases in the library media center from home. The form for the research journals (see appendix D) was distributed to students. For each search, students were asked to fill in all the slots -- including date, goal, a source found, location of the source, a database used, searches used, helpful points, and difficulties in searching and/or understanding the information.

- Note cards: Evidence and bibliography

Although the note cards were not analyzed for this study, students' use of them needs to be described because the researcher will refer it in this report. Note cards were assigned by the teacher as a way to keep track of the relevant information found in specific sources. As the teacher pointed out during the interview, one of her objectives for this assignment was "to get them to do research efficiently and not to waste time." If they had all the information on cards, students would not have to go back for the same information again: "I'm trying to teach them to do it right the first time, [that is] to get complete information the first time." Students were asked to keep the extracted information on one side of the card and the bibliographic information on the other side.

Each student received a packet with an example of a note card and two bibliography cards on each of seven sheets, one for each source. Students were required to make their own cards according to these examples and to submit them to the teacher at the end of their speeches. However, students were permitted to record any information from each source on any topic, if they could not find any information on their topics.

Table 6 below shows the progress of the fieldwork for the study. It includes information related both to the instruction students were given and to the researcher's collection of data.

3.3.5. Instruction on sources

After students had turned in their initial maps, they began the process of information seeking and use. From the second day to the fourth day of the project,

<Table 6: Fieldwork Schedule>

Day 1	Assignment packet distributed Concept mapping instruction Topic selection Initial map and a paragraph assigned
Day 2	Initial interviews with six students
Day 3	Initial map and a paragraph collected Library day for students Initial interview with one student
Day 4	Initial map and a paragraph collected Library day for students
Day 5	Library day for students Initial interview with one student
Day 6	Classroom instruction: how to make an effective speech
Day 7	Instruction for developing an outline, conducted in a computer lab Final map and a paragraph assigned
Day 8	Final map and a paragraph collected Final interviews with four students
Day 9	Final map and a paragraph collected Final interview with one student
Day 11	Students discussion in a group with their rough draft
Day 13	Final speech Assignment packet and outline submitted Final interview with one student
Day 14	Final speech Assignment packet and outline submitted Final interview with one student
Day 15	Final speech Assignment packet and outline submitted Final interview with one student
Day 16	Final speech Assignment packet and outline submitted

students gathered in the library media center. Ten to fifteen minutes of instruction was conducted by the teacher and library media specialist; the rest of each class period was devoted to students' own searches. The teacher's instructions influenced students' actual information seeking and use.

On the first library day, as students sat around a number of round tables facing a computer-projection screen, the teacher explained what the class would cover for the next three days. She emphasized that the information students used should be unbiased and have authority. Then the library media specialist introduced the sources students were to use for that day, explaining each source's collections and characteristics and suggesting appropriate search methods. This pattern continued for three days.

Sources included the *Readers' Guide to Periodical Literature*, *SIRS*, *Congressional Quarterly (CQ) Researcher*, *Electronic Library*, and *Ebsco Host*. When the library media specialist explained the *Readers' Guide to Periodical Literature*, she pointed to the shelf where the source was located and indicated one volume of it on the table as an example. She mentioned that the *Readers' Guide to Periodical Literature* is an index arranged by topic, that the titles of the magazines are listed in italics, and that dates are also provided. Her introduction of databases accessible through Anne Arundel County Public Libraries particularly stressed *SIRS Researcher* and *CQ Researcher* as useful databases. She introduced both the electronic and the print versions of *CQ Researcher* and recommended them to students. Each issue of *CQ Researcher* is devoted to a specific topic that might be related to an assignment. She noted that the content of *CQ Researcher* was not searchable electronically, although its table of contents and articles can be viewed on line. She touched briefly on *Electronic Library*

as "a database, just a place like a library." For *Ebsco Host*, the library media specialist explained two search options, keyword search and advanced search. Keyword search, which was the default, finds the keywords in abstracts of the articles, whereas advanced search searches entire articles. The library media specialist then recommended that students use the email function available on each database to send the documents to themselves. This strategy was encouraged because it would save students' time and money in the library media center and allow them to print out retrieved articles at home.

Instruction on the second day included the introduction of more sources and instruction on how to access databases remotely. The library media specialist told the students that each database has a different user ID and password, and she gave all the students their own user IDs and passwords. She introduced the *World Almanac* and *Statistical Abstract* in print, and the teacher commented that these were her favorite sources. The library media specialist explained how to use the indexes in the back of each volume: the *World Almanac* has page numbers next to each entry, whereas the *Statistical Abstract* has table numbers next to each entry.

The teacher added that all the information in the recommended sources had been reviewed by an editorial board and emphasized again the importance of using reliable sources. One of the criteria she recommended for judging whether an electronic source, including the Internet, is reliable was whether the information was published elsewhere in print. She used the term "print source" to describe electronic information that is also published in print magazines or newspapers.

On the third day, two more print sources - *Opposing Viewpoints* and *Information Plus* - were introduced. These sources were introduced together because both are

secondary sources. It was one of the teacher's intentions to have students use these secondary sources so that they could learn to use and to cite secondary sources correctly.

Finally, the library media specialist recommended that students determine what Internet sources to use by applying the mnemonic BUILT – Bibliography, Unbiased, Intent and Integrity, Links, and Timely. The teacher and library media specialist again emphasized authority of information. They recommended government sites and electronic "print sources" that are reviewed by an editorial board. Students were told to provide correct URLs for Internet sources included in their bibliography.

3.4. Data collection

To ensure the trustworthiness of this research, the researcher triangulated data collection by using three traditional methods for collecting data in qualitative research: observing students' searches and class activities during class sessions; interviewing the students, the teacher, and the library media specialist; and collecting the documents that students produced during the period of the assignment.

3.4.1. Observation

Observation was comprehensive. It started on the day the assignment was given to students (February 9th, 2001) and continued for two weeks, until students' speeches were delivered. The researcher observed six sessions over the two-week period: three sessions for instruction and three for students' searches. Observations of instructional activities were conducted in the classroom on days one and six and in the computer lab on day seven.

Observations of students' searches were conducted over three consecutive days – days three, four, and five - in the library media center. For observing students' searches, a brief observation guide (see table 7) provided direction for what the researcher should notice during the observations. The guide itself was broad enough to remind the researcher of what data related to the foreshadowing questions could be obtained through observation but was not so restrictive that it limited her perspective. The researcher and students exchanged questions and opinions that augmented what was covered in the guide.

<Table 7: Observation Guide >

Points for observation during searching
• Search options used • Words used for search • Ways and process of search • Assistance used • Kinds of interaction between the source and the student • Other interesting events

Observation of students' searches was informal and interactive (Neuman, 1991a, 1991b, 1993): "Students were questioned about their behavior and encouraged to verbalize their insights and concerns" (Neuman, 1993, p. 27). If a researcher plays strictly an observer's role while the students are conducting regular behavior, students may very well feel an invasion of their privacy, consider the researcher an authority figure, and thus alter their regular behavior. When questions arose during an observation, either the researcher or the students were free to ask those questions of one

another. The crucial point of interactive observation was to get to know what students were doing from the students' perspectives.

As the researcher conducted the observations, she recorded the notes manually on a notepad. After each day of observation, she transformed the written field notes to electronic ones and created expanded field notes about her insights into the observed events. The expanded notes were added to the initial field notes, and the full file was later transported to the QSR NVivo 1.3 for analysis.

3.4.2. Individual interviews

Semi-structured interviews were conducted with the selected eight students, the school library media specialist, and the class teacher. Interviews with students were the main source of data for the study, and the interviews with the school library media specialist and teacher provided additional perspectives.

As Novak (1998) stated, a personal interview is "the most powerful tool for capturing knowledge held by an individual or groups of individuals" (p. 101). For this research, individual interviews combined with students' documents – particularly concept maps and final outlines – were used to capture students' knowledge.

The interviews with the eight students were scheduled at two different times. The initial interviews were conducted after students had handed in their initial concept maps, and the final interviews were conducted after they had turned in their final concept maps. Each of the initial interviews took from 20 to 30 minutes, and each of the final interviews ranged from 40 to 50 minutes. Both interviews allowed the researcher to review students' individual maps and ask questions about them.

Two interview guides were developed, one for the initial and one for the final interviews (see appendix F). An attempt was made to map the interview questions with the initial coding categories extracted from the foreshadowing questions. During each interview, the researcher asked additional questions as they occurred. The guide for the initial interviews was designed before the interviews, whereas the guide for the final interviews was created later, to reflect the students' responses and comments during the initial interviews and the researcher's observations of the students' activities.

Individual interviews with students were conducted informally in the library media center. This setting was chosen to allow students to express their understandings and opinions freely. Before conducting each interview, the researcher assured the students that there were no right and wrong answers to the questions. This assurance was especially effective when students did not seem to have confidence in their answers.

The interview with the teacher was conducted at the end of the data–collection period. To learn the teacher's perspective on the assignment and her objectives and her intentions for assigning it, the researcher asked questions about expectations for students and reflections on students' performance throughout the process. The interview with the school library media specialist was also conducted at the end of the fieldwork period to collect data on the library media specialist's perspective on how students did research for the assignment and on their strategies for seeking and using information. (See appendix G for the interview guides for the teacher and the library media specialist.)

3.4.3. Documents

The documents that students produced throughout the assignment were also crucial data sources because they represented students' knowledge on their topics at various times in the process. These documents included students' initial paragraphs, initial maps, final paragraphs, final concept maps, research journals, outlines, and final speeches. Another set of documents was collected from the teacher about the assignment: the packet describing the assignment and containing the examples of note cards and of bibliographic entries. The researcher obtained and reviewed the manuals of *Electronic Library* and *Ebsco Host* to understand their functions and uses. Other documents included the general information about the school and the students and provided background information and context for this research.

3.5. Data analysis

The findings for this research are grounded in data collected from the participants by employing the constant comparative method of analysis pioneered by Glaser and Strauss (1966) leading to grounded theory (Strauss and Corbin, 1990). The purpose of the analysis was to de-contexualize the data into higher levels of understanding for theory building. The dynamic nature of the analysis required an inductive approach and the constant revisiting and comparing of data to unearth new understandings. As with all qualitative studies, finding the major patterns residing in the data was the primary objective of the analysis.

3.5.1. Initial phase

To facilitate the analytic process, interview transcripts and observation notes were typed and entered into QSR NVivo 1.3, which is a software program designed to support qualitative data analysis. The students' documents, however, were not transformed into electronic form but were analyzed manually.

Data analysis began as the data collection started. After each observation, the handwritten field notes were reviewed, and the expanded field notes with the researcher's thoughts and opinions were included in brackets to reflect the emerging questions and issues that would guide the process of observation. As the series of individual interviews proceeded, the researcher listened at least twice to the audio tapes of each interview and made notes to prepare for the following interviews. Students submitted their concept maps for the interviews and the written components of the assignment on the days the speeches were given. Students' final speeches were all audio- and video- taped, and the audiotapes were transcribed. The transcriptions were verified by the researcher.

After the completion of the data collection, more intensive analysis began. To prepare for this analysis, the interview transcripts and observation notes were printed out; two good copies of all the documents collected were made, one for analysis and the other for preservation. Each set of students' documents (i.e., initial concept maps, initial paragraphs, final concept maps, final paragraphs, outlines, transcripts of final speeches, and research journals) was put in order of the students' assigned ID numbers (S1 to S21) for easy tracing. All the original documents were returned to the students.

3.5.2. Phase I: Preliminary analysis

There were largely two phases of the data analysis. Phase one was the preliminary coding of data sets by hand on the printed or hand-written copies of the data themselves. This process allowed the researcher to become familiar with the collected data; to see how well initial coding categories described the data; and to test the pre-designed tools (e.g., foreshadowing questions, initial coding categories, and criteria for assessing students' concept maps in Table 8 and 9, p. 80) as a mechanism for analyzing students' documents.

The analysis began with the development of codes based on the foreshadowing questions; more categories were generated as coding proceeded. Interview transcripts and observation notes were coded with these original and emerging codes.

The preliminary analysis of the student-prepared documents took a great amount of time because these documents were the largest portion of the data set; because the researcher had to read them closely to become familiar with each of the students' understandings on his/her topic; and because the documents produced at different points in time – an initial map, an initial paragraph, a final map, a final paragraph, an outline, and a final speech – needed to be examined and compared manually to enable the researcher to chart each student's progress.

Students' concept maps were the first student documents to be analyzed. During this preliminary round of analysis, the researcher found that some concept maps would not provide valid data for this research. For example, although the researcher had asked students to draw new initial maps if they changed their topics, two students (S8 and S12) did not do so; thus, the researcher was unable to compare relevant initial maps

with final concept maps and outlines. Another three students (S1, S10, and S18) did not draw their concept maps as instructed. Both their initial and final maps depicted the definitions of their topics, not the domain of the ideas for their speeches. This made the content of their maps very different from that of their outlines and speeches; thus, the researcher could not use their maps for analysis. Three students (S1, S14, and S21) drew their maps carelessly, which resulted in incomplete and incoherent maps. These students seemed more concerned about doing and submitting the required components of the assignment than about doing the work carefully. As one student mentioned, "She [teacher] just said we had to do a concept map, so I turned it in. [For] My speech I just kept changing until I had it the way I wanted it." Lack of attention to detail as well as carelessness also resulted in a lack of labels for the links between concepts, as Enger (1998) had also encountered in her study with students' self-constructed concept maps.

However, not all the documents that these seven students produced were completely excluded from the analysis. For examples, in cases of missing link labels, the relationships were often implied by the concepts or phrases linked or were evident in paragraph descriptions written by students. Further, two students whose concept maps were not valid (S8 and S14) were interview participants, and the researcher was able to clarify the meanings of their maps to some extent. While their concept maps were unsuitable for the systematic document analysis, their paragraph descriptions and their interviews elicited more understanding of the other documents that these same students produced – research journals and outlines.

Other examples of invalid data were missing portions of the assignments, segments which students did not submit. The researcher contacted two students by

email to retrieve these pieces, but only one of them promptly replied and provided the information (his bibliography). The other student sent a note through her teacher saying that she believed that she had already submitted her research journal; she could not be contacted again.

During this phase, the researcher created a table for each map that a student produced, listing the criteria that served as the measures for the concept map analysis. (see table 8). The first five criteria listed reflect the most widely used measures in assessing concept maps (Jonassen, 2000): number of nodes for breadth of knowledge, number of node-link-node combinations for completeness of knowledge, number of direct links to a node for centrality of knowledge, number of levels of nodes represented for depth of knowledge, and the use of link types for flexibility of mind in representing knowledge. After the tables for all the maps had been created, another table (Table 9) was created to compare the conceptual changes that had occurred during each student's progress. Concepts addressed by students themselves in the interviews were examined first, and other concepts that appeared in their maps were traced for changes.

Table 9 was also used to compare (1) final maps and outlines and (2) outlines and speeches. New and changed concepts from each document were extracted and recorded under each student's assigned code so they could be used for analysis. Dropped concepts were also recorded.

One gain from the preliminary phase of analysis was to discover the inappropriateness of quantitative components derived from document analysis and from one data source (final speeches) for more detailed analysis, as described below. As a result, the researcher made two important decisions for further analysis: not to continue

using the quantitative measures listed in Table 8 for analysis and to drop students' final speeches from the analytic corpus.

<Table 8: An Example of Analysis of a Concept Map: Quantitative Changes>

S4: Initial Map	
Number of nodes	17
Number of node-link-node combinations	17
Number of direct links to a node	N/A
Number of levels of nodes represented	N/A
Link types	13 Action / 3 Inclusion/ 1 Characteristic
S4: Final Map	
Number of nodes	12
Number of node-link-node combinations	12
Number of direct links to a node	N/A
Number of levels of nodes represented	N/A
Link types	7 Action / 5 Inclusion

<Table 9: An Example of Analysis of a Concept Map: Qualitative Changes>

S4	Initial Map	Final Map
Change of concepts	Jobs and specific examples under it Greater revenues Property values	Employment Economy
New concepts		Fare -Competition (under fare) Safety -airplanes -Other planes (under safety) -Passengers (under safety)
Dropped concepts		Noise pollution dropped

The researcher's initial criteria for analyzing the changes between each student's initial and final concept maps were the quantitative measures shown in Table 8, which are widely used in assessing concept maps. However, these quantitative measures did not seem to yield any notable findings because of the complexity and dynamics of the

qualitative changes reflected in students' concept maps. For example, the number of nodes present in the two maps did not provide any significant findings. Often, the number did not increase from an initial concept map to a final one. In some cases, the number even decreased when students used inclusive concepts in the final map that subsumed concepts in the initial map. The levels of nodes also did not produce any meaningful understanding about the depth of knowledge construction: although some maps were hierarchical, most were more web-like than leveled.

The quantitative analysis of link types also did not yield any meaningful explanations about the changes in students' knowledge. Not much variety of links was found when comparing students' initial and final maps. Using Fisher's table of relationships (cited in Jonassen, 2000, p. 71; see appendix C), the researcher found that students used three types of links almost exclusively: action, inclusion, and characteristics for both students' initial and final maps. The three other types of links – symmetry, process, and temporal - were rarely found. Because this study focused on uncovering the changes in students' knowledge, counting the numbers of different types of links did not explain any meaningful changes in knowledge construction. As Novak pointed out (1998), key changes in understanding can be tracked by noting conceptual changes.

There are several possible reasons that quantitative measures proved not to be useful in this study. First, the lack of controls in a naturalistic setting made quantitative measures unsuitable. Using qualitative inquiry grounded in constructivism as a methodological framework, this study did not put any boundaries on concepts and information. In experimental settings, however, where the researcher often controls the

specific set of concepts from which students construct concept maps, the result is a limited set of concepts that can be easily measured.

Another reason could be related to the purpose of the assignment and the nature of students' topics. The assignment asked students to build their arguments for persuasive speeches from ideas they encountered in a wide range of information sources. This kind of learning task is clearly different from tasks that require knowledge construction in well-established knowledge domains, which are the areas that often use concept maps for evaluation. Students' topics – such as *abortion* (S1), *endangered animals* (S2), *building more runways* (S4), *requiring the Pledge of Allegiance in public schools* (S16), and so on – involved social issues which have affective and political dimensions as well as the cognitive dimensions which are associated with systematic knowledge domains.

The decision to drop students' final speeches from further analysis was also made because these data sources did not provide any meaningful findings. Comparing the outlines and final speeches, the researcher found that there were no significant changes noted from the outlines to the speeches. In most cases, students followed their outlines exactly as written. The only change noted was the occasional dropping of "assertions" or "evidence" from the outlines to meet the time limit. This change was considered not significant; therefore, no further analysis of the final speeches was conducted.

The preliminary coding and examination of the data set gave the researcher useful ideas about how to continue the analysis. The initial coding categories were found to be especially useful for analyzing the observations and interviews, although

some categories needed to be reconsidered and more categories needed to be added. In addition, this analysis provided reasons to eliminate quantitative comparisons and students' final speeches from further analysis. The second phase of the analysis was conducted to discover more detailed patterns related to students' learning from information.

3.5.3. Phase II: Final analysis

In the second phase of analysis, QSR NVivo 1.3 was used to support the coding of interviews and observations. Although QSR NVivo 1.3 has many functions to support data analysis, the researcher used only some of the basic functions: creating coding categories, assigning codes to the appropriate text segments, and creating the report of codes with coded text segments. In fact, the software supported only the mechanical processes of "cut and paste," leaving the researcher free to perform all the intellectual tasks of the analysis.

As the researcher constantly compared the data segments, multiple coding categories were often assigned to the same data units to reflect the researcher's emerging understanding. Some initial categories were removed because no data could be coded for those categories. For example, "vocabulary used in thesaurus of a source" was removed because none of the databases that students used had a thesaurus. New categories – such as keyword search, subject search, and natural language search – were added instead. Other added categories include all the cognitive and physical activities students demonstrated during information seeking and use.

New categories generated from the analysis of students' concept maps and outlines emerged from a comparison of the details of the changes from initial maps to final maps and from final maps to outlines. These categories branched off from the two categories in Table 9 (p. 80) – changed concepts, new concepts, and dropped concepts. The "changed concepts" category was particularly interesting because different forms of conceptual change were reflected in the data.

Several new categories about conceptual changes were generated through interviews: broadening concepts, combining concepts, narrowing concepts, dropping evidence, and changing evidence. "Adding concepts" and "adding evidence" were substituted for "new concepts." This aspect of the coding was especially important because it underlay the analysis related to the key research focus: how students' use of information affected their learning. Specific criteria for coding each instance of conceptual change are noted below.

- Adding concepts – Every new concept related to the previous ideas was counted, regardless of its level in a hierarchical structure. For example, when a concept was introduced with a subconcept, each was counted as an added concept.
- Adding evidence – Each instance of specific information extracted from a document source -- such as quotes, examples, statistics, or facts -- was counted.
- Dropping concepts – Each concept dropped was counted.
- Dropping evidence – Each instance of dropping of specific information as evidence was counted

- Broadening concepts – Each concept that was broadened from one data source (e.g., an initial concept map) to the following one (e.g., a final concept map) was counted.
- Narrowing concepts – Each concept narrowed from one data source (e.g., an initial concept map) to the following data source (e.g., a final concept map) was counted.
- Combining concepts – Each instance in which two or more concepts extracted from one data source (e.g., an initial concept map) were combined for the following one (e.g., a final concept map) were counted.
- Creating higher concept categories – Each instance of the creation of a broader concept to group existing concepts was counted.
- Putting concept categories in different locations/categories – Each instance in which a student changed the location or a concept from the previous data source was counted.

(Note: Students often indicated evidence with numbers or specific statements. In addition, students' outlines identified specific sources for pieces of evidence.)

In this round, the data in QSR NVivo 1.3 was analyzed relatively efficiently because the researcher was very familiar with the categories and the coding segments (see figure 3, p. 87). For document data, the researcher examined each series of documents produced by a student in order to see the patterns in a larger context. First, the coding categories were reviewed to examine their uniqueness and appropriateness. Next, the segments coded with a category were examined to confirm the

appropriateness of the coding. Appropriate coding categories were listed under each student's document, and the concepts and relationships were extracted from each series of documents - including the concept maps - to compare and to provide the bases for examining the series as a whole. This process led to the discovery and addition of a few more categories to fill conceptual holes. "Creating higher concept categories" emerged as a new category when the researcher found it important enough to be a separate category from "adding concepts." "Putting concepts in different locations/categories" also emerged as another new category.

During this phase of the analysis, changes in the focus of each student's topic were analyzed by tracing the student's statements in initial and final paragraph descriptions and the component of the outline that addressed the purpose of the speech. Each category indicated by the comparison between a student's initial and final paragraph descriptions and between final paragraph description and outline was addressed. However, documents from two students (S8 and S12) whose topics changed to completely different ones were excluded in this analysis. Three types of focus shifts were discovered:

- Shifting focus – Focus shifted to another direction within a topic
- Narrowing focus – Focus narrowed within a topic
- Broadening focus – Focus broadened with an expansion of the topic domain

<Figure 3: Final Coding Categories>

Coding Categories Questions	Relation to Foreshadowing
Voc-Studt (Students' Vocabulary)	2a, 2b
Voc-Insr (Vocabulary of Information Sources)	2a, 2b
Perc-Plan (Perception: Plan of Information Seeking)	1a, 1d
Perc-Mean (Perception: Meaning of Information and Sources)	1b, 1d
Perc-Undst-Infostrt (Perception: Understanding of Information Structure)	1c, 1d, 2a, 2d
Perc-Undst-Prcss (Perception: Understanding of Process)	1c, 1d, 2d
Perc-Mtch (Perception: Matched with Sources)	2a, 2b
Insr (Information Sources Used)	1a, 1b, 2a, 2b
Strg-Gnrl (Strategy – General)	3a, 3b
Strg-Gt (Strategy – Gathering)	3a
Strg-Sl (Strategy – Selecting)	3a
Strg-Org (Strategy – Organizing)	3a
Affct-Assgn (Affected by Assignment Description)	2c, 2d
Affct-Teacher (Affected by Teacher)	2c, 2d
Affct-LMS (Affected by Library Media Specialist)	2c, 2d
Undst-Assign (Understanding of Assignment Description)	2c, 2d
Undst-Chng-TPC (Understanding of Changes in Topic Knowledge)	2d
Learning Strg-Data-Driven	4a
Learning Strg-Goal-Driven	4a
ACTVTS - Keyword search	3b
ACTVTS - Subject search	3b
ACTVTS - Natural Language search	3b
ACTVTS - Browsing	3b
ACTVTS - Reading	3b
ACTVTS - Notetaking	3b
ACTVTS - Highlighting	3b
ACTVTS - Skimming	3b
ACTVTS - Outlining	3b
ACTVTS - Printing	3b
ACTVTS - Reviewing	3b
ACTVTS - Adding	4a, 4b
ACTVTS - Dropping	4a, 4b
ACTVTS - Adding evidence	4a, 4b
ACTVTS - Changing evidence	4a, 4b
ACTVTS - Broadening concepts	4a, 4b
ACTVTS - Combining concepts	4a, 4b
ACTVTS - Narrowing concepts	4a, 4b
ACTVTS - Creating higher concepts to organize existing concepts	4a, 4b
ACTVTS - Putting a concept in a different category	4a, 4b
ACTVTS - Shifting a focus	4a, 4b
ACTVTS - Narrowing a focus	4a, 4b

<Figure 3 continues: Final Coding Categories>

Coding Categories	Relation to Foreshadowing Questions
Learning - Remember	4a
Learning - Understand	4a
Learning - Apply	4a
Learning - Analyze	4a
Learning - Evaluate	4a
Learning - Create	4a

All four data sources – interviews, observations, initial and final concept maps, initial and final paragraphs - were coded and analyzed to produce the patterns according to the final coding categories in Figure 3. Then, another round of analysis was conducted to verify the final coding categories and to determine whether more patterns should be noted in relation to the foreshadowing questions. The researcher tried to relate the categories more systematically to one another to determine whether any conceptual holes existed.

Students' research journals were also analyzed to compare students' search questions with their conduct of each specific search. The particular importance of the journals to this analysis was the series of questions that students generated over time to guide their searches. Changes in these questions indicated changes in students' knowledge of their topics.

In writing the report on the analysis, the researcher first created the overall scheme for presenting the findings. The research questions provided a preliminary focus, and this was expanded by the findings that emerged. Three chapters addressing the findings - chapters four, five, and six - were organized to reflect the progress of students' information seeking and use in relation to their learning task. A final chapter presents the conclusions of the researcher and the implications of the study.

In writing each chapter, the researcher reviewed the coded text to find key patterns and themes. The detailed nature of the coding categories made it easy to recognize both larger and smaller patterns within the text; sometimes the category itself identified a pattern that was important enough to be a section in a chapter. After patterns were identified as sections for each chapter, the researcher reviewed the appropriate text segments to find salient quotations and examples to illustrate the patterns.

The researcher made separate notes about the most important findings that emerged from the analysis. This strategy was helpful in identifying the larger themes in the findings. The notes were an especially useful reminder in writing the conclusions and implications chapter of this report.

3.6. Credibility, dependability, and transferability

In a qualitative study grounded in constructivist paradigm, "credibility," "dependability," and "transferability" are the terms used analogously to "validity," "reliability," and "generalizability" from the quantitative domain (Guba and Lincoln, 1982; Lincoln and Guba, 1985, Guba and Lincoln, 1998). Qualitative studies are judged according to how well they achieve these standards, and this study used a variety of techniques described by Denzin (1978), Guba (1981), Yin (1994), and by Stake (1995) to ensure its quality: data triangulation, establishment of referential adequacy and an audit trail, member checks, and peer debriefing.

Data triangulation ensured the convergence of information from various data sources to guard against bias in the findings. The different perspectives of three kinds of

participants – students, the teacher, and the library media specialist – were ex extensively to ensure that all viewpoints were accurately represented. The thr sources -- observations, interviews, and students' documents -- were also cro checked.

Referential adequacy was established through the collection of an ext array of materials. These were organized both as raw materials and in electrc provide evidence for drawing the findings and conclusions for this study. Th materials also provide the basis for an audit trail.

Member checks were conducted with the participating library media and the teacher. Both of them reviewed the final report and said they agreed researcher's findings. In addition, the teacher provided additional explanatio instruction. She particularly found one of the researcher's suggestions intere plans to incorporate it for her future instruction: "I have not recommended a or dictionary [as a guide for search vocabulary] in the past but will try that t semester," although she thinks that "those sources might not reflect the uniq of a subject area."

Peer debriefing was conducted by all the dissertation committee mer toward the end of this study and by the chair of the committee throughout th study design, data collection, data analysis, and report writing.

The technique used to ensure dependability involved corroborating t findings with the findings of previous research (e.g., Bilal, 2000; Fidel *et al* Kuhthau, 1991, 1993; Large and Beheshti, 2000; Marchionini, 1989; McGr Neuman, 1991b, 1993, 1995, 2001, 2002; Schacter *et al.*, 1998; Small and I

1994; Todd, 1999). Transferability was fostered by using purposeful sampling, collecting extensive descriptive data, and developing a thick description of the context that will allow readers to determine how well the findings fit with their own settings and experiences. Quotations enabled the researcher to reveal the context as much as possible through the comments of the selected participants. Thick descriptive data provide an opportunity for comparison with other possible contexts. All these techniques will allow researchers and others with similar research questions to derive implications for their own contexts.

3.7. Limitations of the study

As all studies do, this research has limitations. First, the naturalistic approach indicates that the research context cannot be controlled and that the findings can be transferred but not generalized. Additionally, participants were limited to junior honors students in one class in one high school. Although the researcher initially attempted to have more classes participate, only one class was available for this research. Next, the task was limited to one assignment which students conducted for two weeks and which allowed students to choose their own topics of interest; observations were limited to six scheduled class sessions. Another limitation comes from the researcher's background as a non-native English speaker. This study was heavily language dependent and it is possible that the researcher did not catch some nuances of the high school students' language during interviews.

The fact that only three searching sessions could be observed is a particular limitation of the study. The majority of students preferred to work individually at home,

since all the electronic sources and the Internet sources were available online. This limitation promises to be a particular concern for other researchers interested in students' information behavior, as more and more students gain even greater access to out-of-school resources. Lastly, it should be noted that the study did not collect any data on the process of students' conceptual changes as they occurred; it could only infer the process from analyzing students' documents and retrospective interviews.

Chapter 4: Initiating Information Seeking

This first chapter of findings focuses on (1) how students initially understand information seeking prior to their actual information seeking for an assignment and (2) how their understanding of information seeking changes over time. The chapter particularly reports students' information seeking and use during the information-seeking process at the beginning of the assignment.

Because the processes of information seeking and use are not clear-cut and linear, it is difficult to report the findings for each question in a discrete manner. Rather, it is more meaningful to present the findings according to the issues and patterns arising from the data. The findings thus will be reported and discussed in meaningful groups rather than arranged in order of the research questions listed (see table 10).

For this report, questions have been grouped into categories that suggest related findings. Due to the nature of qualitative data analysis, these findings include issues not expected as well as issues easily anticipated. In addition, when they are related to different question groups, findings will be reported and repeated in several different sections. Table 10 shows the relationships between each of the foreshadowing questions and the issues arising from data analysis, which are organized in the following order of presentation:

<Table 10: Findings and Foreshadowing Questions for Chapter 4>

	Findings for Chapter 4					
	Selecting the topic	Changing the topic	Planning	Understanding information	Understanding structure	Understanding retrieval
1. How do students initially understand information and information sources?						
1a. How do students plan information seeking and expect to access information and information sources?	X	X	X			
1b. What do information and information sources mean to them for doing their assignments?				X		
1c. How do they understand 1) the ways that information is structured in a source and 2) the processes used to retrieve the needed information from the source?					X	X
1d. How do students' understandings about information and information sources change over time?				X	X	
2. How do information structures of information sources affect students' understanding?						
2a. How is the information structure of an information source similar to and different from students' initial understandings?					X	
2b. How do the levels of vocabulary they use match with the levels of vocabulary that the source presents?					X	X
2c. How do the existing curriculum categories and the given assignment of class affect students' understanding of information sources?			X	X		
2d. How does students' interaction with information sources change their understanding of the sources and the topics?	X	X				X

Answering these research questions requires an understanding of how students began to work on their assignments. To begin the information seeking and use for their assignments, students had to select their topics. The first section of this chapter describes how students' information seeking affected the focus of these topics. How students' information seeking affected changes in the focus of their topics over the full course of their information seeking and use is examined in detail in chapters five and six.

The next section of this chapter, which describes students' planning of information seeking, answers the questions about how students planned and accessed their information prior to the initiation of their searches. Issues related to another question, the influence of the assignment description, have been merged and added for the section here.

The following section describes how students understood information and sources and how their understandings changed over time. Because data analysis showed that students' perceptions were influenced by the subject of the class, the purpose of the class assignment, and the assignment description, the findings regarding these aspects are also reported here.

The focus of the next section is how students understood the structures of sources and how that understanding changed over time, which touched upon all the questions above to some extent. Because only one of the recommended databases had subject listings and none of the students used that function to search by controlled vocabulary, the question about how the similarity and differences between the

information structures of sources established by controlled vocabulary and students' vocabulary could not be addressed.

The final section of this chapter addresses how the process of information retrieval was initially perceived by students and how their perceptions changed as they moved along. It particularly touches upon how students' understanding of topic knowledge was enhanced because of their understanding of information structure and of the process of information retrieval.

4.1. Selecting the topic

The first task given to students was to choose a topic for the assignment in class on the day the assignment was given. The teacher helped students with topic selection by stating some topics from her previous class to give students some ideas of what kinds of topics could be chosen. Individual students were allowed to use any of the topics mentioned or to choose any topic that was personally interesting. First, they were told to brainstorm for a minute and select three preliminary topics that came to mind. Then they were told to prioritize the topics and finally to choose one. A variety of topics were chosen because of different personal interests. Many of the topics were controversial (see table 11), reflecting the fact that the class was about persuasive speech.

Each student was then assigned to draw a concept map of his or her topic to identify preliminary ideas and to submit the map on the following day. The teacher gave students a 10-minute instructional segment on the nature of concept maps and on how to draw them (see chapter 3, p. 63).

<Table 11: Students' Topics>

	Initial Topic (seen in initial map)	Topic changed (seen in final map and outlines)	Types of change
S1	Abortion *	Abortion*	No change
S2	Effects on the environment	Endangered animals	Change type 2
S3	The benefits of Arts	The benefits of Arts	No change
S4	Building more runways	Building more runways	No change
S5	Cell phone use while driving	Cell phone use while driving	No change
S6	Censorship	Literature censorship	Change type 2
S7	Censorship	Censorship of music/lyrics and freedom of speech	Change type 2
S8	Death penalty*	Mexican food*	Change type 1
S9	Delaying school staring time	School starting time delayed	No change
S10	Discipline*	Discipline*	No change
S11	Driving age (Is 16 too young?)	Is 16 too young to drive?	No change
S12	Effect of music on human minds*	Abortion and pro-choice*	Change type 1
S13	Going away to college	Going away to college	No change
S14	Legalizing marijuana*	Legalizing marijuana*	No change
S15	New restriction on R-rated movies	Violence in the media	Change type 3
S16	Pledge in public schools	Pledge in public schools	No change
S17	School uniforms	School uniforms	No change
S18	The importance of knowing first aid*	The importance of knowing first aid*	No change
S19	The importance of reading	The importance of reading	No change
S20	The value of safe driving	Drunk driving	Change type 3
S21	TV/Music effects on people*	TV/Music effects on people*	No change

* indicates an invalid map (see pp. 77-78 for reasons)

The students' initial concept maps showed that all students had at least some ideas about the chosen issues when they selected their topics. Students were able to set out general ideas about the topics they selected and to note the ideas they would prefer to present. The initial maps also reflected the wide range of the levels of students' prior knowledge of their topics. Some students had clear ideas of what issues were involved and prepared detailed graphical presentations of these ideas and the relationships between and among them. Other students had less clear ideas and showed fewer ideas

and relationships in their maps, including concepts and connections that they would pursue for searching.

4.2. Changing the topic

Throughout students' information seeking, changes in their understanding of their topics occurred. Seven students changed their topics at different points during information seeking, while the other fourteen remained with their initial topics. The reasons for the changes were different from student to student. However, all seven students who changed their initial topics did so because of the information they found. The information often directed students to areas that were either unrelated or related to their initial topics.

Broadly, three types of changes occurred, as noted in the third column of Table 11 (p. 97). One type is a change to a topic in a completely different domain. Two students, S8 and S12, fell into this category. S8 changed her topic from *death penalty* to *Mexican food* because of her perceived information overload on her initial topic: "there was too much controversy over the issue [i.e., death penalty] and too much information to choose from, and it was hard to choose a side of the issue." Her comment also implied that she had not known much about the issue when she began. The other student, S12, changed her topic from the *effects of music on human mind*s to *abortion and pro-choice*. In this case, in contrast to the prior example, she said that she could not find information she liked about her topic and decided to change her topic to a more popular one for which more information might be easily available.

The second type of change involved choosing a narrower issue within the subject domain of an initial topic. Three students - S2, S6, and S7 – made this type of change. These students narrowed their initial topics and ideas as they found information. S2, whose initial topic was *effects on the environment*, changed his topic to *endangered animals*, which was a narrower concept. The concept of endangered animals had also appeared in his initial map as a subconcept, "saving wild animals." Reviewing a list of topics in the table of contents in a special issue of *CQ Researcher* on the environment made him think the new topic was attractive. S6 changed from *censorship* to *literature censorship*. Initially, this student had not had much knowledge about *censorship* and soon realized that it is a big issue; she decided to focus on *literature censorship*, which has some relevance to high school students in terms of their learning environment - schools and libraries. S7's topic was also *censorship* initially, but she changed to *censorship to music/lyrics and freedom of speech*. In her initial map, she had presented her ideas as censorship affecting our general rights to speak, listen, and view in public.

The third type of change, changing to a broader topic, was observed in two students, S15 and S20. In other words, students tried to retain their main ideas about the topics but incorporated other relevant ideas. The topic for S15 was initially *new restrictions on R-rated movies*; she changed it to *violence in media*, retaining the concept of her initial topic but including the new ideas of "violence" and "media." S20 changed from the *value of safe driving* to *drunk driving*. This student had tried to search with several different keywords on her initial topic but couldn't find information she thought to be relevant. Instead, she found that alcohol was the leading cause of

driving accidents, that information on drunk driving was frequently the most commonly presented information on the hits returned, and that there are many sources available on drunk driving.

4.3. Planning information seeking

Although preparing a plan for information seeking was not a part of the required task, students intuitively had some ideas about how they would go about searching for information on their chosen topics. They knew how to start their process of information seeking and what they expected to happen during the process.

4.3.1. Internet as a starting point

The Internet was the students' first choice of a source to start their research. Although the teacher had recommended other sources for this assignment and cautioned that students should be very careful in citing Internet information, students chose the Internet as a starting point because they were familiar with using it and because it provides a great deal of information. S19 mentioned that "my first inclination will probably be to go on the Internet and type in 'reading' and, you know, see what comes back." S5 added that "Personally, I like using the Internet. I mean, I had a biology lab yesterday and I found all the answers on the Internet. I mean, that's what I use it for."

Students expected to use the Internet to find what's available and then to narrow their initial ideas. S14, who particularly liked using the Internet for this assignment, recommended one site that brings up a list of related questions in response to the

questions he typed: "It is a really good one because that takes out a lot of the work that I have to do."

This finding corresponds with the observation from the teacher and the library media specialist that students' first choice for research assignments was the Internet. The library media specialist called this "the shotgun approach." Both the teacher and the library media specialist indicated the importance of this assignment as a way to teach students how to do research using a variety of reliable sources in part to counteract students' general tendency to use the Internet first for their research assignments.

4.3.2. Following assignment guidelines

The recommended sources and other elements of the assignment noted in the assignment description were important to students. Students believed that they could complete the assignment without difficulty if they just followed the guidelines in the assignment description. Prior to their research, students had identified specific information sources such as the Internet, *Electronic Library*, newspapers, and magazines as the information sources that they would use. As students began to use each source, they became familiar with its strengths and the weakness -- which was in fact one of the teacher's intentions in having students do this assignment. In the case of print sources, students realized that some sources contain more information on their topics and some contain less. They found that some sources did not even include their topics. For example, two recommended print sources, *Information Plus* and *Opposing Viewpoints*, had collections of articles on some of the popular topics but no articles on some of the topics that students chose, such as *cell phone use while driving* (S5), *the*

importance of reading (S19), and so on. Other print sources, *World Almanac* and *Statistical Abstract*, also did not have all the quantitative information that a student sought. *Readers' Guide to Periodical Literature* pointed to different magazines, but only a few of them were available in the library media center.

4.4. Understanding information and information sources

4.4.1. Information as a physical entity: Discrete and separable

Students' understanding of information was influenced by the assignment requirements. For students, information should be something that is "true" and that "supports their opinion" from the beginning. Students mentioned four kinds of information they anticipated using in their speeches – "quotes from experts," "statistics," "examples," and "facts." This variety was largely affected by the assignment description given on day one, which required students to test the "facts," "opinions," "statistics," and "specific examples" to see if the information is reliable and objective. The teacher imposed these guidelines on the students as means to support their opinions on the issues.

Students understood from the first day that information could be separated into the pieces noted above. This understanding continued throughout the process of information seeking and was reinforced by the outline template (see figure 2, p. 65) introduced to students on day seven. The purpose of the template was to help students organize their ideas and information in a logical order for an effective speech. The template was specific enough for students to insert the specific kind(s) of information they found as evidence for their ideas.

Once students had selected their topics, they had to determine how the topics could be supported by these kinds of information. When they laid out their concept maps, they thought that the concepts could be found during searching and expected to use the words in their maps for searching. S5 said she could identify her argument from the beginning and expected to add specific evidence which could make her argument stronger. S19 stated that she needed to find specific information as evidence on her topic, *the importance of reading*, although she thought that her argument was naturally logical without adding any supporting concepts and evidence. Students, in general, were optimistic that they would find information on their topics.

Students perceived information as valuable as a physical entity. They printed out any information they thought had relevance to their topics. They judged whether they had enough information by the number and length of the articles they collected. Students believed that they should have enough information because they "printed all the information out," because "each of them is lengthy," and because they had more articles than the assignment required.

Having information in hand was considered important because it enabled students to keep track of what they had found and collected. Students decisions to collect information in paper were influenced by the teacher, who emphasized "efficient" research -- meaning that students were expected to get all the information they needed at the moment they accessed it. Although the teacher did not specifically suggest that students gather as much information as they could at one time, she had warned students of the difficulties involved in going back to a source after one has left it. Students also seemed to feel that it was difficult to get back to a specific source after leaving it.

Printing out all the information that they thought relevant was a popular strategy that allowed them to revisit the information whenever it was necessary. Students believed it was effective to go back and look through the information they'd collected if they needed more information.

4.4.2. Information sources: Reliability

Students were concerned about collecting information from reliable sources because their assignment required them to test the information for its appropriateness as evidence for their argument and to test the information sources for reliability and authority. Although the assignment guidelines listed specific questions that students could ask for testing both information and information sources, students mainly focused on the reliability of the information sources. Students were aware that there is a lot of unreliable and biased information, particularly on the Internet, and that they needed to be selective in choosing information. Students mentioned criteria such as whether the information was from a major organization like a government agency or a university and whether the authors have appropriate qualifications (e.g., Ph.D.s) to discuss the topics.

With the teacher's emphasis on using reliable sources, students tried to shift their attention from the Internet to the recommended sources. They soon realized that it was not easy to discern reliable from unreliable sources on the Internet and that they had to make an effort to do so. A student who had said she liked the Internet very much in the beginning explained later that "I like using the Internet. But for research like this, it is better to go to databases because those are the qualified ones."

4.4.2.1. Effect of assignment description, curriculum category, and instruction

The assignment description provided a lens for students to see and to shape what to look for about information and information sources. Students believed that following what they were required to do would yield the needed information and thus enable them to finish their assignment. These students were honors students and were very eager to produce satisfactory products. Most importantly, they valued as reliable information statistics, experts' opinions, and concrete examples which the teacher had emphasized. They knew that the data should be from reliable sources, such as the recommended *World Almanac* and *Statistical Abstract*. Students tried to find some numbers related to their topics if they could. For example, S5 tried to find the number of accidents and deaths related to cell phone use while driving. If students thought that it would be difficult to relate and prove their argument with numbers, they tried to find some examples and experts' opinions from reliable sources, such as newspapers, news transcripts, magazines, government sources, etc.

Another part of the assignment description that affected students' information seeking was the class they were taking – persuasive speech. The nature of the class determined how students focused not only their final products but also their information seeking. Toward the middle of the students' information-seeking process, the teacher conducted an exercise with students to emphasize the purpose of a persuasive speech. It covered a range of issues, and students were to congregate according to their choices of the answers. For example, one of the questions was which they would least prefer: to be very sick, to be very poor, or to be disfigured. Students had fun moving around in the

classroom and grouping themselves according to their common ideas. The purpose of this exercise, according to the teacher, was to help students know themselves and their peers in order to motivate their preparation of speeches for their audience. She emphasized that a good speaker would have to know his/her audience well to customize the speech and continued to point out that students should realize that there was great diversity in students' interests and thoughts. She then concluded that a speech should be objective and logical in providing information in support of arguments.

This exercise was given six days after the assignment had been distributed, around the time that students would have just passed the initial stage of their information seeking in terms of time. Some students had already collected much information on their topics, while some were still struggling with the initial ideas and were not even sure about their topics. However, no matter where they were in the process, this exercise and the teachers' remarks definitely affected students' decisions to go further in their information seeking.

Students began to focus on how their speeches would have an impact on their peers. Some students' topics directly addressed some of the popular concerns of high school students, such as *Is 16 too young to drive?* (S11), *going away for college* (S13), *delaying school starting time* (S9), etc. Other topics on social issues were not directly related to the students' everyday concerns. In this case, students had to make their topics and speeches relevant to their peers in some way. S19 commented, "I don't think... reading to preschoolers was important to what I am saying -- that reading is important -- but I had to tailor to my audience, which is teenagers." S5 described her concern for audience as follows: "I already have an idea how dangerous it [cell phone

use while driving] is. I know people die just from watching things like *Oprah* and from seeing news. My first step would be related to audience. Every kid has a cell phone these days."

As students were formulating their foci and collecting information on their topics, the teacher conducted significant instruction in the computer lab on the seventh day. A full class session was devoted to the instruction for outlining, a technique intended to help students shape and deliver their arguments more effectively. The outline template was loaded on individual computers, and the teacher explained how to fill in each slot. Students entered their own examples into the outline template and saved their work to guide the development of their own outlines.

Together with the kinds of information that were emphasized in the assignment description, the outline template particularly influenced students' further understanding of information seeking and use for their speeches. Students thought that their speeches could consist of different information that was discrete and separated from the context. In a later stage, when they had to put the collected information together, they commented about using "bits and pieces of information from all the documents collected" and extracting "certain sentences from an article although the content of the article is not relevant."

4.5. Understanding information structures

Students understood that the information structures of electronic and print sources were different. The key difference was the use of the subject guide or index for

searches in print but not for searches in electronic sources. This difference persisted throughout the processes of information seeking.

When students retrieved information from print sources, they often referred to the subject arrangement on the shelves and/or to print indexes available in the library media center and the public libraries, such as the *Readers' Guide to Periodical Literature* or an index available in the back of a monograph. Students were usually aware of the section of the shelves on their topics and browsed the titles. If they knew the location of the books on their subjects, they went directly to the shelves. S2, who had been interested in the same subject for a long time, said, "I usually know where the books are in this library because I've learned it since ninth grade." He mentioned he looked in the index and found relevant pages of the books according to his interest. Another student, S8, found a book using the computer catalog and looked up its table of contents to find the relevant chapters.

Students understood that information structures in electronic sources are not based on subjects. As seen in Table 12 below, they understood from the beginning that "topic" and "dates" are the two most frequently used methods for structuring and accessing information in these sources. A free-text keyword search or a natural language search was perceived to be a mode of "topic" searching in electronic databases and the Internet. Controlled-vocabulary search was not considered and used at all by the students, whereas an index tool, table of contents of a book, or arrangement of bookshelves was understood as a mode of searching only in print sources. Three of the eight students interviewed were able to specify in more detail ideas related to their topics. They did not distinguish between free-text keywords and controlled-vocabulary

searching because both were perceived as ways to locate "words" that appeared in the documents and thus were similar to students' entries.

<Table 12: Students' Ideas of Information Structures of Sources>

Students	Initial	End
S2	Keywords (electronic databases) Subject (index of print sources) Viewpoints Date	Subject (index in a print source), Words (electronic databases), Viewpoints Date
S4	Topic, Date (Recent Info First)	Topic, Date
S5	Topic, Date (Internet, electronic databases)	Topic, Date, Relevancy (Internet, electronic databases)
S8	Keywords (Internet, electronic databases) Subject (Internet) Author (Court cases) Title, Author, Subject, Type of Sources	Each database and source has its own structure of information and thus has a different way of accessing information.
S14	Topic, Relevance (Internet) Date, Author (Library Catalog)	Topic, Date, Relevance
S16	Topic, Date (electronic databases)	Topic, Date, Reading Level (Electronic Library) Each database has its own structure of information.
S17	Topic, Date, Type of Sources	Topic, Date, Type of Sources
S19	Subject(media center) Keywords (Databases) Title, Author	Subject Words (Databases) Title, Author

It was easy for students to conceptualize how information would be organized in a system by visualizing how they would access the information; therefore, students understood how information is structured in terms of the ways they accessed information. Students were most familiar with *Electronic Library*, one of the recommended databases, whose search mode defaulted to free-text natural language searches with the option for Boolean searches. Students easily understood and expected those two search options to be available in all electronic sources. In fact, *Electronic Library* had a strong influence on their understanding of information structure. Two students in particular mentioned that information is organized by its type of source (e.g.,

newspapers, TV/radio news, pictures, books, etc.), an idea which came directly from the categories of materials in *Electronic Library*.

Interestingly, S5 and S14 mentioned "relevance" as a way to organize information because it was a way to sort and present information on the screen. This was another indicator that students' notion of information structure overlapped with how they searched and saw the information on the screen. However, those two students knew that they could make rankings with dates as well as with words. For them, dates and words are ways of structuring information in an electronic database.

As students moved along in their search processes, they began to realize that the ways information is presented by a source does not tell everything about how the information might be relevant to their topics. In fact, the absence of a subject guide in a source caused some concerns and confusion to some students. Although one source, *Ebsco Host*, has the list of subject categories and a controlled-vocabulary search option, none of the students considered and used the function or browsed the subject categories available. When students saw the information presented with their searches, they could observe that the subjects and the levels of the subjects for the information returned are mixed. Some of the hits were relevant, some were somewhat relevant, and some were totally irrelevant.

One student, S2, pondered that there should be more than the two levels of information – relevant and non-relevant information – and that the relevance rankings did not show degrees of relevance. In the beginning, he believed that he could easily distinguish the relevant from the irrelevant information because he knew what he was seeking. Then, he realized that, even though the information did not seem relevant to his

topic, it might be relevant information according to the kind and conceptual level of information that he needed. He commented, "I don't think information is anything that's relevant now; I think there's stuff above and beyond what 'endangered animals' information is. Under 'endangered animals' you have the specific type of species and stuff. That's information too. [But, it didn't come up from searching]"

4.6. Understanding the process of information retrieval

Students' understanding of the information retrieval process was greatly affected by the capabilities of electronic sources. Because students relied on these capabilities for their searches, they believed that they could meet their information needs easily. Students expected to make some progress just by putting their keywords into the sources. They believed that they could start searches without planning analytic search strategies in advance. The library media specialist pointed this out as one of the students' problems in searching:

> They see an article and they read the abstract, but they're not always certain that's what they're looking for....I don't think that even the honors kids sit down and really think through a topic before they start doing research. I think they just get their topic and they go for it without really genuinely sitting down and saying, What are the questions involved here? Um, what does this subject mean? ...I think they form their research after they read what it's about.

In fact, one of the phrases that students frequently mentioned was "and then, I will go from there," indicating their perception that information retrieval using the electronic sources is interactive. When they did not have much knowledge about their topics and about what information would be available, they wanted to see what options were possible. For example, S 17 said "[I will] just start out broad. Look maybe especially on

the Internet or uh ... some databases. Look up for some school uniforms and see if I can narrow it down into some categories." S19 also indicated, "I think that this way [using online sources] you can get more information and narrow it down. Like with a search engine you know you don't have to sit there and read through everything." Students' preferences for interactive searches have been confirmed by previous studies on students' search behaviors with electronic sources, including the Web, and with different age levels. Students from elementary, middle, and high schools all preferred highly interactive searches (Bilal, 2000; Fidel *et al.*, 1999; Large *et al.*, 1999; Marchionini, 1989; Schacter *et al.*, 1998).

Students did not seem to have the same level of anxiety in using the electronic sources as in using the print sources and thus believed that searching is easier with electronic sources. Surprisingly, students understood the amount of information available online to be a benefit, not an intimidating factor, for doing their research. Students believed that the electronic sources performed many of the intellectual tasks that they had to do for themselves with print sources. The biggest perceived advantage of using electronic sources was that the sources filtered through and sorted out the relevant information according to students' preferences without their having to dig through all the pages of books, magazines, and newspapers. Students knew that they could access a great amount of information using the electronic sources and believed that the sources indicated what's relevant by ranking the results. S19 mentioned, "It definitely makes it easier, especially with computers ... it will tell you what's relevant."

Access to the great amount of information available online gives students many possibilities for finding new information. Students knew the benefits and weaknesses of

searching electronic sources. They knew that it was critical to use search terms that could be matched with the terms that authors used in documents when they searched by keywords. S8, who knew what she expected, commented, "If you [want to] look under the right stuff, you've got to find the terminology that they [authors] used most of the time." However, students also understood that the advantage of using keyword searches was that they did not have to know exactly what they were seeking when they searched. S8 continued, "Getting the exact information isn't always that easy, but you can usually find stuff that will take you where you want to go. If you don't find exactly what you need, you can find stuff that is related or near it and take you to somewhere else." S19 commented, "What I think is really nice is that if you don't know exactly what it's gonna be under ... I think it's helpful for that just because I know what I'm kind of going for since I already have some ideas of what I think the information I'm gonna find is."

Readily available full text was also a reason for students' belief that searching was easy. All the recommended databases allowed full-text access, and students wanted the full-text articles in their email accounts or in printed form right away. Physical availability was a major reason that students preferred the electronic sources to the print sources. The library media center subscribed to a limited number of magazines, which limited students' physical access to print sources. One of the print sources recommended, *Readers' Guide to Periodical Literature*, directed users to many magazine articles, but not all of these were accessible in print at the library media center. Students thought it was frustrating to know the information was not physically available after they had spent time locating the information from searching the *Readers'*

Guide to Periodical Literature. With the electronic sources that offered full-text data, however, they did not have to worry about unavailability of the information in print in the library media center. S16 said, "I think it's pretty easy. Everything is readily available to me and as long as I have the initiative to go and do. I think it's pretty easy to go and get a research project done." S4 also mentioned, "I think the hardest thing for me is actually saying I'm going to do it. But, when I do I sit down and get started, I think it's easier than before. There are still some challenges, but eventually I search and find what I'm looking for."

Students understood the process of retrieving relevant information from electronic databases as a simple "type and click" operation, and thus they did not put much cognitive effort into searching. Because students thought that searching is easy and requires little cognitive effort, they were willing to revisit the databases for more information whenever they felt they needed to gather it. S2 commented, "I didn't spend so much time on each one [document] because I knew I could find so many others."

During searching, students often made their decisions very quickly without carefully examining the functions available in a source as well as the information presented to them. Students knew that each source has different ways of retrieving and presenting information, but they were not conscientious in examining what functions were available in a source to retrieve relevant information. For example, throughout the process, and even when a keyword search failed many times, no student even considered using the *Ebsco Host* subject-search function that enables users to browse the categories and click to search.

When a search failed, students switched around their search vocabulary and search options very quickly and without carefully examining what they already had in their sets of hits and what they could do in particular situations. For example, many students used the natural-language search function, which was *Electronic Library*'s default, to start their searches. But if they did not think it worked, they switched to Boolean searching to try another search using the same selection of words. They failed to scroll down and look at other options they could use to limit their searches. One student was constantly complaining during her search that she didn't get recent information, although the database had a function to limit the search by publication year.

Students' understanding of the easiness of searching was contrasted with their understanding of the difficulty of organizing the information gathered. Students believed that searching and organizing information for their final products were two separate tasks. Somehow, students believed that they would not have to think hard for searching but would have to think hard for organizing and putting the information into their speeches. S14 said, "Gathering is ... not hard because you don't have to think about it. It's pretty much just going out and doing it." He continued, "Research [Searching] is pretty easy compared to actually taking the research and putting it into your speech and making it make sense. That's the challenging part." S16 added that "[Searching is easy because] Just the information that's there. The hard part would be organizing it and getting it down to a level that's very effective to present."

During class sessions at the library media center, the library media specialist had given students individual IDs and passwords of the recommended databases so they

could access these resources from outside the school. All the students interviewed said that they had used remote access to search and had used the recommended set of the electronic sources when they did so. Some students preferred to work at home, where they had their own computers and Internet connections.

As the teacher expected, the assignment changed the understanding of some students about the process of information seeking and using electronic and print sources together. S2, who had said in the beginning that he liked print sources such as books much more than the electronic sources, made a notable change. In the beginning, he had said:

> Books are easier to use and it's [from] an expert. I've grown up using books. I mean, I like using computers, but I don't like using computers to find important information.... I think it's pretty easy – well, for me it's more difficult - for me to use a computer to find information. I find it easier to research in a book to find information. Because in a computer it gives me stuff that I don't need. In a book it's an expert that wrote it in a book and it's harder to do a bibliography on the Internet.

He later described what he had learned:

> Last time I said *Elibrary* [*Electronic Library*] wasn't that good. But I like it now, *because I found how to do it* [*italics added*]. It is a lot more helpful..... And I emailed them to my email address from school so I went home and looked on that. That's a lot easier than, I think, than using the *CQ Researcher* and stuff.

Convenience was an important factor that was attractive to students because it allowed them to get information without the constraints of time and geography. Students understood the Web-based electronic databases as easy and convenient and relied heavily on the capabilities of all the electronic sources.

4.7. Summary and conclusions

This chapter has described how students' perceptions of information seeking changed from their initiation of the process to the end. The first two sections reported how students proceeded with their activities of topic selection. Students selected their topics according to their personal interests, and some of them changed their topics as they found or did not find information. Three types of change were identified: (1) change of topic to a completely different domain, (2) change of topic into a topic in a narrower domain than the initial topic, and (3) change that involved choosing a topic from a broader domain and including more ideas. All these changes were affected by the information students found along the way.

Prior to their information seeking, students selected the Internet as their first choice to begin examining their individual topics. Students anticipated that the Internet somehow would provide "something" in order for them to progress in their information seeking. The kinds and amount of information on the Internet were perceived to be a great benefit for their research, not an intimidating factor. Because doing a good job which could result in a good grade was important for these students, they were sensitive to the instructions and assignment description, which emphasized using information from reliable sources.

Students understood that information could be discrete and separable from the context when using it. The kinds and formats of information anticipated by students mirrored the information that the teacher described in the assignment description: statistical data, examples, experts' opinions (quotations), and facts. When organizing

these kinds of information for their speeches, students used the specific outline template which allowed them to insert their own ideas along with the information they found.

Students thought it was important to have information as a physical entity to which they could return whenever necessary. They even judged whether they had enough information according to the number and the length of the documents retrieved.

As students moved along in the information-seeking process, they learned the strengths and weaknesses of each source and determined which sources would be suitable for their topics. In addition, they learned that some sources are more reliable than others. The nature of the curriculum, persuasive speech, affected students' focus of information seeking. As students went along in the process, they thought more carefully about the purpose of the class and adapted what they learned to help them shape their products.

Students' understanding of the information structures of sources was that electronic sources have structures that are different from the typical structure of print sources. Students did not even consider controlled-vocabulary searches with the electronic databases, whereas they primarily used subject guides or indexes with print sources. For students, the information structure in either kind of source was perceived to be the same as the ways that they could access information in that source. Thus, the information structure of electronic sources in general was affected by the interfaces of the Internet browser and the *Electronic Library*, which students had the most experiences in using. Students believed that print sources were arranged by subject on the shelves but that electronic sources could be organized as they wanted (by topic, date, relevance, etc.) through free-text searches.

In particular, students were well aware of the differences between free-text and controlled-vocabulary searches and of the benefits of conducting searches in electronic databases. Lack of a subject guide in an electronic source and lack of attention to the controlled-vocabulary search function caused some concerns about students' understanding of information during information seeking. One student pointed out that, although he retrieved all the relevant information on his topic on the screen, different facets and conceptual levels of the information made it difficult for him to retrieve and to determine the relevant information.

Students did not have anxiety about using these electronic databases and understood searching was easy because the electronic databases shared their cognitive burden of analyzing and refining their topics. As a result, they did not put much cognitive effort into searching, although they anticipated learning from this rather "complex" electronic information environment as they searched. Students' searches were not analytic or planned in advance but interactive and responsive to what appeared. Students believed that the information presented would reflect the information available on their topics. They expected first to see "what's out there" and then to narrow their ideas. Students' expectation of learning from searching was evident when they commented that they believed they could always find something related to their topics in keyword searches, which they saw as a great benefit.

The amount of information available from the databases and the available filtering functions were of great use in students' searching. Students saw these as benefits because they spared them some intellectual work, such as sorting by relevancy according to criteria. Availability of full text online also played a role in students'

understanding that searching is easy. Having quick access to full-text information was one of the main reasons students preferred electronic sources to print ones.

Students understood information seeking with the electronic databases as a simple "type and click" operation. They expected most databases to be similar in terms of how they could be searched. Students often did not carefully examine what functions were available other than "type and click" and thus made decisions quickly on the functions available as well as on the information presented. In contrast to students' understanding that information retrieval was easy, they understood that organizing the information retrieved was a challenging task that involves cognitive effort. The databases would not help with this task.

Convenient access to the information in electronic databases was an important factor in students' preferences for these electronic sources. One student confessed that he now liked electronic sources more than print sources because he had learned how to use them. Allowing remote access to students enabled students to work at home.

This chapter reported the findings about how students initially understood information and sources in conducting research for their assignment and how their understanding changed over time. The next chapter will examine how students actually went about gathering, selecting, and organizing information during the processes of information seeking and use.

Chapter 5: Information Seeking and Use

This chapter reports the findings on students' strategies and activities for information seeking and use in pursuit of meaningful learning. Although "meaningful learning" is a widely used term, there is no shared definition of the process and activities involved in meaningful learning. For this study, a constructivist adaptation of cognitive learning theories was used as a broad conceptual framework to define meaningful learning. One of the theories used to analyze students' strategies and activities was Mayer's SOI model of constructivist learning - *selecting, organizing*, and *integrating* information.

As the analysis proceeded, one question regarding this theoretical framework emerged in light of the findings: How do SOI processes apply in the context of information seeking and use? Neuman (in press) pointed out that "Mayer's SOI model does not seem to reflect the processes of meaningful learning with information that concern library media programs" (Partial answer to "too narrowly communicated," para. 3). Further, while Mayer's SOI model presents human cognitive processing in a linear manner, the cognitive processes needed in the context of information seeking and use are dynamic and cannot be linearly represented.

For this study, "gathering" was added to the Mayer's SOI model to accommodate the context of information seeking and use. Independent information seeking to find meaningful information for learning is one of the crucial tasks for students, whereas a set of learning materials that is potentially meaningful is assumed for students in Mayer's framework. In addition, "using" was added to reflect the fact

that meaningful learning with information in school settings generally involves the creation of a product that shows how the information was used. "Use" of information is addressed directly in chapter six.

"Selecting" and "organizing" are relatively easy activities to observe, but "integrating" information is an underlying cognitive process that is not accompanied by any observable activity. Because integrating information into students' knowledge begins with students' information seeking as they constantly construct "external connections" between new information and existing relevant knowledge, integration is understood as an underlying process that occurs constantly as students gather, select, organize, and use information for meaningful learning.

The findings for students' strategies and activities in information seeking and use suggest that all five processes – gathering, selecting, organizing, integrating, and using information – are very closely related, although these processes produce different activities. The overall concept of the modified model suggests the intertwined nature of the five processes throughout information seeking and use. While the original SOI processes focus linearly on the microscopic perspective of information processing in human memory systems, the model for the context of information seeking and use takes into account the necessary cognitive activities and strategies for gathering and using information as well.

This chapter reports the strategies and activities of students as they gathered, selected, and organized information. The relationships between the findings and foreshadowing question three are introduced in Table 13 below.

<Table 13: Findings and Foreshadowing Questions for Chapter 5>

	Findings for Chapter 5		
	Gathering (Integrating)	Selecting (Integrating)	Organizing (Integrating)
3. What strategies and activities do students use for restructuring information?			
3a. What strategies do students use to gather, select, organize, and integrate information for their research?	X	X	X
3b. What activities do students demonstrate in gathering, selecting, organizing, and integrating information?	X	X	X

5.1. Gathering information

Students began to gather information even though they did not have specific foci in mind to guide their searching. As they gathered information, students expected to get to know more about their topics. In fact, the gathering process was a learning process: students learned about their topics by analyzing and refining them through searching. Their strategies were (1) using broad vocabulary for their searches and (2) gathering general information first and specific information later. Students' observable activities for gathering information were (1) browsing and scanning the titles, (2) following the online links found in the documents retrieved, and (3) emailing and printing the information.

5.1.1. "Start out broad"

Students working with the electronic sources began by entering keywords related to their topics. However, they seldom found what they wanted at first. For

example, S20 keyed in "driving accidents related to drinking" and "driving defensively" for her initial topic, *the value of safe driving*. Some students used keywords that were too broad. For example, S9 used "education" and "health" for her topic search on *delaying school starting time*. She said she wanted to see if there was anything related.

Having only a sense of direction that was somehow related to some preliminary ideas for their searches, students examined each set of results returned after entering some broad search vocabulary. Most students believed that starting their searches with broad vocabulary was effective and helpful "to see what's out there." S17 particularly believed that it is easier for him to start out broad and then to narrow down than to start with specific concepts and to broaden; he had had previous experience with starting with specific ideas and then finding it difficult to broaden his search.

The vocabulary that students used was limited in terms of scope and number of search terms/search questions and often came from their initial concept maps. For example, S17 (*School uniforms*) used "school uniforms" and "behavior," which he had identified in his initial map. He first tried both terms together to see what was available. When the results returned, he carefully browsed not only to find information for possible use but also to see what the results said about school uniforms and behavior. S16 (*Pledge in public schools*) had ideas about what her argument would be but wanted to examine and gather information by using only a limited number of terms, such as "Pledge of Allegiance," "Pledge," and "public schools" for different searches. S4 (*Building more runways*) kept trying the same keywords, "effect of building runway" and "runway building," throughout the searches to find different aspects of his topic.

Students had different purposes when they used the same keywords. For example, S16 (*Pledge in public schools*) used the same keywords, "Pledge of Allegiance" and/or "public schools," for different searches conducted to find information on (1) current examples of using the Pledge in school, (2) the reasons the Pledge shouldn't be required in public schools, and (3) the U. S. laws on the Pledge. S2 (*Endangered animals*) also used the same keyword, "endangered animals," for all his searches, even though the searches had different purposes. He used the term to find (1) information on why endangered animals should be protected, (2) organizations that exist for the protection of endangered animals, (3) current situations involving endangered animals, (4) the causes of animal extinction, etc. Many other students used only several keyword(s) directly related to their topics throughout the process, aiming to find different aspects of a topic.

When students found by browsing the results that their search terms and questions did not work, they tried either to change their vocabulary, as the library media specialist had recommended, or to switch to another search option (e.g., from Boolean to natural language). The changed search terms reflected the results returned, indicating that students were interactive in finding new search terms while searching. The process involved constant circling until they found what they liked. For example, S2 (*Endangered animals*) first tried "endangered species" but said it did not work very well: "I used 'endangered species.' I didn't get the stuff. I didn't get the sources I wanted... I used that at the beginning of my research, so I don't remember exactly what it was. But from then on, I just used 'endangered animals.'" S8 (*Mexican foods*) described why her first keywords did not work: "Well, like looking on the computer just

typing in certain keywords, like typing in 'Mexican food,' it just gives you a whole bunch of recipes and how to make the stuff but it doesn't tell you about nutritional facts or like health or anything like that. So you had to find the right keywords. I think I used, like, 'nutrition.'" S19 (*The importance of reading*) commented on how she managed her searches: "I used a lot of different searches. I started off with 'readings,' but those were too broad.....I started asking, like, 'Why should teenagers read? Why is reading important?' A lot of different questions... It took me a while to find what I wanted."

Students tried to get the information that they wanted not only by changing their search vocabulary but also by switching their search options from natural language to Boolean search or from Boolean search to natural language. For example, S12, who worked on *effect of music on human mind*, started by using the natural language search option to ask "what is the effect of music on human mind?" But she was not satisfied with the results returned and switched to the Boolean search option. She first used a combination of "effects on human minds" and "music," then "music effects" and "human minds." However, the search with those terms did not yield information that she liked. She switched frequently, using the same set of keywords when using the Boolean option. None of her searches led to the information that she wanted, and she changed her topic the next day. Other students also switched search options as well as databases whenever they felt stuck.

There was no searching help available to the students either on the databases themselves or in the library media center except for asking the library media specialist. She had stressed the importance of students' ability to formulate their search questions. Both she and the teacher had told students to "think hard about synonyms" and "jot

down ideas" to prepare their searches. However, this advice was not helpful when students had a hard time thinking of the appropriate keywords. Although the teacher had warned them to examine Internet sources carefully, some students turned to these sources directly to find information because of the hope that the Internet might be easier to use and might provide more information on their topics. Two students said they used the same search engine, *Ask Jeeves*, because it is easy to use and had been effective in finding what they wanted for earlier searches. Students knew that they had to be careful in citing Internet sources but said they would keep trying *Ask Jeeves* and other search engines anyway.

Students also had to find the right terms for the print sources. Some students were very confident that their topics would be included and were able to locate their terms without any difficulties. S17, for example, went straight to the "listings" volumes of the *Readers' Guide to Periodical Literature* to search his topic, *school uniforms*: "When I looked it up, I think I had to look up 'school' or 'education'; maybe down under that there was 'school uniforms.' But ... I didn't look in the index; I felt pretty confident that that would be there." However, it was hard for some students to locate terms related to their topics. Some had difficulties in finding information in the recommended print sources. S5 (*Cell-phone use while driving*) had difficulties in finding terms about her topic in print sources because "my topic is so recent, a lot of the stuff in [*World*] *Almanac* and *Information Plus* was outdated." Students also had difficulties in accessing some of the periodicals that were listed in the *Readers' Guide to Periodical Literature* because the library media center did not subscribe to them.

5.1.2. Gathering general information first and specific later

When students mentioned that "I have general information," they meant one of two things: (1) they had documents containing background information on their topics or (2) they had gained a general understanding of ideas through the information presented in documents they found. The latter also meant that students understood the general aspects of the topic, whether those came from one article that dealt with the background information or from many different documents that dealt with different aspects of the topic. For this study, "general information" was understood to be the general information retrieved on different aspects of a topic when students searched electronic databases. The different aspects of a topic could be presented in a document or in different places within documents.

One of the reasons that students tried broad vocabulary for their searches was to gather anything related to their topics. In the beginning, students did not rush to find only the information they needed. S5 said, "I looked at general things [documents generally] and gathered specific." S19 said, "I had my ideas in my head of what I wanted to find, so I did a lot of keyword searches, but ... yeah, I sort of wanted to find anything I could on the topic. Just felt good to have something to find the evidence of ... someone agree with me." This strategy yielded both general background information and more targeted information on different aspects of the topic. General information contributed to students' understanding of their topics in the beginning. Although students said they knew about their topics, they agreed that they "often come across ideas that I have not thought of" when they searched.

When the number of results was too large or when the results included too much irrelevant information, some students who had relatively clear ideas of their arguments tried to narrow their searches by adding more search terms. S5 described what terms she used to find information on *cell phone use while driving*. She mentioned "I used 'cell phone' and 'driving,' and then that was still a little too broad. So I entered 'cell phone,' 'driving,' and 'accident.' And then I found a lot of information. That's just what I wanted."

Some students tried to narrow their searches by entering narrower search terms that they gleaned from the results. For example, the initial search terms of S17 (*School uniforms*) were "school uniforms" and "behavior." After browsing the results returned by his initial search, he found that "violence" was the most common behavior mentioned in the results. He then picked up "violence" as a keyword.

5.1.3. Browsing and scanning the titles

Since students used broad vocabulary for searching on a topic, they often retrieved a large number of results. Browsing the results and scanning their titles and headlines was one of the most frequently observed and mentioned activities for gathering information. Students believed that this was the easiest way to see what is available on a topic and to narrow their thoughts. Additionally, titles and headlines in the results seemed important for students not only to judge whether they would lead to other resources but also to understand more about their topics.

Students seemed to go through all the results presented, at least the results on the first screen, to find the information they wanted. S2 mentioned that he always clicks

every one of the first ten results. S5 said she had to be patient and just had to see "what every single one was about." However, if the titles did not seem to be relevant at first glance, students would not look at them. S8 said, "There would be a few that didn't seem to fit; but then you just skip over those by looking at the titles and go to the next one." S16 mentioned that "titles are very helpful, because that helps me weed out the things that ... may not be appropriate for my topic. A lot of times, titles might not be good but then actually it has a lot to do [with my topic]. So I think it will be helpful if the titles are more ... tell me more about the articles than what is really there. Like a summary."

Students also browsed and scanned the titles when they gathered information from print sources. S14, in particular, said he found one book for his topic, *legalizing marijuana*, by browsing the shelves. He described the process: "I was just looking through the library. There was a section on drug abuse, and I just looked through and I found one." S2 (*Endangered animals*), who already knew the section where the relevant books on his topic were located, browsed the shelves to scan the titles.

5.1.4. Following the links

One way students gathered information during their searches was to follow the promising links within information they found. Students often followed links to Internet sources from the information they retrieved using electronic databases. They were very careful to use Web sources directly through search engines such as *Google*, *Lycos*, *Yahoo*, etc. They believed a Web source to be reliable if an article retrieved from the recommended databases was linked to it. As S17 said, "Lots of them [documents

retrieved] had other references to other Web pages to go to. I guess I find better information that way." S5 mentioned that she found an interesting example from the Internet unexpectedly while she was reading an article retrieved from one of the electronic databases: "I found one web site. Remember I told you about that girl on *Oprah* that was killed ... I found it in an article in the newspaper, and then, they gave a link to the Website the mother had set up for the girl, trying to get people more aware ... You find a certain article and just go from there. It will take you to all different [information]"

5.1.5. Emailing and printing

As reported in the previous chapter, students believed that information consisted of physical entities and wanted to have their information in their hands. Students wanted to gather as much information as they could about their topics, and their most popular strategies for gathering documents were to email themselves and/or to print the documents. Emailing, in particular, had been strongly encouraged by the teacher and library media specialist during class instructions so that students wouldn't use valuable class time for copying down articles and for printing them.

As S16 described it, "I use all the resources that I can to look up, as much information as I can about the topic. Any information that would seem pertinent about my topic I would write down ... I print out ... or even if it's not necessarily directly related, I might need it later so I print that out." S4 mentioned, "I looked at all of them and scrolled down ... And I open it. And if there is information that looks good, even

one piece, I just send it to my email." Gathering as much as they could was perceived important by many students.

Except for the Internet, all the electronic databases that students used had a function for emailing articles. All the students interviewed preferred to work at home, since they could have more time to read the articles carefully and to work without thinking about the time. S5, who preferred to work at home because her computer at home was much faster than the computers in the library media center, said, "Because [from] the databases ... you get all of them ... sorted by relevancy. And then I look through them and see something I want there and print it out. And go to the next one and if there is something I saw I print it out. And then I print them all out and then I go back over. But just gathering the information is I just find and print it."

No student tried to extract information from the documents on screen before emailing them. Since they were inclined to print out the information without careful examination, often they found that they had information that was not relevant to them when they looked at it later. S5 and S14 commented that "that happened a lot." Then they just "put the information on the bottom of the pile" for possible future use.

5.2. Selecting information

It is important to repeat that the processes of gathering, selecting, and organizing are not linear and cannot be divided into discrete pieces. In fact, the processes are so dynamic that one can hardly say they occur in any particular patterns. They repeat themselves in large and small cycles. Students usually started with gathering information but might have felt the need to go back to an earlier stage from any stage in

the process. It is necessary, however, to identify each stage in order to highlight the strategies and activities related to it.

As students gathered information, they tried to select what they needed for creating their final speeches. They began to realize that the information they gathered had two different uses: to help them understand the topic and to help them finish their assignments. Students agreed that they would not use all the information they gathered but would certainly use pieces of it. What they selected from the information they had gathered is the information they would use for their speeches. This section will report how the process of selection occurred by describing strategies and activities students demonstrated.

Two main strategies were identified for choosing information that would be used for the final speeches: weeding and selecting. The documents that were difficult to read and understand, that had different foci/perspectives, and that were redundant with other documents were weeded. When students selected documents and information to use for their speeches, they used criteria such as reliability of the source, topical and functional relevance, easy reading level, and "uniqueness."

5.2.1. Weeding

Students had clear reasons for weeding out some pieces. The predominant one was the level of difficulty of the documents. If a document was difficult for them to understand, students simply weeded it. As they read the documents, they found that they could not use some of them because of that difficulty, even if the documents were from reliable sources. Students indicated that they could not deliver their points clearly if

they did not understand the information. S14 said, "Because when articles are written, they have certain public [audience of readership]. You know, something from magazines, it's scientific and full of information, but nobody understands. Class wouldn't understand that. But something that people read everyday, then I can understand and I can present it well to the class." S19 mentioned, "If I didn't find something ... I'd probably go to a new article. It was too hard to understand. Because I knew that some of the sources are more in depth. If I couldn't understand it, I tried to find ones that are more clear so I was able to use it better."

Some documents gathered were redundant, and students felt that they did not have to use all of them. Weeding redundant information was one strategy for selecting only the information they needed. Students knew they needed information on each aspect of the main ideas they would present for their speeches. As S17 clearly described, "I don't need all of one specific thing. I need some on violence, some on academics, some on self-esteem. I can't have everything on self-esteem, so I just looked through. Also, I didn't want a bunch of things that were very repetitive. I need things that are going to be sufficient to prove the point. But I don't want to be saying the same thing over and over."

Another strategy was to weed the documents that did not match the perspective or focus that students had shaped until that stage. When students were gathering information, they gathered documents containing general information as well as those with specific information on their topics. As they moved along, they became more focused about what direction to pursue and thus did not feel the need to keep all the documents gathered. Therefore, students weeded the documents that were general or

that had foci different from their main ideas. Examples of weeding the general documents include S19 saying, "Some of the information in the beginning was more general. So I didn't end up using a lot of it. When I started to focus on teaching phonics, that's interesting and helped me understand a little. But it wasn't specific enough for my speech on reading to high schoolers."

Students had several strategies for weeding the documents that did not match their foci. S19 described her approach:

> I guess I started looking up reading. I found there was one debate on how to teach between whole language and by phonics. There is a debate on how important it is for parents to read to their children, which is something that doesn't affect our class because we don't have any kids. Things like that. Different reasons why reading is important. Reading to preschoolers was important to what I am saying -- that reading is important -- but I had to tailor to my audience, which is teenagers.

Students also weeded according to the priority or perceived importance of the information, even if the information itself was relevant and on focus: "There ended up being a lot of information that I didn't use in my speech because the speech could only be seven minutes long. So a lot of the stuff that I have on the history of marijuana I had to take out because it's just way too much detailed information" (S14).

5.2.2. Selecting reliable sources

Reliability of sources was considered the most significant criterion that students used because it was emphasized and echoed a number of times throughout the process and because, as the teacher had indicated in the beginning, one of the purposes of giving

this assignment was to introduce good and reliable sources to students as research tools. The library media specialist strongly advocated that the first criterion students should apply was whether the information was reliable and unbiased.

When a student said he or she had "useful" information, it seemed to indicate that the student had good and reputable sources: "I think that most of what I found is useful. Most of what I found came from good sources. There were a few things that I found that came out of a couple magazines with maybe not the best reputation itself. Not so much as being a bad magazine but not necessarily [scholarly]."

The criteria that students used for judging reliability were primarily the credentials of the organizations that provided the information and of the authors of the pieces; the information itself was secondary. Students thought that their arguments would be more persuasive if the information were from reliable sources. They seemed to consider information from the government as the most reputable. S4 described his thinking as follows: "I pulled out some of the major things. Like facts that would get my point across more clearly. Like, if it was a choice between using something from the government or a [general] background [information] in economy [written by someone I don't know]; I'll trust the government more and use that ... because it would make more of a point to the audience."

Students believed information can be false if it does not come from reliable sources. S5 examined information to see if it was factual and accurate and whether the author had credibility in the field. Students considered the authors' degrees in the field important indicators of credibility. As S5 described:

> I had to pick out different stuff like actual credible sources and stuff, and make sure it wasn't just some food critic, make sure that what they were saying was like, relevant in that and it was .... factual and I could see how it could be true and going through that. And look at the references from the sources and ... [references?] like what the people's status is. Like for one of them the source was a dietician; I looked at what kind of degree and where she got her degree.

5.2.3. Selecting information that is topically and functionally relevant

The concept of "relevance" had different meanings to different students. One major meaning was whether the information was directly related to their topics. For students, the meaning of direct relevance was whether the information was supportive of their views about their topics. Students often wanted to select only the information that supported their views. For example, S14 stated, "Anything I got that was pro-marijuana legislation was good and, um, only things that were anti-marijuana were bad."

The library media specialist observed this tendency that students often do not want to see beyond one side of an issue and thus tend to divide information into black and white:

> If they're the negative on an issue, they don't see any benefit in reading the positive. Even though an article that's dealing with the positives often times will mention the negatives ... Their experience is limited in dealing with these issues. ... It's the age. But I think it's very difficult for them to, um, really go into depth with an issue because they haven't really thought that deeply or haven't had that experience with it. Also this is an age that they make judgments very, very quickly. Everything is black and white, and ... that also limits their research.

Some students also went to book sources for their information and used the index in the back of a book or its table of contents to identify the relevant chapters for

their topics. S8 said she looks for the table of contents and reads only the relevant chapters; S2 mentioned he looks for the index and finds the pages dealing with the relevant aspects of the topic.

When students extracted information from documents, another important criterion for judging its "relevance" was its functionality – that is, whether the information matched the kinds of information they had been told to use for their speeches: facts, statistics, examples, and experts' opinions. With the documents in hand, students seemed to look for specific information that could be used for their speeches. At this point, they were trying to find specific information to support their arguments more strongly. S5, who was looking for hard data mentioned, "I look for percentages. I look for, like, accidents caused by that ... I look for the numbers for people using cell phones and I look for risks like increased risks ... or I look for specific examples of accidents." S8 mentioned that "I just look at the actual document or look in the books and stuff. I look through the actual definitive evidence for certain facts." Students particularly looked for the things that would make their arguments strong. Examples include S16, who could not give up an idea that she got from an unreliable source because, she believed, it would make her argument strong. Therefore, she searched for the same idea in a reliable source and found it.

5.2.4. Selecting unique information

Selecting "unique" information from the documents was considered important. Students generally tried to dig into the information they had to find information they had not found elsewhere. For students, unique information should be "impressive" or

"unexpected" information to their peers. S5 mentioned that she was trying to find some unique information from a particular document: "A lot of them were saying the same things. But, there's probably something [unique] in every one of the articles."

These students were teenagers who wanted to look good in front of their peers, and they made a great effort to find unique information that would persuade their peers. Some students even wanted their topics unique from others because they believed a unique topic would make them look different from others. S14, who was struggling to have a unique topic in the beginning, continued to make an effort to have unique information. He mentioned, "things that people don't know, or things that people would think is one way but it's really another. Like, I found that the U.S. government Bureau of Statistics ... Mortality statistics said that no one has ever died because of smoking marijuana. That's a pretty good fact, so I knew that would be one of the key ones I'd need in my speech."

5.2.5. Skimming and reading

Students had to be knowledgeable to weed irrelevant documents and to extract useful information from the documents they gathered. Students would use a strategy that the researcher identified as "skim and read." While skimming, students went through the whole document quickly to see if anything was closely related and/or usable for a speech. Students would actually read portions of it as they selected information. They first tried to understand what the document was about in general and then tried to find the specific kinds of information that were expected for the assignment. S8 said that she "look[ed] through the actual definitive evidence of certain factors. [I read

through every article] unless it's really really long. And then I skim through it but, just like looking for real hard evidence and then, like, taking, like, quotes from people if there are people quoted."

Students indicated that they did not spend much time in reading, however. S16 mentioned that "I don't have a lot of time, so I need quick information. And, you know, the stuff that will help me right away." Students selected information by reading only the parts of the documents they thought might be helpful. Students' "skimming and reading" behavior when selecting information reflected their search behavior and their understandings of the easiness of finding information. Students knew that there is a great amount of information available and that they could find the needed information easily if they wanted to do so. S16 indicated, "The volume of information is so great you could pick out the things for your case and use it." This approach also explains students' tendency to make "quick" decisions during information gathering to find, email, and print information quickly without carefully examining it.

5.2.6. Highlighting

Students' preference to email and/or print out the documents enabled other related activities during information seeking and use. As S5 said, "You can just print it out rather than photocopy ... or just taking notes. You can highlight instead of taking notes, for example. And I think it saves you a lot of time." Highlighting was considered an efficient way to select information from the documents.

For some students, highlighting was one of the major strategies for extracting information from documents. These students highlighted the portions of each document

they wanted to examine more carefully. Often, they came back and examined only those portions. As S5 noted, "After I print out all the documents, [I] take out my highlighter and I go through all the important stuff I want to use." Other students used highlighting as one way in addition to other methods. S17 commented, "Lots of times, highlighting, scribbling, jotting down notes on just the documents themselves."

Some students, however, did not find highlighting to be a useful strategy. S4 said that he could not decide which portions were important to highlight: "I did [highlighting] last year, but, when I highlight it, I end up highlighting everything. So it's not really a useful tool for me."

5.2.7. Making note cards

Making note cards for evidence for their arguments was one of the required elements of the assignment. Before they came to the stage of writing their evidence on note cards, however, they had already extracted the specific information from the documents by "highlighting, underlining, scribbling, or jotting down" the information. Students selected from the portions that they had previously extracted to write on their cards. S2 mentioned that, after he selected specific sentences from the documents that he thought applied to his argument, he "took all the necessary steps like making a bibliography and all that stuff, writing note cards."

Many students made the cards just to fulfill the assignment requirement. they did not use note cards to extract and record their information for their speeches because the teacher permitted students to use any information, not only information on their topics, in making their note cards. S5 commented:

> I only use cards when I have to. [Be]cause cards, for me, like, they just get everywhere, and then [when] I am looking, [I'm thinking] 'God where did I put that card?' That's hard for me .... I am not the most organized person. If you are not an organized person, note cards aren't going to help you, [be]cause they end up being everywhere.

5.3. Organizing information

Clearly, students started to integrate information into their knowledge bases as soon as they began the process of information seeking. However, information and students' ideas came particularly close when they brought the selected information together for organizing. Extracting needed information and putting it on note cards allowed students to move forward to the next step: organizing information.

Two primary strategies common to all students in organizing were categorizing and outlining. Some students indicated that they first organized the information and then tried to think about the specific order of how their ideas and the supporting information would be presented; other students indicated that they tried to perform both activities at the same time. In either case, it is hard to separate the two processes because it was obvious that students already had their ideas in general when they began to organize their information into conceptual categories. That is, the categories generated represented the ideas that had emerged. Outlining, which was required by the assignment, was used as a structural method to integrate the organized information with their ideas.

5.3.1. Categorizing

Organizing activity was perceived by students as more cognitively demanding than gathering and selecting information. As S14 noted:

> Organizing was the real hard part, because that's where the thinking comes in. That's probably what took the longest, too. I remember up in my room where I've got the computer and everything. I had papers everywhere. And like I had an organization method in my mind; but if you look in the room you couldn't tell because there were just papers laying everywhere. But basically I did it into categories, like here - how I had the categories for my chart [concept map] - so I basically put it in those three categories.

Students categorized information according to their general ideas of how they would present their arguments. Students had their organizational structures in mind - although they were not complete and detailed - before they began to organize the information. Those structures were imposed by the concepts represented in their maps and by the outline format. S5 indicated, "I was thinking about it and how I want to do my speech. I wanted to narrow it down into three main categories." S17 described his process as, "I kind of lay everything out and kind of categorize things as far as this has to do with these subtopics and maybe make piles. And by that time I usually would have planned out where I want my speech to go, where I want this specific thing. Say I want to start out with violence then I'll pick up the pile, look through, and try and put that in order." Students used their ideas as a preconceived organizational structure rather than categorizing the information on its own merits without their ideas in mind.

Using note cards to write selected information and citations affected students' organizing activities. Students using note cards indicated that organizing information

began with organizing note cards. S16 indicated that she used note cards for categorizing information:

> From there [main ideas on cards] you can group them together. Well, this is a bunch of cards about people of legal cases on [trials] about the Pledge. That, kind of, goes under "people's rights" or something about that. And ... this is a bunch of cards about how teachers may feel. And that would go with "adults and citizens"... at the top of the card, you would have a general idea for each one.

One strategy for organizing information was to group the note cards according to the categories identified in their concept maps as main concepts. Having their final maps done before they worked on their organization of information allowed students to use the maps as conceptual guides. S4 said, "By the concept map is how I really organized which of the information fits into 'safety'; there should be some 'fares,' 'economy,' 'employment.' Or do I need to make another one [concept category] that I can fit a group into?"

Students' organizing activities were closely related to their particular use of information – creation of the outlines for their final speeches. Some students pointed out that they also needed to think ahead about their outlines for their speeches to decide how they would go about organizing information. Students used a certain approach, such as problem and solution or pros and cons, to conceptualize their speeches to persuade others more effectively. S19 said, "I kind of went through, and I had to think of the pattern of my speech. So I decided to go for the problem - solution thing. And then I kind of organized it that way."

5.3.2. Outlining

Outlining was the final step students used to prepare for their speeches and proved to be another way to organize information. As S19 reported, "I organized it by doing the outline itself." Students used the outline template (see figure 2, p. 65) as a way to put together their ideas with information they'd found. Basically they inserted their ideas and specific information extracted into the outline. Not surprisingly, students' processes of outlining were very similar. S4 described, "I take my major assertions first and then provide the major reason behind that. Which I think on this concept map would be the ones that directly branch off from the main topic. And then I would use the different information that I collected. I would take bits and portions and put them in where I think they would fit best."

Students' derived three common benefits from outlining: (1) it helped them organize information according to their own ideas, (2) it helped them break their main thoughts into more concrete and narrow ideas, and (3) it provided an overall organizational structure into which they could insert their information. Thus, outlining enabled students to bring all the information and their own ideas together into a coherent structure.

Students' idea of outlining was inserting and matching each of the required categories with a specific piece of information. As S19 indicated, "I made sure that I had something for each item, and I think that would be sufficient." The outline template also listed and named specific things to be included in a designated order, so it allowed students to see the holes when they did not have the information.

It was obvious that the outline template lessened students' cognitive load in organizing their information for their speeches: students did not have to create their own structures for presentation with the given outline template. Even with the template, however, students still thought organizing information is an intellectually challenging task. This finding is consistent with Neuman (2001, 2002), who argued that "structuring" is the most important skill that students need to master in order to learn with information.

5.3.3. Reviewing and changing

Students were aware of the need for logic and coherence in their outlines as they worked on them. They tried to make sure their ideas and information flowed naturally and included all the necessary components listed in the outline template. Because they had to give their speeches in front of the whole class, this "natural flow" seemed to be crucial. S19 said, "Basically, I am trying to state my ideas and kind of the quotes of what I found or support. I don't want to sound too awkward, though. Like 'So and so said this.' It should be prettier than that. You know, basically an idea and support and an idea and support, maybe support and an idea."

Students found and filled conceptual holes while they reviewed their outlines. S16 pointed out the importance of reviewing the outline to make it more meaningful and understandable: "I kind of go through an outline twice. The first time, it might not be so organized. But the second time around, you can put your ideas into more ... you can see what's wrong with it and put them into better order. It usually takes two times to organize." S19 concurred, "My outline kind of had a few holes in it. So I had to go back

and find some more information." S17 also indicated that "I did my outlines and filled holes afterwards. Then I concluded my outlines."

5.4. Summary and conclusions

This chapter addressed the study's findings for foreshadowing question three in terms of how students gathered, selected, and organized information. The original SOI model by Mayer, modified according to the context of information seeking and use, served as the conceptual framework. The modified model include five processes - gathering, selecting, organizing, integrating, and using - as critical in the process of information seeking and use. Integrating actually occurs as an underlying process of gathering, selecting, and organizing; using, which also occurs throughout the process, is defined in this study as the creation of the final information-based product. The processes identified, however, are not linear and often circle around in both large and small cycles -- at least, in terms of observable strategies and activities.

Findings suggest that students started their searches generally, anticipating that they would get some ideas from the results returned by using broad vocabulary as search terms. Students' search terms remained broad and general throughout their information gathering. It was particularly interesting that they thought they could find specific aspects of the topic and related aspects of the topic with the same broad search terms. This finding suggests that students did not plan their searches in analytical ways but planned to be "interactive," using the results returned to browse more thoroughly.

When a search did not yield results that were satisfying, students tried one of two strategies: trying different vocabulary or switching to another search option. When

they tried different vocabulary, they simply picked up the terms they saw in the titles among the results returned. Because they had to think for themselves and because their ideas were still vague and preliminary, the number of terms was limited. Students would have appreciated sources that present related subject categories to further their searches. For example, a couple of students praised one Internet site, *Ask Jeeves*, on which entering one search question yielded many related search questions that students could select. They said it was very helpful to have the list of related search questions because it diminished their need to make up search terms or search questions.

Students often had to negotiate their search vocabulary regarding their topics when they used the print sources. Unlike the electronic databases they used, which are searchable based on words appearing in the documents, the print sources had indexes that often did not reflect students' vocabulary. In some cases, the print sources did not have up-to-date information on current issues related to students' topics.

Students gathered general information about their topics first and specific information later. General information gathered in the beginning helped students understand the topics, whereas specific information was used more directly for their assignments. If they had clear enough ideas about their arguments to gather more specific information, they narrowed their searches by adding more terms. Students also used narrower search terms that they gleaned from the results.

The students' activities for gathering included (1) browsing and scanning the headlines and titles to see what was available on the topic; (2) following the links presented in a document, which often led to Internet sites; and (3) emailing and/or printing the documents they thought to be relevant. Emailing and/or printing were

particularly popular strategies among students, since they did not have enough time to read the documents in the library media center. Students found emailing and printing to be necessary for them to go back to helpful information.

Emailing and printing documents without thoroughly examining them led students to weed some of them according to the foci for speeches. Conceptual and language difficulties in reading and different foci/perspectives were the reasons for weeding a number of documents. When they extracted information from the documents, students looked for the reliability of the source, topical and functional relevance as required by the assignment, an easy reading level, and uniqueness in content.

Students weeded the documents containing redundant information. They often weeded documents that used difficult language (i.e., that were not written for the general public) on the grounds that they themselves could not understand them and their peers would not understand them either. Students also weeded documents that focused on aspects of the topic which were no longer relevant to the focus of their speeches.

The teacher and library media specialist had repeatedly emphasized the importance of reliability of sources for this assignment, and this reliability was the foremost criterion that students used in gathering information. Students understood reliability in terms of the qualifications of authors' and the reputations of sponsoring organizations, and they applied this criterion consistently. They looked for more reliable sources to confirm information they had encountered in "lesser" sources. When they found the same information in different sources, they went for the more reliable source in terms of the qualifications of its organization and authors.

Students knew that the information they gathered should be relevant to their general topics and specific foci. They seemed to see the issues as black and white, and they often rejected documents that supported the side of the issue other than their own. If they supported the "pros" of the issue, they often refused to consider documents that presented "cons"; if they selected such documents, they ignored information that did not support their own ideas. Students were also aware of another kind of relevance, functional relevance, that came from the assignment description, which specified the kinds of information - facts, examples, experts' opinions, and statistics - to be included in their speeches. Students looked specifically for such information and extracted it from the documents whenever possible. They also looked for "unique" information because they believed that unique information critical to their viewpoints could make their arguments much stronger.

Students' observable activities included skimming and reading documents, highlighting portions of the documents, and making note cards with information extracted from the documents. While skimming and reading the documents were necessary to extract needed information from documents, students did not spend much time reading individual documents because they thought they could find the information in other documents or because they needed information quickly. Highlighting was also a popular strategy to extract information among some students because it saved them the extra effort of writing the information. Making note cards, one of the requirements of the assignment, enabled students to write the extracted information and its citations on the cards.

Categorizing the information collected was one strategy used for organizing information. Students categorized the information according to their ideas of how they would present their speeches. Often, concepts represented in students' final concept maps were used for the category labels. Another strategy was outlining, which was required by the assignment. Students indicated that outlining enabled them to integrate information with their own ideas as they organized. Outlining was a useful tool for students because it allowed them to match their ideas with information and because it showed holes in the information or ideas when a specific line was empty. Although integrating began to occur as students began to gather information and tried to make sense of the information encountered, organizing and integrating culminated in the outline stage: the selected information and students' ideas converged when the outlines helped students achieve a more specific focus.

This chapter focused primarily on the specific strategies and activities that emerged as students gathered, selected, organized, and integrated information. The next chapter will examine how students used information – that is, how they moved forward conceptually by bringing their ideas and information together for learning.

Chapter 6: Information Use and Learning

This chapter describes students' learning as they used information to produce their final products. While the previous chapter described how students gathered, selected, and organized information, this chapter focuses on how they used it at various stages – that is, on the patterns of change reflected in students' growing understanding of their topics and on how information played a role in those changes and thus in students' learning. The final set of foreshadowing questions is the framework for reporting the findings for this chapter (see table 14).

<Table 14: Findings and Foreshadowing Questions for Chapter 6>

Foreshadowing Questions	Findings for Chapter 6		
	Change Patterns	Learning Experience	Levels of Learning and Information Use
4. How is students' information use reflected in final products related to learning tasks?			
4a.How is students' initial understanding of the topic changed or expanded?	X	X	X
4b. How is students' understanding of information represented in their products?	X		

How students learned about their topics was examined in terms of the changes they made in describing these topics. The changes were grouped into patterns identified through analyses of students' interviews and documents - including their initial concept maps, initial paragraphs, final concept maps, final paragraphs, and final outlines. Students' documents were analyzed by hand, and interview data were used to corroborate the patterns that emerged from the documents. These individual patterns

were compared to confirm general patterns. Four main patterns of change were identified: simple, analytic, organizational, and holistic. Table 15 shows these patterns.

Students' learning experiences as they engaged in the processes of information seeking and use were characterized as data-driven and goal-driven. Data-driven learning occurred more frequently in the beginning of the processes, whereas goal-driven learning occurred more often as students moved along.

A framework borrowed from the six levels of learning of Bloom's taxonomy (Anderson and Krathwohl, 2001) is used to represent how students understood information as reflected in their processes of information seeking and use. Because the taxonomy identifies the kinds of cognitive processes required to attain the learning outcomes, it is a useful tool for analyzing students' learning with information.

<Table 15: Change Patterns of Students' Concepts and Ideas>

Types of changes	Changes in more detail
Simple change (489)	Adding concepts (186) Dropping concepts (160) Adding evidence (133) Changing evidence (4) Dropping evidence (5)
Analytic change (34)	Broadening concepts (9) Narrowing concepts(18) Combining concepts (7)
Organizational change (27)	Creating higher concept categories to group existing concepts (17) Putting concepts in different locations (10)
Holistic change (6* of 57 documents)	Shifting focus (2*) Broadening focus (1*) Narrowing focus (3*)

Notes: 1. The number in parentheses indicates the number of instances.
2. * indicates the number of documents by students, not the instances relating to changes in individual concepts.
3. For holistic change, 57 documents from 19 students – 19 initial paragraphs, 19 final paragraphs, and 19 outlines – were analyzed (see chapter 3, p. 86).

6.1. Patterns of change in students' concepts and ideas

If a change across the documents students produced involved (1) the simple addition or removal of a concept or (2) the addition, removal, or replacement of an example, it was labeled a "simple change." If a change made the concept cognitively different in terms of its conceptual level or meaning, it was named an "analytic change." Students also made "organizational changes" that affected the overall arrangement of the structures of their ideas. Those instances included (1) inserting conceptually higher concepts to organize existing concepts hierarchically or (2) placing concepts into different categories. Lastly, any change that affected the status of a whole argument was indicated as a "holistic change." Instances of this type of change include (1) shifting the entire focus during the course of information seeking and use, (2) narrowing the focus to a particular aspect of a topic, and (3) broadening the focus to a more general view of the topic.

These four patterns of change can be linked with Ausubel's four types of learning. Simple change corresponds to subsuming concepts. When new concepts are readily subsumed in one's knowledge structure, only slight modification occurs during the interactive process of subsuming concepts. In this study, the instances of this kind of modification are addition or removal of concepts and/or addition, removal, or changing of evidence. Analytical change can be linked with progressive differentiation and integrative reconciliation. When new concepts modify old concepts, qualitative changes - differentiation with more specific concepts (progressive differentiation) and reconciling new and old concepts (integrative reconciliation) - occur. The instances of these changes are broadening, narrowing, and combining concepts. Organizational

change corresponds to superordinate learning. When learners develop a different way of organizing existing concepts, they make new meanings by reorganizing. Here, the instances of reorganization include creating higher concept categories to group existing concepts and putting concepts in different locations. Holistic change does not seem to fit readily within these four types of learning. However, progressive differentiation and integrative reconciliation with some changes in personal interests seem to result in holistic change.

Changes in students' knowledge differed in type and number depending on when documents were produced. Simple change was the dominant type throughout the process, regardless of documents, as Table 16 and 17 below show. Changes from initial to final maps and from final maps to outlines were slightly different: more analytic and holistic changes occurred in the beginning, and more simple and organizational changes took place later.

<Table 16: Number and Percentage of Occurrences of Three Types of Changes>

Type of change	Initial to Final Map	Final Map to Outline	Total # of Occurrence
Simple	199 (85%)	290 (92%)	488 (89%)
Analytic	28 (12%)	6 (2%)	34 (6%)
Organizational	7 (3%)	20 (6%)	27 (5%)
Total # of analyzed concepts	234 (100%)	316 (100%)	550(100%)

<Table 17: Number of Occurrences of Holistic Change>

Type of change	Initial to Final Map	Final Map to Outline	Total # of Occurrence
Holistic	5*	1*	6*

Note: The number indicates the number of instances from 57 documents analyzed.

The findings that more analytic and holistic changes occur in the early stages of information seeking corroborates Kuhlthau's (1991, 1993) findings that students formulate their foci in the beginning of their information seeking and use, during the "exploration" stage. The occurrence of more organizational changes in the later stages was inevitable as students polished their final products for the assignment.

All these patterns were dynamically related to one another because instances of change did not often occur alone. However, each pattern in each category is analyzed and described separately for the purposes of this research.

6.1.1. Simple change

Simple change was the predominant type of change as students moved through the process of information seeking and use. Instances of simple change accounted for 89 percent of all conceptual changes (see table 16, p. 155). Todd (1999) also reported that adolescent girls predominantly changed their knowledge structures by "appending and inserting new ideas and deleting ideas" in existing knowledge structures, thus "providing more specific layers in the hierarchy of ideas" (p. 21). When students encountered new ideas regarding their topics, they added new concepts to reflect the new information. However, if they could not find the information that they thought they would find, they removed the concepts. Their efforts to seek more convincing evidence for concepts resulted in additions and changes of evidence as they sought and found the specific types of information required for their assignments.

6.1.1.1. Adding concepts

As students learned more about the different aspects of their topics, they added concepts that appeared in their final concept maps and outlines. Some clear examples of adding concepts are shown in Table 18.

<Table 18: Examples of Adding Concepts and Ideas>

Students and Topics	Added Concepts from Initial Map to Final Map	Added Concepts from Final Map to Outline
S2 Endangered animals	- laws and ways of protection -- by endangered species act of1973 --by federal and state agencies	--- people protect the act because of its importance --- problems still remained ---- high expenses to save some species ---- small animals not supported --- extinction of animals --- efficiency of preventing animals from being listed as endangered
S4 Building more runways	- it increases safety -- of older planes -- of passengers - it influences fare -- decreases with competition	- airports and airlines do not keep up with demand - safety compromised for profits - growing population with new airports - pollution not a problem
S16 Pledge in public schools	- requiring the Pledge is not appropriate	- the Pledge establishes religion by forcing people to make a public confession of faith in God - the Pledge creates ignorant pride - a mentality of superiority to others is un-American -brainwashing tactics have noxious effects - "God-with-us" Manifest Destiny concept has devastated millions
S17 School uniforms	None	- school uniforms have social value -- uniforms hide socioeconomic differences -- uniforms provide an avenue to take pride in their school - school uniforms have economic value -- school uniforms are already used as a tool to stop violence -- schools take advantage of uniforms -- there is less need to fight
S19 The importance of reading	- reading is not done enough by teenagers - skills achieved by reading alone - skills achieved by reading aloud - to raise reading scores - replaced by other entertainment	- teenagers claim to be too busy to read - reading can be boring and difficult - teenagers need to improve reading skills - reading more improves the problem --more leisure time needs to be spent for reading pleasure --reading aloud is a wonderful way to read

Note: Single dash (-) indicates the highest level of concepts (ideas), and double, triple, and quadruple dashes indicate the subordinate concepts under the higher concepts.

For example, S2 (*Endangered animals*) created his final map based mostly on his own knowledge, except for one category labeled "laws and ways of protection." He created this category because he came across the concept by reading a document. He mentioned that he had already known about other concept categories that appeared in his final map but that he "did not know they had this." Both subconcepts linked under the concept of "laws and ways of protection" --"endangered species act of 1973" and "federal and state agencies" -- were new concepts discovered from his reading. He continued to add more concepts for his final outline --"extinction of animals" and "efficiency of preventing animals from being listed as endangered" -- and linked more subconcepts and examples to these concepts. He picked up these concepts from the documents gathered while he was integrating his ideas and information through the process of completing his outline. He obviously added them to fill the conceptual holes.

S4 (*Building more runways*) also added two new concept categories and new subconcepts to expand upon them: a "safety" concept category and "old planes" and "passengers" as subconcepts. He encountered these concepts when he was reading an article describing the close distance between two airplanes during a landing. He commented, "If you build more runways, that means you're going to have to space it out more so there's less of a chance of planes colliding and so it makes the passengers feel safer on that." He also added a concept category labeled "fare," with "competition" as a subconcept.

For his outline, he used the concepts listed in his final map and added several more to describe the existing concepts in more detail. He tried to explain the problems

of current airports and airplanes with two additional new concepts: "airports and airlines do not keep up with demand" and "safety is compromised for profits."

An example of adding concepts as a result of reading about other concepts came from S16 (*Pledge in public schools*). One of her new concepts, "appropriateness," was drawn from "adults/citizens," which she had broadened from "parents" in her initial map when she began to question whether requiring the Pledge is "appropriate." Thus, she explained that "appropriateness" was derived conceptually from "adults/citizens." She also added more concepts between drawing her final map and making her final outline.

Both maps that S17 created represented the same main concepts about his topic, *school uniforms*. His outline was much more detailed and included more ideas under those main concepts. He also added another main concept for his final outline – the "economic value" of uniforms. He had not specifically sought information regarding that concept but found it in the articles he gathered. He expressed in his interviews that proving his argument was much easier with numbers and that the "economic value" of school uniforms can be explained easily with numbers.

S19 (*The importance of reading*) learned and added many new concepts from her information seeking, all of which were more concrete than the concepts in her initial maps. Among the new concepts added to her final map and final outline were "reading scores," "other entertainment," "reading aloud," and "reading alone" -- all found during information seeking. An additional concept related to her topic also emerged from her information seeking: the perception of reading as "boring and difficult for teenagers."

6.1.1.2. Dropping concepts

When students drew their initial maps, they brainstormed and listed the concepts they thought they would find in information seeking. As their work progressed, they dropped some concepts while retaining others. Dropping concepts occurred in three kinds of cases. Most commonly, students dropped concepts listed in their initial maps for final maps or outlines because they could not find relevant information. Another common case involved students' dropping a majority of concepts to focus on a few specific concepts. Lastly, students dropped concepts simply because of the time constraint on their speeches. Table 19 lists some examples that are relatively clear.

<Table 19: Examples of Dropping Concepts and Ideas>

Students and Topics	Dropped Concepts from Initial Map to Final Map	Dropped Concepts from Final Map to Outline
S4 Building more runways	- it increases noise pollution - it decreases property values	- it creates jobs such as pilots - it creates jobs such as ATC's
S9 Delaying school starting time	- it will result in better attendance rate - kids are alert for the first period - it will cause funding issues	- it decreases transportation
S11 Is 16 too young to drive?	- it depends on experience	- license enables going to college -- students need to [go to] work to pay for school [college]
S17 School uniforms	None	- it improves self-esteem - it improves academics
S18 The importance of reading	- reading should be encouraged by parents - reading is a characteristic of discipline -reading is a characteristic of mental growth - reading is a characteristic of valuable entertainment - reading requires cognitive skills - reading requires interest in learning	- reading can be done alone

Note: Single dash (-) indicates the highest level of concepts (ideas), and double dashes indicate the subordinate concepts under the higher concepts.

S4 (*Building more runways*) described why he dropped some concepts from his initial map as follows: "Actually, from the research that I got, what I found was that it showed more in certain areas than in others. So, like on my old map, I couldn't find some of the stuff that I thought would be easy to find, so I just took that out." Interestingly, he dropped the concept of "noise pollution" for his final map but inserted it again for his outline. There, he tried to show that "noise pollution is not a problem" because the "FAA limits noise caused by airplanes and some airports by putting on additional restrictions." The documents produced by S11 also showed that she dropped one category of concepts in her final map because she found more plentiful information for other areas. For example, she dropped "college" and its subconcepts for her topic, "Is 16 too young to drive?"

Students dropped concepts when they felt that they would not have enough time to cover all the concepts they had generated. This happened either at the time of organizing information or at the last minute, when they made the final outline or prepared to give their speeches within a time limit. At these times, the concepts dropped were considered not critical to persuading the audience. But, as one student indicated, "That kind of hurt me because, after I did all the research, I didn't want to just take it out because I put all that hard work into it and now it won't even show. But I had to because it would penalize me instead of helping." S9 (*Delaying school starting time*) provided another example of this situation. On her initial map, she had included "funding" and "transportation" to address her topic. Because she did not have enough time to cover all the information, however, she focused on "teachers," "students," and "sleep patterns" because these are more direct and concrete.

S17 (*School uniforms*) dropped two of the three main concepts listed on his final map, "self-esteem" and "academics." After drawing his final map, he explained that it was hard to prove the relationships between these concepts and *school uniforms* because the concepts were abstract and because it was hard to think of any measures to prove the relationships with numbers and statistics. Other instances of dropping concepts because of difficulties in finding evidence occurred when students used concepts that were too specific, such as "property value." S4 (*Building more runways*) dropped this original idea because, as he said, it would be difficult for him to dig up all the statistics regarding "property values" and to compare them before and after building runways.

S18 (*The importance of reading*) dropped many of the concepts from her initial map for both her final map and her final outline. These included "discipline," "mental growth," "valuable entertainment," "parents," "cognitive skills," and "interest in learning." Compared with the concepts in her final map and outline, these concepts were more abstract and broad and could not be supported by specific, concrete evidence. As she explained, "I think the ones that I found support for made it over here [in the final concept map], but I don't think I went specifically to research with these things [concepts in initial concept map] because this was more like brainstorming. I was just thinking what I was hoping to find. And some of them I found and some I didn't."

6.1.1.3. Adding evidence

"Evidence" refers to examples and other kinds of specific information directly extracted during information seeking and use that students used to support their arguments. Facts, examples, statistics, and experts' opinions were all used as evidence.

Evidence came from specific sources, and students had to mention these sources in their outlines and bibliographies.

Students tried to find and add convincing evidence as they looked for information (see table 20). But in their initial and final maps they concentrated on representing their conceptual understandings of topics rather than on showing specific evidence. Instead, they added more detailed evidence for their outlines. Among the interviewed students, only two had final maps that were detailed enough to include some evidence they had found.

As he moved from his final map to his outline, S2 (*Endangered animals*) added a rather unique example of endangered animals, "Galapogos tortoise," and an example to show how habitat was being destroyed in "South America." He added these concepts because he thought that it was important to let students know the "real situation" related to his issue. He also added examples of how teenagers could help these animals: "write letters to lawmakers, newspaper editors" and "ask your teacher if your class can become a Kids in Nature Defense Club."

Students added evidence when they thought the evidence was either crucial or required. S5 (*Cell-phone use while driving*) added two examples of actual victims of accidents caused by cell-phone-using drivers, which she found serendipitously by following the links in articles she had retrieved. She also added actual figures showing how big the cell-phone industry is today, how many people use cell phones while driving, and the number of people dying in cell-phone-related accidents every year. She considered all these pieces of crucial evidence.

<Table 20: Examples of Adding Evidence>

Students and Topics	Added Evidence from Initial Map to Final Map	Added Evidence from Final Map to Outline
S2 Endangered animals	None	- "The habitat of South America is getting destroyed and the concern is that these tropical forests have a greater biodiversity" - "Pollution from agricultural chemicals and industrial wastes can contaminate the air and water, causing harm to may animals ..." - "11,046 of the 18,276 organisms investigated are on the verge of extinction" -"1/3 of all US plants and animals are at risk of extinction" -"The Galapogos tortoise is one of the most endangered animals on earth" - "Ask your teacher if your class can become a Kids in Nature Defense Club"
S5 Cell phone use while driving	- Michael Roberts - Morgan Lee Pena	- "Pushing small buttons requires a lot of concentration" - "A demanding conversation makes it difficult to concentrate on driving" - "Drivers on phones change lanes more often and check mirrors less often ..." - "A driver talking is as dangerous as a drunk driver" - "approximately 10,000 deaths each year from accidents involving a distracted driver." - "of those 10,000, 450 deaths are attributed to cell phone use"
S16 Pledge in public schools	None	- "In DC and surrounding areas, 75,000 students in public schools are immigrants or children of immigrants, including noncitizens and refugees" - "A big problem in public schools is its failure to appreciate the values of deeply religious people who have no choice but to attend public schools" - "Foes of the Barry bill who argued that patriotism is learned through life experience not by the recitation of 31 well known words"

<Table 20 Continues: Examples of Adding Evidence>		
Students and Topics	Added Evidence from Initial Map to Final Map	Added Evidence from Final Map to Outline
S17 School uniforms	None	- "Uniforms are cheaper. A full school uniform may cost $30-$50, whereas a Ralph Lauren outfit and Nike sneakers can cost hundreds" - "The nationwide trend of requiring school uniforms in hopes ... boosting grades has won its first big-city public school district –Philadelphia's" - "Long Beach school district reports a 32% decrease in students suspended from elementary and middle schools the first year after uniforms were introduced" - Long Beach school district also reports a 51% decrease in fighting ..."

S16 (*Pledge in public schools*) searched specifically for evidence she considered crucial to her argument against requiring the Pledge of Allegiance in public schools: the percentage of students in public schools in a region "who are immigrants including noncitizens and refugees." If the percentage was large, she reasoned, her point would be more significant. She discovered the importance of the concept itself as she searched, and she knew that the next step was to find the numbers: "One of the things that I have to figure out is what percentages of the students are not citizens." In the end, she found the number and included it in her outline.

S17 (*School uniforms*) tried to make his point in his outline by providing an example of a situation in which adopting school uniforms had proven successful: "Philadelphia School District." He added actual numbers in describing how crime rates and suspension have gone down in one school district in California after it had adopted school uniforms.

6.1.1.4. Changing evidence

Most students' initial and final maps were not detailed enough to allow a comparison of the evidence there with the evidence in their outlines. Only one student who thought she found better examples substituted newly found examples for her initial ones (see table 21). The new evidence was more unique or concrete than the original ideas.

<Table 21: Examples of Changing Evidence>

Students and Topics	Original Concepts in Initial Map	Evidence in Final Map	Changed Evidence in Outline
S3 The benefits of Arts	- dance - theater - music - painting - sculpture - architecture	- Mt. Rushmore - Lincoln Memorial - Picasso's Guernica - Statue of Liberty - The Iwo Jima Memorial	- Statue of Elizabeth Thorn - A bronze statue of a war dog and its handler - The Korean Veterans' War Memorial

S3 (*The benefits of Arts*) used different examples in her outline than she had used in her final map. In the map, she had written "Mt. Rushmore" and "Lincoln Memorial" for examples of "memory of important people." In her outline, however, she used the "statue of Elizabeth Thorn" from the Battle of Gettysburg and the "current effort to have a bronze statue of a war dog and its handler" erected at the Vietnam War Memorial. The student's examples in her final map were more popular and better known to people than her examples in her outline. She also changed her example for "memory of important events" from "Picasso's Guernica" to "The Korean Veterans' War Memorial," which many of the students might have visited.

6.1.1.5. Dropping evidence

Dropping evidence occurred in two different situations: dropping evidence related to dropping connected concepts and dropping individual pieces of evidence. When a concept was removed, its supporting evidence was also removed. Dropping evidence was identified in five instances in two students' documents (see table 22).

<Table 22: Examples of Dropping Evidence>

Students and Topics	Dropped Evidence from Initial Map to Final Map	Dropped Evidence from Final Map to Outline
S9 Delaying school starting time	None	- "more bus drivers are needed" - "more money for bus drivers is needed" - "there are not enough buses for all students"
S11 Is 16 too young to drive?	None	- "16 year olds pass MD's requirements for license daily" - "more and more accidents are caused by drivers under 18"

S9 (*Delaying school starting time*) dropped evidence in her final map because the higher-concept category was removed for her outline. She removed the concept "transportation," which the evidence supports. S11 (*Is 16 too young to drive?*) dropped two of her individual pieces of evidence from her final map to her outline. Although the concept to which the evidence related, "graduated licensing," was one of the foci of her argument, she dropped "16 year olds pass MD's requirements for license daily."

6.1.2. Analytical change

Conceptual changes related to the formation of ideas on the basis of information have been identified as analytical changes. Analytical changes accounted for six percent of all conceptual changes (see table 16, p. 155) and occurred relatively more frequently

at the beginning of information seeking than at the end. Twenty-eight instances were counted from students' initial maps to their final maps, whereas only six instances were counted from their final maps to their outlines. This indicates that students engaged in more analytical changes primarily during searching and formulating foci for their topics.

In fact, the information encountered often played a significant role in these conceptual changes. Although the number of occurrences of analytic changes was small (only six percent), the changes influenced significantly the formation of the students' foci. When students encountered relevant information that did not completely match their existing ideas and they liked the information, they often made their concepts broader to include it. When they developed in-depth interest in specific aspects of concepts as a result of discovering new information, they broke down the concepts into narrower ones. When they found information that related to their initial ideas or showed similarity to other information or when they needed to arrange their ideas according to the information, they combined concepts into one.

6.1.2.1. Broadening concepts

When students found information that did not fall into the concepts that they held because the concepts were too specific, they broadened their initial concepts to make the information applicable. Some of the clearest examples are listed in Table 23. For example, S4's (*Building more runways*) initial concepts, such as "greater revenues" and "property values," were too specific to fit the information he found, which was related to but not exactly matched with these concepts. Thus, he decided to broaden his

focus and added "economy" to his final map to include the meanings of his initial concepts. Later, in his outline, he added "local impact" to explain the economic benefits of building more runways. He replaced another concept from his initial map, "jobs," with "employment." In his initial map, he had listed only "airplane" and "airport related jobs" for "job" opportunities created by building more runways. However, when the information he gathered also included more employment opportunities through attracting large companies to the area, he used only "employment."

S16 (*Pledge in public schools*) also tried to broaden the concepts she used in her initial map to incorporate the information she gathered when she found a crucial concept that would strengthen her argument that was not listed in her initial map. Initially, she had thought the only adults who would question requiring the Pledge in the public schools were "parents." As she searched, she realized that it was a broader issue when she encountered the fact that there are a large number of noncitizens living in this country. This made her broaden her "parents" concept to "adults/citizens and noncitizens."

<Table 23: Examples of Broadening Concepts and Ideas>

Students and Topics	Original Concepts in Initial Map	Broadened Concepts for Final Map	Broadened Concepts for Outline
S4 Building more runways	- greater revenue - property value - jobs -- airport and airplane related jobs	- economy - employment	Remained - employment
S16 The Pledge in public schools	- parents	- adults/citizens and noncitizens	Remained

Note: Single dash (-) indicates the highest level of concepts (ideas), and double dashes indicate the subordinate concepts under the higher concepts.

6.1.2.2. Narrowing concepts

The concepts students listed in their initial maps were generated from brainstorming and were thus often broad and abstract. As Table 24 shows, students found information about different aspects of their initial concepts; they broke down the concepts into narrower ones.

<Table 24: Examples of Narrowing Concepts and Ideas>

Students and Topics	Concepts in Initial Map	Narrowed Concepts in Final Map	Narrowed Concepts in Outline
S3 The arts	- the arts benefit cultural preservation	- the arts benefit history - the arts benefit culture	Remained Remained
S16 The Pledge in public schools		-requiring it in public school is inappropriate	- requiring it is "undemocratic" - "unhealthy"
S17 School uniforms	- school uniforms affect behavior	- school uniforms decrease violence	- school uniforms decrease crime and suspension rates
S19 The importance of reading	- gained knowledge by reading	- reading improves language, speaking, vocabulary, and comprehension.	Remained

S3 (*The benefits of Arts*) broke down her initial concept - "cultural preservation" - into "history" and "culture" for her final map. She did so because she wanted to explain how arts benefit "culture" and "history" separately and to introduce some examples of how the arts serve these two different areas.

One of the new concepts, "appropriateness," added in S16's (*Pledge in public schools*) final map was narrowed into two more concrete concepts for her outline: she divided "appropriateness" into "undemocratic" and "unhealthy." She was actually arguing for the "inappropriateness" of requiring the Pledge in schools and came up with these two concepts to explain this inappropriateness. She described requiring the Pledge

as inappropriate because "the Pledge's presence is undemocratic" and "it promotes unhealthy patriotism."

One of S17's (*School uniforms*) main concepts was "behavior," but he changed it to the narrower concept of "violence" in his final map, indicating that "violence" is influenced by school uniforms. He then went even more into deeply into the concept of "violence" for his outline, including "crime" and "suspension at schools" – narrower concepts he had encountered while gathering information on "school uniforms." As he found that "suspension" and "crime" rates have gone down in some schools since the adoption of school uniforms, he tried to argue that school uniforms help to reduce violence, that is, "crime" and "suspensions" at school.

The same process was used by S19 (*The importance of reading*), who listed broad and abstract concepts for her initial map but tried to include more specific information on those concepts as she gathered more information. Particularly, she transformed one of her initial concepts, "gained knowledge," into several different concepts: "language," "speaking," "vocabulary," and "comprehension." She found specific evidence that could support her initial idea that "reading" is one of "(the characteristics of) gained knowledge" in an explanation of specific aspects of what knowledge can be gained through reading.

6.1.2.3. Combining concepts

In some cases, students combined two or more concepts to represent one idea. Terms labeled "ideas" were not very clear in the beginning but became more focused as students moved toward the end of their research. Interesting examples in this category came from two students as seen in Table 25 below.

<Table 25: Examples of Combining Concepts and Ideas>

Students and Topics	Original Concepts in Initial Map	Combined Concepts in Final Map	Combined Concepts in Outline
S3 The arts	- cultural preservation (from map I) - visual arts (from map II)	- history -- memory of important concepts -- memory of important events --memory of important people	Remained
S16 The Pledge in public schools	- Pledge was employed by government - Pledge is recited in all public schools - Pledge promotes patriotism and militarism	- government/schools assumes appropriateness (of the Pledge) - Pledge promotes patriotism	- officials in public schools require the Pledge in public schools Remained

Note: Single dash (-) indicates the highest level of concepts (ideas), and double dashes indicate the subordinate concepts under the higher concepts.

S3 (*The benefits of Arts*) tried to present benefits of the arts for different purposes. However, before her search, she did not know what forms of the arts she would choose to describe. She drew different initial maps representing two different domains of the arts and labeled them as I and II. In one map, she mentioned the different forms of the arts; in the other map, she listed the concepts related to the purposes and benefits of the arts. In her final map, as her ideas became clearer, she merged the two maps into one by listing examples of arts objects or forms under the appropriate concepts. For example, under "history," she listed three different purposes and listed examples of relevant pieces of art under each: "Statue of Liberty" under "memory of important concepts," "The Iwo Jima Memorial" and "Picasso's Guernica" under "memory of important events," and "Lincoln Memorial" and "Mt. Rushmore" under "memory of important people." The "history" concept had been broken down from "cultural preservation" in one of her two initial maps, and the examples were

drawn from the other initial map, where the concepts had been labeled as "Sculptor," "Architecture," "Paintings," etc.

S16 (*Pledge in public schools*) initially listed "government" and "schools" separately to indicate that the "Pledge was employed by government" and the "Pledge is recited in all public schools daily." But in her final map, she listed "government/schools" together to indicate that "government/schools assumes appropriateness (of the Pledge)." Further, in her outline, she was mainly focusing on whether reciting the Pledge is appropriate in public schools. The initial concepts, "Pledge was employed by government" and "Pledge is recited in all public schools daily," were already assumed for her final map and final outline.

She followed a similar pattern with another concept, "patriotism." In her final map, "patriotism" and "militarism" were combined as "patriotism." She had listed the two concepts separately but concluded that there is no significant difference between them. She then chose to use "patriotism" as the somewhat broader term.

6.1.3. Organizational change

As students moved toward the end of their projects, they tried to organize their ideas and information into structures for their outlines. Table 16 (p. 155) shows that more organizational changes occurred during this stage of the process than in earlier ones. Two strategies were identified: generalizing the existing ideas to create higher categories of concepts and reorganizing the existing concepts into new sequences. The former was more common than the latter, although both were used.

6.1.3.1. Creating higher concepts to organize existing concepts

One way of organizing concepts was to group the concepts into categories and label them. As one student indicated, "I just made my things more broad instead of the ways they were. Before, they were very specific. I think that's gonna help me to organize it better because it's easier to generalize the different things together." As Table 26 shows, in creating higher concepts, students had to come up with new conceptual categories that would include all the relevant ideas and information.

<Table 26: Examples of Creating Higher Concept Categories>

Students and Topics	Original Concepts in Initial Map	Added Higher Concept Categories in Final Map	Added Higher Concept Categories in Outline
S4 Building more runways	No concepts were organized with a higher concept category for final map	- safety increases -- safety of airplane increases -- safety of passengers increases -- delay decreases - employments - more pilots have jobs - ATC have jobs - it stimulates economy of airline industry	- major problems in today's airports and airplanes - benefits of building more runways
S5 Cell-phone use while driving	- it has function of being in contact with people at all times - it has function of business - it has function of usefulness in emergencies - it results in distraction - it results in accidents	- it is convenient -- business use -- call for direction -- call 911 for emergences - it is dangerous -- distraction -- accidents -- deaths	Remained
S9 Delaying school starting time	None	- extra-curricular activities are modified - zero hour classes are provided	- students' concerns

<Table 26 Continues: Examples of Creating Higher Concept Categories>			
Students and Topics	Original Concepts in Initial Map	Added Higher Concept Categories in Final Map	Added Higher Concept Categories in Outline
S13 Going away to college	None	- it helps you adapt socially -- it forces to be in close contact with other people. -- it gives you an opportunity to meet people from all over the country	- it provides academic and social benefits -- it is convenient -- you can join clubs and organizations -- it gives motivation to succeed

Note: Single dash (-) indicates the highest level of concepts (ideas), and double dashes indicate the subordinate concepts under the higher concepts.

Two higher concept categories that appeared in S4's (*Building more runways*) outline were the "major problems of today's airports and airplanes" and "the benefits of building more runways," which he believed would provide the rationale to begin his argument. The concepts included from his final map under the former concept category are "safety," "passengers," "other planes," and "delays of airplanes." Under "the benefits of building more runways," he included "employment," "it stimulates economy of airline industry," "more pilots," and "more ATCs."

S5 (*Cell-phone use while driving*) grouped her ideas into three main categories. She described her thought processes: "I was thinking about it and how I wanted to do my speech. I wanted to narrow it down into three main categories. I guess I figured I'd start with this one and then go to that and go down with this one." She labeled the categories "widespread" (an added concept), "convenient," and "dangerous" (two higher concept categories). Except for "widespread," which was a newly added concept, these two concepts were created from concepts in her initial map, such as "business use," "call 911 for emergencies," "distraction," "accidents," and "deaths." In her

outline, she used all three main categories as different assertions, and she listed supporting reasons and evidence under each.

S9 (*Delaying school starting time*) also tried to group the information she found and to map it into existing concepts in her final map to prepare for her outline. She found, however, that she had to group the existing concepts in some new way to make her speech more organized. She created "Students' concerns" for her outline and used "teachers' concerns" from her initial map. She categorized the concepts in her final map related to the "students' concerns" category and added "extracurricular activities" and "zero-hour classes" in that category.

S13 (*Going away to college*) had six different concepts for her final map but grouped them into two main categories for her outline: "independence" and "academic and social benefits." "Independence" had been in her final map, but "academic and social benefits" was created to group newly added concepts as well as to encompass such existing concepts as "meet people from all over the country," " adapt socially," "convenient," "clubs and organizations," "motivation to succeed," and more.

6.1.3.2. Putting concepts in different locations

When students organized their thoughts and information, they sometimes tried to put concepts into more suitable categories by moving them to different categories or locations. To make their speeches more logical and coherent, students both created higher concept categories and moved concepts from one category to another. As Table 27 shows, one clear example from S11 (*Is 16 too young to drive?*) elaborates the process.

For her topic, she first listed three concepts - "maturity," "experience," and "responsibility" – separately. She then added several more concepts for her final map and placed them in different categories for her final outline. This made her presentation substantially different because it changed the main concepts that she had begun to investigate. Particularly, "graduated license program" was added to her final map as a lower concept under "experience" but became a higher concept for her outline. Ultimately, she emphasized the concept as crucial and used "maturity" and "experience" to support her argument that the "graduated license program" was necessary for teens.

<Table 27: Examples of Putting Concepts in Different Locations>

Students	Original Concepts in Final Map	Concepts Moved from Final Map to Outline
S11 Is 16 too young to drive?	-maturity -experience --graduated license program -responsibility	-Graduated license program --maturity --experience

Note: Single dash (-) indicates the highest level of concepts (ideas), and double dashes indicate the subordinate concepts under the higher concepts.

6.1.4. Holistic change

Holistic changes affecting the overall focus of the topical domain also occurred. As students learned more about their topics, their ideas about how they would present the topics changed substantially. Naturally, the results of the change affected the content of the speeches. Three types of holistic changes included (1) shifting the focus, (2) broadening the focus, and (3) narrowing the focus. In analyzing for holistic changes, three kinds of students' documents were examined: initial paragraphs, final paragraphs, and statements of purpose in the outlines. Excluding documents from two students who

changed their topics into completely different subject domains, a total of six instances of holistic change occurred among the documents students created at three different times.

6.1.4.1. Shifting focus

Most students had selected their sides of the issues before they began their research. However, some students were not clear about their views, although they initially set out their arguments with certainty.

One student shifted her focus dramatically as she learned more about the topic and whenever she produced a new document. Her initial focus was to argue that TV/Music have no effect on people. In her initial paragraph description, she wrote that "TV/Music have no effect on people whatsoever ... The most serious problems such as Columbine are mainly caused by psychological problems." But she shifted her focus for her final map to argue for the opposite view, that the violence of TV/Music affects young adults and children, because she had found much information to support this perspective. She described her focus in her final paragraph description as "some children do not know the difference between right and wrong and looking at TV causes them to think the things they see on TV are right." After her final map, she changed her focus once more for her outline to argue that TV/Music affect people in both negative and positive way -- because she had found information on both sides of the issue. Finally, she described her objective as "to persuade the audience that TV and music affect people" to describe both positive and negative affects.

6.1.4.2. Broadening focus

S15's change of her topic from *new restriction on R- rated movies* to *violence in media* illustrates a broadening focus because the former topic was narrower than the latter. Initially, she had set out only those concepts related to her topic; but she expanded her ideas and added more concepts regarding violence in media. In her final outline, she used the concept of new restrictions on R-rated movies for her introduction but then focused on violence in media and how it affects young people.

6.1.4.3. Narrowing focus

Often students selected their topics without much knowledge about them, and many students were not clear about what aspects of their topics were interesting and how they could present these. Narrowing a focus from initial concepts occurred frequently, as students developed more knowledge of and interest in particular aspects of their topics. S2 (*Endangered animals*) narrowed his focus from *effect of environment* to *endangered animals*. "Saving wild animals" had been listed as a subconcept in his initial map, although it had been labeled differently from *endangered animals*. Initially, S2 had tried to focus on the negatives and positives of protecting the environment. But soon after he discovered his interest by spotting the topic *endangered animals* among the list of topics regarding the environment, he focused on the status of these animals and how people could help to save them.

Two students who set out the initial topic *censorship* understood the topic differently from the beginning and narrowed it differently as well. S6 (*Literature censorship)* initially focused on "music," "movies," "television," and "video games" as

subconcepts but decided to focus on censorship of literature. The initial concepts of S7 (*Censorship of music/lyrics and freedom of speech*) were "press," "speech," "music," and "video." Her concepts in her final map were the same except for the change of "press" to "media," but her concepts in her final outline focused heavily on "music" and "lyrics." The differences in narrowing their foci reflect the students' personal interests as well as the information they had. In particular, S7 seemed to focus on narrower issues, "music" and "lyrics," more and more as she moved toward the end.

6.2. Learning experiences

Students' learning experiences related to their chosen topics can be identified largely both as "data-driven" and "goal-driven." Cognitive psychologists generally use these terms to identify the characteristics of learning in a knowledge-lean domain in which specific knowledge is required to solve a problem. However, the knowledge domains used for students' tasks in this study are too broad, complex, and dynamic to apply the same meanings.

"Data-driven" learning is defined in this study as the acquisition of knowledge that has emerged inductively from data without the learner's certain intention to pursue that knowledge. "Goal-driven" learning means acquiring knowledge regarding the answers to specific questions or purposes in a learner's mind. Individual students' learning experiences ranged across a continuum of data-driven and goal-driven learning. Particularly in the beginning, they sought general information to formulate a focus and a perspective, a step Kuhlthau (1991) had identified in her Information Search Process. Although students said they had some direction when they began to seek

information, they also anticipated learning from the information they found. As they gathered, selected, and organized information, their learning generally became more goal-driven. Although learning could be still data-driven in the later stages, more goal-driven learning experiences were found among students as they became more focused about their topics and thought about using the information in their final products.

6.2.1. Data-driven learning

Students expected to learn as they sought and used information. Expecting to find something that could give them ideas, they tried to find any information related to their topics. "Data driven" learning was at the basis of all their early strategies and activities for gathering, selecting, and organizing/integrating information.

Formulating focus was data-driven. Students began at a general level with their searches. As they saw the information returned during their gathering, selecting, and organizing, they constantly related that information to their own ideas. S16 (*Pledge in public schools*) knew the importance of formulating a focus to go further with the process: "I think before I weed them [irrelevant information] out, it's important to come up with some ideas that ... or maybe as I weed out I come up with ideas." S5 (*Cell-phone use while driving*) said, "I would make things a little different if I couldn't find anything."

Students narrowed their foci to some of their initial concepts if the information found matched these ideas. S4 (*Building more runways*) said, "I found that it showed more in certain areas than in others." Another factor that moved students to some areas rather than others was the personal interest generated from the information they found.

For example, S7's (*Censorship of music and lyrics*) initial ideas were to include concepts such as "press" and "speech" rather than "music." Additionally, she intended to pursue a particular relationship and concept represented in her initial map: "(censorship) was determined by whom." She did not include those in her final map and outline because she had not found information about the relationship and the concepts. Because she did not find the information she initially pursued, her interest shifted from her initial ideas to "music" and "lyrics."

Three students, including S4, particularly mentioned that they deleted some of their concepts because they could not find the information that they thought they would find. S19 (*The importance of reading*) said, "I think that ones that I find support for made it over here [final map] ... And some of them I found and some I didn't."

Some concepts emerged from the information unexpectedly when students found new concepts during their information seeking. In fact, students used broad search vocabulary to find ideas that they did not specifically expect to find. S19 (*The importance of reading*) said she found some concepts that she did not really think of when browsing -"teenagers should read aloud," "other entertainment replaces reading," "teenagers watch too much television," and "emphasis on reading scores." At first, she thought "emphasis on reading scores" was so different that she did not want to look for information on that idea for her speech. However, she changed her mind: "At first this isn't relevant. But I saw so much of it that I realized that, like, this must be a whole aspect of the topic. The issue kept coming up in articles and even under different searches that I did on the importance of reading and focused on it."

The number of appearances of the information was crucial to students' decisions about whether to include concepts in their speeches. These "new" concepts then became different aspects of the topic. In S19's (*The importance of reading*) case, she found other documents that applied to "other entertainment," "too much television," and "how to teach reading" and reported that the information on these concepts came up as often as information on "reading scores."

When students gathered, selected, and organized information, their strategies supported accessing as much relevant information as they could. Students who supported this view, including S8 (*Mexican food*), believed that "It does show you other things that could be helpful or something. It could give you a broader view of, like, what you're researching so you could understand it better. So even if you can't use it for your speech or your research or whatever, it can give you a better understanding." As S5 (*Cell-phone use while driving*) mentioned, "I find something that I like. I find one site that I like and I'll pick out some facts that I like from that and look them up." It was a soothing fact for students, as S16 indicated, that "The volume of it is so great you could pick out the things for your case and use it."

6.2.2. Goal-driven learning

As students approached the end of the project, they became clearer about what they needed to finish their assignments. They were in general clear about their arguments and what evidence would support their views. However, they had to solidify their ideas and information to meet the assignment requirement – a persuasive speech. This specific requirement influenced the content and structure of the information they

used. In the process of polishing their final products, they also began to find some conceptual holes and to think how they should fill them.

One of the students' goals was to get good grades. They were very concerned about each element that the teacher required, including the kinds of information specified: facts, examples, statistics, and experts' opinions. As a result, students looked specifically for these kinds of information, capturing and extracting the pieces of information from articles. When they listed the information found as evidence, they often quoted sentences from the source without paraphrasing them. They were conscientious about providing a bibliographic entry for each piece of evidence, since this was required.

As students made their outlines, they tried to fill all the required slots. For example, S19 (*The importance of reading*) said, "Because you can clearly see if you don't have a subheading then that means your assertion doesn't have reasons." She had to go back for more information a couple of times to fill the holes. She needed more information to back her ideas that teenagers are busy with their "jobs," "clubs," and "other entertainment."

Meeting the requirement of a time limit was also goal-driven. Many students had more than the five sources required, and some of them who had gathered too much information had to cut some out to meet the requirement of a seven-minute speech. S14 said he had gathered too much information. He explained that, when he listed all the information gathered with his ideas, his outline became "too long" and he knew he would "not be able to finish within seven minutes." He knew that he had to cut out information: "I had to do so because it would penalize me instead of helping." S2

(*Endangered animals*), who used nine sources, said "I didn't want to go above [nine sources] because I didn't have any other room to place it."

6.3. Levels of learning and information use

The revised Bloom's taxonomy for teaching and learning (Anderson and Krathwohl, 2001) identifies six levels of learning: "remember," "understand," "apply," "analyze," "evaluate," and "create." These processes describe the cognitive activities necessary for achieving meaningful learning. Applying the taxonomy to the kinds of learning acquired through information seeking and use enables one to see the kinds of cognitive activities involved in learning with information at each level and to determine whether each level of learning has been achieved in relation to a particular learning task. The learning task determines the levels of learning intended to be achieved. The assignment used for this study focused on the highest level of learning in the taxonomy: creating a final speech that was unique to each student.

<Table 28: Students' Cognitive Activities with Information>

Levels of Learning*	Cognitive Activities
Remember	Recognizing Recalling
Understand	Comparing and generalizing Capturing specific information
Apply	Generating ideas from the extracted information Reshaping initial ideas to match the information
Analyze	Focusing Categorizing and outlining
Evaluate	Prioritizing Testing
Create	Hypothesizing Constructing

* Levels of learning adapted from *A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives* (Anderson and Krathwohl, 2001)

The specific activities identified at each level indicate how students engaged with information to complete their learning task (see table 28) and what cognitive skills were involved during students' engagement. Students engaged more and more with information as they applied higher levels of cognitive skills and moved along the process to produce their final outcomes. Particularly, students' use of the higher levels of cognitive skills shown in the Table 28 - such as focusing, categorizing, prioritizing, hypothesizing, and constructing - indicated their constructive engagement with information to form their own ideas coherently. Students applied these specific activities to progress in their learning to complete their learning tasks. This progression, however, does not mean that these specific cognitive skills were used in a linear manner. In order to achieve the highest level of learning for the assignment used in this study, students used different levels of cognitive skills throughout their information seeking and use. All levels of cognitive skills are needed, and the higher levels of cognitive skills were particularly crucial.

6.3.1. Remember

"Remember," the lowest level of learning, is defined as "retrieve relevant knowledge from long-term memory" (Anderson and Krathwohl, 2001, p. 66). The cognitive activities identified among the students in seeking and using information for learning were "recognizing" and "recalling." From the beginning, students had to rely heavily on retrieving information from their own knowledge. As soon as they selected their topics, they were asked to identify and list the relevant information during the

processes of information seeking: this required "remembering" information. The two activities of (1) recognizing and (2) recalling enabled students to retrieve simple concepts and facts that were not connected coherently with their ideas as a whole.

6.3.1.1. Recognizing

As students browsed and scanned the titles and headlines of the hits returned, their basic cognitive activity was to recognize information that was relevant to their topics. They often did this by looking at titles and headlines: "If there is a title that really stands out, like, if I really like it, or oh! I want to look at this one" (S5). However, students were often misled by titles, which did not always convey the proper representation of the information contained in the articles. S19 (*The importance of reading*) complained that "the titles of the articles were kind of misleading. Either you think it's going to be helpful but it's not at all. Or that it is helpful and it is. Like, I am sure that a lot of the sources and articles that I didn't even try probably did have information. But you don't always know." S16 (*Pledge in public schools*) also believed that "a lot of times, titles might not be good but then actually it has a lot to do. So I think it will be helpful if they contain more … accurate. Like, tell me more about the articles than what is really there. Like, summary."

Students recognized the aspects of the topics that they wanted or didn't want as they browsed and scanned the hits. Even though they often could not articulate a focus for their topics in the beginning, they were able to recognize different aspects of the topics presented among the hits returned. For example, S1 (*Abortion*) recognized a concept that she did not want to pursue further as she was searching. She had used

abortion as her keyword and found that many of the hits returned in her first page had to do with RU-486, an abortion pill. When she saw so many hits related to that concept; she said, "I want to focus only on surgical abortion."

6.3.1.2. Recalling

Recalling was a popular strategy among students for choosing specific information. Although students were required to submit note cards with specific evidence for this assignment, more than half of the students interviewed said that they would not make the cards unless they were required. Two students particularly did not want to use notes for recalling relevant pieces of information: "I read it over and I'll remember it .... I can take it from a paper and I know it's on that page. It might take me a little longer where exactly it is on that page, but generally I can remember what the statistics and stuff and that's what I usually look for and pick out" (S4: *Building more runways*). S5 (*Cell-phone use while driving*) described her preference as "I only use cards when I have to ... If you are not an organized person, note cards aren't going to help you. [Be]cause they end up being everywhere. That's the problem with me. I can remember a lot of stuff."

6.3.2. Understand

The next level of the revised taxonomy is "understand," which is defined as "construct meaning from instructional messages, including oral, written, and graphic communication" (Anderson and Krathwohl, 2001, p. 70). For this research, this definition was adapted as follows: "construct meaning from information including oral,

written, and graphic communication found in information sources." Understanding the meaning of the information is the basis of using information to learn. Students' cognitive skills used for understanding included (1) comparing and generalizing the hits brought by searches and (2) capturing specific information in an article that was thought to be relevant. These activities led students to engage more with information than just "remembering" it.

6.3.2.1. Comparing and generalizing

Students had the benefits of using electronic sources to find information about their topics and to select ideas that could be presented for their speeches. Students could access as much information as they wanted. S19 (*The importance of reading*) commented that an advantage of using the electronic sources is "you can get more information and narrow it down, like with a search engine." As students searched, it became evident that they tried to make sense out of the hits returned by their searches.

As students narrowed their ideas to formulate their foci or perspectives, they compared the hits retrieved by different searches and generalized the common concepts among them. Students not only looked generally at what was available but also sought the common themes among the hits related to their topics. S19 (*The importance of reading*), in particular, provided an interesting example of comparing the hits from different searches and generalizing the common concepts across different sets of hits: "Just from finding so much information that ... at first this ['reading scores'] wasn't relevant.... But it kept reappearing. I figured that was important." She also confessed

that some of her other concepts, such as "(reading can be done) reading aloud" emerged in the same way.

Another interesting example came from S17 (*School uniforms*), who compared and generalized the hits from the titles and headlines returned by his search using "behavior" and "school uniforms" as search terms. From searching, he found that "violence" was the common theme represented in the hits. He described his decision as follows: "I saw an awful lot of the rates that violence decreased after school uniforms were brought into the public schools and private schools also."

S8 (*Mexican food*) found a new aspect of her topic by comparing and generalizing the information that appeared. Originally, she had thought "it [Mexican food] was good for you somehow, but it's not at all. Throughout the research it was just stuff like that." She then decided to include the information against her initial stance on her topic and to broaden her focus to a pros-and-cons approach.

6.3.2.2. Capturing specific information

When students skimmed or read articles, they tried to understand the information that caught their eyes as relevant or interesting. Students made initial attempts to understand the information before they made any decisions on whether to select it, and they captured specific information that they perceived as particularly relevant. The specific information focused on the kinds required for the assignment – facts, quotes, examples, and statistics.

Students captured specific information that they thought was crucial to include in their speeches. S4 (*Building more runways*) tried to understand the general concepts

in articles first and then focused on the specific information presented: "I took each article that I had separately, and I looked at them. And I was looking through it for the main ideas and then after I understood the general concept of that article, I would go back and look for specific information like statistics and things like that."

Some of the specific information was captured if the information was understood as relevant or as straightforward in expressing an idea. Students captured the information by "just seeing the statistics themselves and the words themselves." For example, S2 (*Endangered animals*) captured a piece of information - Endangered Species Act - that was straightforward and self-evident as a related concept. As students marked the information by highlighting it or taking notes on cards, they identified more information for their topics.

6.3.3. Apply

One level higher than "understand" is "apply." It was defined originally as "carry out or use a procedure in a given situation" (Anderson and Krathwohl, 2001, p. 77) but is redefined here as "use information in the context of a chosen topic and perspective appropriate to students' learning task." Once students understood information, they needed to apply it to the context of their topics. This context was the focus of students' arguments and had been represented in concept maps as well as in outlines. Reconciling their own ideas with the information found occurred constantly as students either tried to match their ideas with the information found or translated the information found into their own words in order to make it coherent with their ideas.

Two specific cognitive activities were (1) generating concepts from the extracted information and (2) reshaping initial ideas to match the extracted information.

6.3.3.1. Generating new ideas from extracted information

Some ideas came from students' own knowledge bases and more were generated from the information they gathered. Students reviewed this information and extracted the pieces that were most relevant to their topics. Students commented that they took "bits and pieces of information" from the articles collected on the basis of the terms in their concept maps and outlines. In fact, many "adding" activities occurred as students generated new ideas from the information.

Students generated and added new ideas from the specific information as they attempted to translate the information into their own words. Students believed that, if they did not have any specific idea of their own, they could learn it from the gathered information. S14 (*Legalizing marijuana*) said "I looked at those [documents] and figured what information I could use for my topic and went back into that and pulled out facts and statistics there and also anything that I thought could help me with this assignment."

S2 (*Endangered animals*) reported that, when he selects information from an article, he "look[s] through real quick. And when I find something, then I read above it and below it to find out if it applies to me." S5 (*Cell-phone use while driving*) indicated that she tried to add ideas from the information: "when I was looking for information, I just started out looking for general information and then if I find different stuff I'll make more categories."

Students extracted the kinds of information required as evidence for the assignment. S4 (*Building more runways*) indicated, "I tried to find specific things because it keeps me more on focus." S5 (*Cell-phone use while driving*) generated the "widespread" concept as she saw the number of cell-phone users increase over the years. S17 (*School uniforms*), who came up with the information that "school uniforms are cheaper than designer clothing," generated the concept "economic value" of school uniforms.

6.3.3.2. Reshaping initial ideas to match the extracted information

Students reshaped their existing ideas to match their information, giving a clear indication of reconciling their ideas with the information collected. The cognitive activities that resulted in "analytic changes" fall into this category. As S4 (*Building more runways*) commented, "[I looked for] a group of things that I could use to explain different things in my persuasive speech." His "different things" were the specific concepts that he initially generated. Because the information he found did not support the specific concepts directly, he found it difficult to apply the new information in the way he had planned. He broadened his initial, specific concepts in order "to have a lot more room and different areas to speak in."

S16 (*Pledge in public schools*) reshaped her "parents" to "adult/citizen/ noncitizen" from the information found because she thought this extension was logical, although the article in which she had found this idea did not directly address her topic. She also tried to use broader concepts in her final map, compared to the ones she mapped initially, because she thought that she could "go to more specific later."

6.3.4. Analyze

The next level of learning in the Anderson and Krathwohl (2001) taxonomy is "analyze," defined as "break material into constituent parts and determine how the parts relate to one another and to an overall structure or purpose" (p. 79). For the purpose of this study, "analyze" was redefined as "break broad ideas into narrower ones and determine how the narrower ideas relate to one anther and to an overall structure." Students analyzed their information based on their understandings and application of information to their arguments in order to represent more focused and organized ideas. The two specific activities they used were (1) focusing and (2) categorizing and outlining.

6.3.4.1. Focusing

Focusing on the relevant information was essential for the students to make good speeches. Students used two processes to formulate the foci of their speeches. In some cases, they stated a focus and used it as the basis for making distinctions between relevant and irrelevant concepts. In other cases, they allowed the focus to emerge as they made decisions about whether the information they retrieved was relevant or interesting.

Having a focus in the earlier stages of information seeking enabled them to concentrate only on the relevant aspects of a topic and to narrow some of initial ideas on the basis of the information available. For example, S17 (*School uniforms*) found additional factors involved with *school uniforms* beyond the ones he had identified in

his maps (such as "parental involvement" and "teacher involvement") but said he would not concentrate on these but focus instead on "violence" and concepts related to it.

Focusing also includes consideration of information in light of crucial contextual issues - such as audience, appropriate level of language, etc. After the exercise in class designed to help them know more about their peers, they knew that the speech should be relevant in some ways to their classmates. Although some students selected topics related to popular issues among teenagers, many students who chose less "relevant" topics developed their foci as they gathered, selected, and organized their information. S19 (*The importance of reading*) said; "All I wanted to do [prove] was that reading is important before [searching]. Then I found a lot of subtopics under that. Then I decided to make it more for teenagers. I tried to make my speech why teenagers should read." S14 (*Legalizing marijuana*) considered his peers as a filter for gathering and selecting information on legalizing marijuana. He said, "I just kind of looked at it through the audience's perspective. What would they have to hear to persuade them to see it this way?"

6.3.4.2. Categorizing and outlining

Students were guided by several tools for organizing the information they gathered and selected: concept maps, outline templates, and note cards. Although their concept maps guided their ideas in formulation during the search process, those did not generally include specific information they expected to gather and select during their information seeking. The outline templates proved to be particularly helpful for students, however, because they provided something specific to support their efforts as

they integrated their new information with their own ideas. S17 (*School uniforms*) particularly mentioned that he "learns by doing" and that outlining helped him learn.

All the students interviewed grouped note cards according to categories. Often, their concept mapping also guided students to break down their ideas. Because they had to generate categories about their topics for these maps, the maps themselves gave students a ready tool for grouping ideas. Three students - S4, S5, and S16 - indicated that they used the concepts in their final maps as categories for organizing the information. S4 (*Building more runways*) said, "By the concept map is how I really organized."

S16 (*Pledge in public schools*) believed she organized her ideas as she organized the information. She said, "[organizing information is] More like organizing my ideas together ... I come up with concepts that I am looking for ... more broad things and then evidence that I find ... I make cards of those and put it under the concepts that I have for my speech."

For students, categorizing information meant not just grouping the information itself but pairing information collected with the matching idea. Filling in all the slots in the outline template was the major activity by which the students categorized information. S4 (*Building more runways*) commented that he first listed the assertions and major reasons behind the assertions and then inserted "the different information" that he collected, which was "bits and portions," where he thought "they would fit best." S5 (*Cell-phone use while driving*) also said she used "little bits of all of the information." S2 (*Endangered animals*), S4 (*Building more runways*), and S16 (*Pledge in public schools*) commented that outlining helped them break down their ideas into

more concrete ones. Students decided that they had covered their topics thoroughly when they could not break them down any more. Then they matched the information gathered with their own ideas. S2 (*Endangered animals*) described how he outlined:

> I made an outline first. When you make an outline, you can organize your thoughts. So I broke down different things. Like the first thing I had was "destruction" and "pollution." I looked under all the sources I had and found out if anything could be "destruction" and "pollution." Then I put note cards in this little box. And then I kept doing that for each part. The next part was, like how people help animals with their laws. And I wrote down the note cards from that and then put them inside a box. And when I was done with the research, I looked at all the cards and I filled in the information in the outline. So ... if it says "pollution" and "destruction" in my outline, I broke down the sources that said it and I put down, like, bibliography number so I could look back later and include it in the speech.

6.3.5. Evaluate

The next level of learning is "evaluate," defined as "make judgments based on criteria and standards" (Anderson and Krathwohl, 2001, p. 83). This definition remained the same for this study. Students began evaluating information as soon as they started searching, and not all the information gathered was used for final products. As students became more clear about their ideas and information during their negotiation of meanings, they extracted only the relevant information from the pile of information gathered. They developed their own criteria and standards or used the criteria and standards imposed by the teacher as requirements for the assignments. The cognitive activities of (1) prioritizing and (2) testing were used to negotiate the meaning of information as students engaged in the evaluation process.

6.3.5.1. Prioritizing

Students identified crucial ideas as they made their judgments about the information and generated their own ideas about their topics. To organize their speeches effectively, students determined which pieces of information were more and less crucial to their topics. S16 (*Pledge in public schools*) said she "figured out what was important and the strongest point ... that will appeal to the audience" during the process of evaluation. S16 considered the concept "adults/citizen/noncitizen" very crucial and decided to present it in the beginning of her speech. S5 considered one of the concepts she added - "widespread" - crucial because she thought "it would make my argument even more important." S5 (*Cell-phone use while driving*) also decided to use the examples of accidents caused by cell-phone use while driving because that was one of the main reasons she had decided to select this topic. She had been particularly excited when she found an example in searching and said she "would definitely include this example" in her speech, since it was "such a sad story."

Students pointed out that sometimes the articles that were interesting to them were different from the articles that were important to their topics. Often they found it interesting to read articles that were somewhat relevant but not directly focused on their speeches. S19 (*The importance of reading*) commented that she focused on "teaching phonics" at one point but did not end up using the articles "because it was not specific enough for my speech on reading to high schoolers." S 16 (*Pledge in public schools*) found it interesting to read "many articles that were against what I was trying to say" but admitted that she would not use the information and instead would "prove that they were wrong."

6.3.5.2. Verifying

One of students' major concerns in choosing information was verifying of the reliability their sources: who published it or what were the credentials of its author. Students had already had some experience in comparing sources. S17 (*School uniforms*) tried to verify which article came from the more reliable source when he found the same information in two articles. He made his decision based on the reputations of the magazines themselves: if he had a choice between *Jet* and *Newsweek*, he would use *Newsweek* because "the information in *Newsweek* would probably be more newsworthy." S16 (*Pledge in public schools*) tried to bypass the requirement to use reliable sources when she found a crucial fact in a teenager's personal webpage. She knew that she could not use the source and thus tried to find the same fact in a more reliable source. She was happy to find it in *The Washington Post*.

The importance of weighing sources and information was lost on some students. Two students in particular thought that anything related to their points of view on their topics was good information and anything related to an opposing view was simply not good. For these students, information seemed to be "black and white," as the library media specialist commented. S19 (*The importance of reading*) articulated her thought in more detail:

> Information should be supportive of what I want to say.... It was interesting, because I found a lot of articles saying that it wasn't a problem, that teenagers do read enough. That bothered me.... I learned to kind of ignore things that weren't helpful. I don't know if I can do that or not ... I will just use the ones that would support my argument.

Students introduced only linked information the negative sides of their arguments. For example, when S4 (*Building more runways*) argued for his side, he ignored much information and included only one negative point, which he used to persuade his audience that the point did not really describe a problem. In his outline, he indicated that "noise and pollution" would not be an issue because the "FAA limits them."

6.3.6. Create

The highest level of learning in the revised taxonomy is "create," which was originally defined as "put elements together to form a coherent or functional whole; reorganize elements into a new pattern or structure" (Anderson and Krathwohl, 2001, p. 84). For this study, it was redefined as "put different ideas and information together to form a coherent or functional whole; review and reorganize them into a new pattern or structure." "Create" subsumes the five lower levels of learning and emphasizes that learners generate their own knowledge structures representing their understanding of information in a coherent manner. The cognitive activities of (1) hypothesizing and (2) constructing are associated with "create."

6.3.6.1. Hypothesizing

When students selected their topics and started their searches, they had preliminary hypotheses (arguments) that they wanted to prove with the information they found. All the students interviewed had generated their own hypotheses regarding their

topics. While some hypotheses kept changing as students found new information, most hypotheses remained the same.

Some students were not very knowledgeable about their topics in the beginning, and their preliminary hypotheses could be easily challenged by new information. For example, S21 (*TV/Music effects on people*) shifted her hypothesis several times: from "TV/Music did not have an effect on people," to "Violence of TV/Music has a negative effect on young people," and finally to "TV/Music has both positive and negative effects on young people." S11 (*Is 16 too young to drive?*) also changed her hypothesis from "Teenagers are not too young to drive" to "Teens can be safer drivers if they follow the graduated license program." S17 (*School uniforms*) changed from "school uniforms influence behavior, self-esteem, and academics of students," to "school uniforms decrease violence, improve self-esteem, and improve academics," and finally to "school uniforms have social and economic value and reduce crime and suspension rates in schools." The changes reflect the fact that the information students found did not support their preliminary hypotheses.

6.3.6.2. Constructing

The outline template specified that a hypothesis (an argument) should be supported by assertions and reasons under each assertion as well as by evidence supporting each of the reasons. Thus, each student's hypothesis was expected to be supported by a coherent structure conveying strong reasons based on information. In order to make coherent structures, students tried first to make sure they had information about everything listed so there was something to put in all the required slots.

When students perceived conceptual holes as they listed their ideas and information, they went back to the sources to get more information. For example, S5 (*Cell-phone use while driving*), S16 (*Pledge in public schools*), and S19 (*The importance of reading*) confessed that they had to return to their searching to get more information to fill holes either perceived on their own or shown in their outlines.

To make the overall structure coherent, each student decided on a general approach at the beginning of the project. The two most frequently used approaches were (1) pros and cons (by 13 students) and (2) problems and solutions (by 8 students). Based on the approach selected, students had to generate their own structures to prove their hypotheses. Students reviewed their outlines at least twice to make sure they made sense.

Students recognized that merely filling the required slots would not guarantee good outlines. S5 (*Cell-phone use while driving*) emphasized her attempt "to order information in a meaningful sequence." S14 (*Legalizing marijuana*) commented that he organized his information "in different patterns that made sense [for each category]." For example, chronological order worked best for his "history" category but not for his "health-related facts" category. S16 (*Pledge in public schools*) said, "I would say that the outline form really helps when you are integrating. *Because you can see it come together [italics added]*. Outline form helps me break down ideas into more concrete and more organized [ones]."

6.4. Summary and conclusions

This chapter reported the patterns of students' understandings about the topics reflected in their products and how they learned during the process of information seeking and use. The patterns of change reflected in students' documents were grouped into four categories - simple, analytic, organizational, and holistic - and more detailed patterns of changes were identified in each category. Simple changes include five different patterns: adding concepts, dropping concepts, adding evidence, changing evidence, and dropping evidence. Analytic changes include broadening, narrowing, and combining concepts. Organizational changes include creating higher concepts to categorize existing concepts and putting concepts into different categories. Holistic changes include shifting, narrowing, and broadening focus. Students' efforts to formulate a focus on their topics in the beginning led to more analytic and holistic changes at the earlier stages of information seeking and use than at the later ones. As they moved along to put their ideas and information together for their final products, students made more organizational changes.

Students' learning experiences were both "data driven" and "goal driven." In the beginning of the process, as they were trying to understand their topics and to formulate the foci for their speeches, students were especially open to the available information. As they found information that made certain aspects of the topic interesting, students developed and refined their foci. In other cases, the information gathered indicated that certain aspects of the topic were more interesting or easy to pursue than others, leading students to focus narrowly on those aspects.

The electronic environment is particularly friendly for "data-driven" learning. Students considered the amount of information available a great advantage because they believed they could find at least some information related to their topics in some ways even if they could not find the exact information they wanted. Changing topics was influenced mostly by the information they found in their initial searches. When they found too much or too little information on their chosen topics, they changed their topics into more manageable ones.

Students often discovered new ideas from searching in the electronic environment. The number of appearances of information was important for students' decisions to include that information in their speeches. If different searches yielded the same information, students considered this information an important aspect of their topics and included their discoveries as new concepts.

"Goal-driven" learning was related to the requirements for the assignment. As students became clearer about their foci, they tried to formulate their speeches to satisfy these requirements. Filling all the slots of the outline template was another important goal for students. They listed all the information they found that supported their ideas; if they found any holes in their outlines, they found more information to fill them. The time limit required by the teacher was important in guiding students to tailor their speeches to seven minutes: they had to select the most important information they could cover in that time.

Students' cognitive activities while using information fell into all six levels of learning found in the revised version of Bloom's taxonomy (Anderson and Krathwohl, 2001): remember, understand, apply, analyze, evaluate, and create. Using original and

redefined descriptions of each level of learning as appropriate for this study, more detailed cognitive activities were identified under each. All the specific activities began right after students started their searches.

The students' learning task required them to achieve the highest level of learning, "create." Students engaged with information more as they applied the higher levels of cognitive skills identified in the revised Bloom's taxonomy. Students' learning progressed as they engaged with information to produce their own products. As they moved closer to their final products, they used the higher levels of cognitive skills.

The lower levels of learning – "remember" and "understand" - were particularly enhanced by the electronic environment that allowed them to access much information in their searches. In other words, cognitive activities such as recognizing, recalling, comparing and generalizing information, and capturing specific information were supported by the electronic environment. Since there is a great amount of information readily available to students in many different formats these cognitive activities occurred much faster and more easily with electronic than with print sources.

The higher levels of learning – "apply," "analyze," "evaluate," and "create" - were guided and facilitated by the tools assigned for the students: concept maps, note cards, and the outline template. Particularly, the outline template was a significant tool for the achievement of the highest level of learning, "create." At the level of "apply," two cognitive activities emerged: generating ideas from the extracted information and reshaping ideas to match the information. For the "analyze" level, students used two cognitive activities: (1) focusing and (2) categorizing and outlining. For the "evaluate"

level, students used (1) prioritizing and (2) testing. In the highest level of learning, "create," students' cognitive activities were (1) hypothesizing and (2) constructing.

Chapter 7: Conclusions and Implications

The focus of this research was the overall question of how high school students use information to learn. The concluding sections of chapters four, five, and six summarized the findings from each of the major aspects of the study and pointed out some of the specific issues coming from them. This chapter revisits the major findings as a whole and draws general inferences from across the full set of findings. It also draws issues and implications for library media specialists, systems designers, and future researchers.

7.1. Overview of findings

Qualitative inquiry has proven to be appropriate for this study because it allowed the researcher to explore how the processes occurred in an authentic context and to identify the issues and patterns that emerged. All three data sources – documents, interviews, and observations – were important in producing the findings, as the researcher triangulated the data from these sources in the analysis.

This research involved the use of self-constructed concept maps in conjunction with individual interviews as research tools to capture how and when the specific changes in students' knowledge occurred. This approach was unique because the most dominant use of concept maps from many studies has been testing students' mastery of content in rich conceptual areas in controlled settings using quantitative measures. In this study, using concept maps and individual interviews allowed the researcher to study students' learning processes as they occurred in an authentic context and to follow the

students' learning activities as students sought information and produced their final products.

Analyzing the findings in the light of various theoretical perspectives allowed the researcher to analyze and present the findings at a higher level of abstraction. In particular, this study grounded its findings in two theoretical frameworks related to meaningful learning: Mayer's SOI model (1999) and Bloom's revised taxonomy (Anderson and Krathwohl, 2001). Because the original SOI model does not reflect the context of independent information seeking and use and because it does not account for how students learn by using information independently, two new processes -- gathering and using -- were added to Mayer's original three -- selecting, organizing, and integrating. Integrating was seen as an underlying process because students constantly integrate information as they gather, select, organize, and use it. Meaningful learning in the context of information seeking and use must consider specifically how all five of these processes are related to the creation of meaning by individuals.

In reporting the processes of gathering, selecting, organizing, integrating, and using information, this study not only presents findings that corroborate findings from existing studies but also provides some partial answers to the questions raised by these studies. As research indicates (e.g., Bilal, 2000; Fidel *et al.*, 1999; Marchionini, 1989), students' searches are highly interactive rather than analytical. Students choose to start broadly and to narrow their ideas by interacting with sources. Because students in this study were very familiar with using the Web, they expected to get many results from their searches and moreover were not overwhelmed by the task of searching or by the amount of information available. During a series of searches on a topic, students

expected to refine their ideas through a process that began with using broad and general search terms and continued with browsing and scanning results for specific ideas. Thus, they gathered general information first and specific information later. This strategy proved effective because they did not often have clear ideas about their topics at the beginning of the project.

This finding provides a partial explanation of an issue raised by the findings of an existing study: why students perform better on ill-defined tasks than on well-defined ones (Schacter *et al.* 1998). In the current study, interactivity occurred not only in searching but also in learning during searching. The nature of the learning task in this study was ill-defined in that the task encouraged an exploratory mode of learning across subject domains rather than being confined to a specific subject domain. Students had already developed their skills as interactive searchers through many previous uses of Web sources.

The common patterns among students in gathering and selecting information confirmed that Siegler's overlapping wave model (1997) applies to information seeking and use for learning. Students used strategies they knew had worked for them in earlier attempts to search electronic information on the Web. Popular strategies included these six: browsing and scanning the titles to see what was available on topics, following links to other documents, emailing documents to their accounts, weeding documents that were difficult to read, reading and skimming documents, and highlighting. According to Siegler (1997), strategies that are frequently used will be continuously more prevalent, whereas strategies that are seldom used will gradually disappear. This

research suggests that these six strategies will be used more often because they meet students' needs in an electronic environment.

Students' strategies and activities were heavily affected by instruction and the given assignment. Particularly, students tried to make sure they used reliable sources to meet the requirements of the assignment for using authoritative information. When they had choices between two pieces of information, they selected the one with more authority by examining the author's credentials and the credibility of the publishing organization, regardless of the content. Students' use of an outline template, an organizational method adapted by the teacher, was another key example. From the beginning, students looked for the kinds of information that the teacher listed as appropriate for the assignment - facts, examples, experts' opinions, and statistics - and tried to extract appropriate pieces of information or ideas and insert them into slots of the template to complete their outlines.

The other framework used to explore the process of using information for learning was the revised Bloom's taxonomy by Anderson and Krathwohl (2001). By identifying six levels of learning with respect to the different levels of cognitive skills involved with each, the taxonomy provided a framework for identifying cognitive activities at each step of the processes of information seeking and use. This study particularly reports that students used all levels of cognitive skills and applied higher levels of cognitive skills as they engaged more deeply with information.

The study thus provides some insights into the question raised by McGregor (1993) about when and how students use higher-order thinking skills. Students in her study with eleventh-grade students in a gifted program also used all levels of higher-

order thinking skills as they searched for and used information to build their own knowledge structures. In the current study, all the detailed cognitive activities under each level of learning (see table 28, p. 185) show how and when higher-order thinking skills were used. The findings indicate that the electronic environment enhanced students' use of low levels of skills – remember and understand – in the beginning of their progression toward their goal. Students' uses of higher levels of skills – apply, analyze, evaluate, and create – were largely guided and more affected by the tools provided by the teacher as students focused more to create their final products. Particularly, the teacher's emphasis on reliable sources, the outline template, and the concept maps all guided students' achievement of the three highest levels. Students relied heavily on those tools as they tried to diminish the cognitive burden imposed by these higher levels. The findings here reinforce Neuman's (2001, 2002) findings of the importance of providing instructional guidance to "structure" information as students engage in learning with electronic information.

Students' documents reflect that new information played a significant role in students' use of information as they moved to create their information-based speeches (see table 15, p. 153). Four types of change patterns in students' understanding were identified: simple, analytic, organizational, and holistic changes. These patterns are consistent with Ausubel's four types of learning – subsuming concepts, progressive differentiation, integrative reconciliation, and superordinate learning. The patterns also illustrate the "exploration" stage in Kuhlthau's Information Search Process model (1991, 1993). In the beginning of the process in the current study, students tried to formulate foci for their topics as they explored new and different ideas, engaging

primarily in analytic and holistic changes as they did so. However, as they moved along to create their final products, more simple and organizational changes occurred (see tables 16 and 17, p. 155). Throughout the process, simple change was the most dominant type of change that occurred (see table 15, p. 153), reinforcing Todd's (1999) findings that appending, inserting, and deleting ideas in one's knowledge structure were the dominant types of knowledge change when adolescent girls sought information on heroin use.

This study found that students' learning with information is both data-driven and goal-driven. Students learned throughout the process of information seeking and use, indicating that they integrated new information with their existing ideas as they searched and used information. Particularly, this kind of learning is different from learning in a traditional classroom setting, where structured learning materials like textbooks are available to students. Data-driven learning was facilitated by students' own searching and using information to construct their ideas, and goal-driven learning was facilitated by the teacher's instruction and the tools designed to help students generate their products.

7.2. Overarching theme: Dynamic learning - interactivity and serendipity

Students' learning was dynamic. All five processes in the modified Mayer's SOI model – gathering, selecting, organizing, integrating, and using – were greatly influenced by many factors: the nature of students' task, the teacher's and library media specialist's instructional activities, and the information environment in which students worked. In all the processes, students needed to use a variety of cognitive skills to

construct meanings from information encountered as they created their information-based products.

Two themes that could be drawn from the findings – interactivity and serendipity – illustrate the characteristics of dynamic learning. Interactivity indicates students' cognitive work at making sense of information encountered by interacting with the sources. The other theme, serendipity, can be defined here as the students' practice of seeking, finding, and recording information from many different places, without expectations, and with no clear direction in mind.

Students' general perceptions and understandings about information and information sources revealed that students implicitly expected to learn "something" from interacting with information and information sources. Their expectation was not necessarily to find precisely what they wanted but to find anything related to what they wanted, even if it did not match their preliminary ideas. Thus, students' learning was data-driven to the extent that they used all the information they found to help them settle on specific foci for their speeches.

Interactivity and serendipity emerged as themes particularly because of the availability of the electronic sources as research tools and because of the nature of the learning task, which allowed students to pursue their learning in their own directions according to self-chosen topics. Students began their searches with preliminary ideas without analyzing thoroughly their needs and questions in advance. They perceived the amount of information available as a great advantage for doing research. Students did not have information anxiety in conducting their searches. They believed that they would eventually get something because of the great amount of information available

online. When they did not find exactly what they wanted, they continued to search in the belief that they would find "something" related to it. If students could not find the information for their initial foci, they were willing to turn their arguments to different ones according to the new information found. Students, in fact, were highly influenced by the new information found during searches and tried to adapt their foci to accommodate the information.

7.2.1. Issues related to library media specialists: Preparation for dynamic learning

When students gathered information, they used strategies that led them to a wide range of information before they formulated the foci for their topics: they used broad search vocabulary "to see what's out there." This approach was contradictory to the notion of the library media specialist in the study, who believed that students should think thoroughly in advance about the specific questions that needed to be asked and answered in searching about their topics. She was aware of students' preference to be "interactive" with their searches but understood it as a problem or an indication that students were not successful in searching.

It is hard to say whether "interactive" searching or "analytic/planned" searching should be pursued in the early phases of students' learning about a new topic. However, one clear finding of this study is that interactivity is a characteristic of students' perceptions and behavior. The findings suggest that the electronic environment fosters dynamic rather than fully planned learning. As S17 pointed out, he chose not to focus narrowly in the beginning because he was afraid to miss out on much of the good information that he might find that was related in some way to his topic. Library media

specialists might have to think differently and try to address the dynamic nature of learning in searching - for example, focusing on the skills students need to narrow their ideas as they search. Students' cognitive activities identified using the revised Bloom's taxonomy (Anderson and Krathwohl, 2001) could be used as a framework to develop instruction on, for instance, "how to learn interactively." Those activities could serve as empirical bases for building objectives that would target students' need to practice more successful information seeking and use. Once students know that they learn interactively, they might be able to examine their processes more carefully by focusing on the specific activities associated with each level of learning.

Library media specialists should also provide guidance on search terms during the latter stages of their searches. Although students started out using broad search vocabulary, they needed more specific vocabulary for different aspects of their topics as their searches got more targeted. However, they continued to use the same broad vocabulary to search about specific aspects of their topics. More systematic instruction on developing search terms should be given to students to help them as they progress through their searches. For example, a library media specialist could point to the thesaurus or dictionary for similar terms or could advise students to extract some words from the indexes and tables of contents in some of the introductory documents available to them.

In this study, students unexpectedly found and used much information. Information available in electronic sources, including the Web, poured over the students, who picked up bits and pieces of information from their hits and tried to make meaning from these isolated elements. The nature of the electronic environment enables

gathering information serendipitously. Many information systems, including the ones the students in this study used, rely only on free-text searching without any subject guidance. Unless the information has some relevance to the topic at hand, this practice reinforces fragmented learning rather than systematic knowledge creation. Particularly because they did not use analytic search strategies, which would have enabled them to identify clear and specific search questions, students pursued new information on different aspects of their topics without the necessary background knowledge.

The library media specialist's job should not be limited to helping students gather information but should include providing guidance throughout the whole process of information seeking and use. Often, library media specialists participate only with finding what students want. As the library media specialist in this study mentioned, she is involved only with the gathering of information and does not intercede in organizing information unless students ask. Library media specialists need to participate throughout the process and to develop tools that will help students construct knowledge from information gathered serendipitously. Some students are good at constructing personal meanings in a coherent manner, while others are not.

In this research, the teacher's provision of several tools such as note cards and the outline template enabled students to construct their ideas and information in a certain format. Students thought the outline template to be very helpful for integrating their own ideas with the new information they found. However, the outline template was used only to create the final speeches. Except for the concept maps that the researcher assigned, students had no help in going through the process of information seeking and use to formulate and to organize ideas to prepare for the outlines. Another

tool given by the teacher, note cards, also provided a way for students to organize the information in accordance with the ideas reflected in their concept maps. However, the cards were used only for recording information and not as a mechanism for putting that information into a logical pattern. Library media specialists - as experts in the process of information gathering, selecting, and organizing - should work with teachers to develop more specific and detailed tools, such as concept maps, so that students can integrate the information they have gathered with their own ideas in a more coherent manner.

The finding that students' learning progressed with their engagement of information according to the revised Bloom's taxonomy (2001) also suggests the importance of providing appropriate tools to guide students' information seeking and use to achieve meaningful learning. As the findings indicate, the tools used to help students construct their own knowledge structures – concept maps and outlines – were particularly crucial in applying higher levels of cognitive skills such as analyze, evaluate, and create.

7.2.2. Issues related to Systems Designers: Support for dynamic learning

The overall themes of interactivity and serendipity suggest issues for systems designers as well as for library media specialists. Although the research began with no intention to focus on learning only in the electronic environment, students' use of the electronic sources was dominant and became the main focus of the research. The results suggest how the systems used by young learners should be designed to support

students' interactivity and serendipity in information seeking and use for meaningful learning.

One fundamental issue identified in this research as well as in other studies (Solomon, 1991, 1993; Neuman, 1991b, 1993) is the students' need for guidance in translating their interest into search questions or terms. Previous research using systems operating with controlled vocabulary identified conceptual as well as linguistic gaps between students' knowledge and vocabulary and systems' knowledge structures and vocabularies. The current research involved three recommended electronic sources and the Internet, all of which defaulted to free-text searching using Boolean or natural-language search options. Only one of those systems, however, had controlled-vocabulary searching as an option. Systems using controlled vocabulary ask students to find the right vocabulary for their searches, while systems using free-text Boolean or natural-language search options directly require students to find the right words that authors used for their particular documents. Both kinds of systems ask students to identify the exact words that either a system employs or that authors use in order to find relevant information.

Whether information is structured with controlled vocabulary or with subject categories, and whether information is retrieved based on free-text keywords or browsing, the information structures of sources that support information retrieval should be designed to help students access and retrieve information easily so that learners can construct their own knowledge. If a source is to function well, its structures and its vocabulary should be easily understood and retrieved by students so that they are able to

construct new meaning in the process of integrating information into their cognitive structures.

This research suggests that systems could be more useful to students if they addressed students' preference to learn interactively and serendipitously. The students who participated in the study learned by interacting with the information retrieved when they used broad vocabulary. Students' preference for interactivity was so strong that they even tried to be interactive using print sources, with which they were not so successful because of the tools' lack of interactivity. For example, using a print index such as the *Readers' Guide to Periodical Literature*, students used vocabulary that was too broad to allow them to browse manually; the lack of a built-in mechanism for narrowing often meant that students failed to find the information they wanted. Electronic sources could easily support interactivity by providing several tools. For example, such tools could display several conceptual paths that students could take, using broad terms at the beginning of their searches and narrowing their searches as they progress. Such tools could include many different forms of subject guides, - such as thesauri, indexes, classification schemes, etc., - that would display a system's organizational structure to the students.

In addition, systems could provide a way to match students' vocabulary to the systems' or the authors' vocabulary. Students' limited experience in searching and lack of knowledge about their search topics often combined to yield ineffective search terms or questions. Systems could guide users to more commonly used vocabulary in the topic areas. None of the electronic sources that students used had this function. Many of the suggestions made here are, however, not new. For example, Neuman (1993) reported

that students had difficulties in using bibliographic databases and made suggestions to design the databases in formats that students could use as tools for learning by adapting the perspective of Instructional Systems Design. While this study's finding of the importance of incorporating such tools for students to focus on learning echoes Neuman's (1993) findings, it adds another framework by providing insights on how students' learning occurs throughout the processes of information seeking and use in an Internet environment.

Although the sources students used were intended for high school students, they did not adequately support students' learning needs. Students' preference for "interactivity" means they make series of searches, some of which are related to one another and some of which are not. The systems in use, however, did not allow students to build series of searches on their topics. In addition, students wanted to catch information in the moment by relating it to their thoughts about their topics; however, the systems did not include functions that address that preference.

A "note-taking" function could be very helpful to students in this regard. Although some information systems designed for students' educational use, such as ARTEMIS (Wallace *et al.*, 1998), include a note-taking function, the systems that students used for this study did not have it. All the electronic sources used allow students to email full-text documents to their individual accounts, but they do not provide ways for students to make connections from the information to their topics and to indicate why the documents are related. Several students reported that many times they could not recall why they emailed or printed some particular documents because they later determined these were not relevant at all. If the moment of thought is lost, it is

hard to gather it later. A note-taking function would also address students' unwillingness to take notes unless required. It would allow students to include their ideas on the information presented to them and would thus support their preferences for interactivity and serendipity even more strongly.

Students did not want to face a heavy cognitive demand when searching. As two students indicated, they liked the sources to do some of the intellectual job for them. For example, these students praised an Internet site, *Ask Jeeves*, that asks the user to type a search question and then displays other search questions that are related to the original question. Often, those questions are more specific and narrow than the students' original question. The two students liked and used this function for their assignment because it diminished their cognitive effort. The list of questions that the site brought in response to their questions enabled them to interact with information and to retrieve information serendipitously. This site provides a good example of a way to support students' meaningful learning by addressing their preference for interactive and serendipitous searching.

7.3. Further research

There are many opportunities for future research branching from this study. These include studies that address methods for evaluating students' information seeking and use as a whole, that expand findings here to other contexts, such as different subject domains, with different learning tasks, and in different age and grade levels; and that investigate the nature of learning strategies in information-rich environments.

More effort should be directed to develop methodologies to assess the meaningful learning that results from students' interactive and serendipitous processes of information seeking and use. These methodologies should allow researchers to address not only the skills students use to find relevant information but also the skills they need to learn from the processes of information seeking and use. Measuring the processes requires not just a snapshot of what is occurring. It requires a comprehensive understanding of how meaningful learning occurs and how knowledge changes throughout information seeking and use. "Meaningful learning" should be emphasized as the goal of information seeking and use in the context of K-12 education.

This study explored the use of individual interviews and concept maps as a research tool. In particular, the findings showed that ideas represented in concept maps affected students' focusing and organizing of ideas throughout the processes of information seeking and use. However, this study did not examine how students who did not use such a tool progress with focusing and organizing their ideas. Gordon (2000) showed some differences between concept mappers and non-concept mappers in searching for information. Future research could address how concept maps serve as a conceptual guide for students' intellectual journey throughout the processes of information seeking and use.

Future research in regard to students' use of information to learn meaningfully could continue to explore this study's original research question in more depth. Little is known about students' learning with information. The issues this study presented suggest a need for much more research. Particularly, more extensive and in-depth

studies could corroborate the findings of this study on how students progress with their learning as they engage with information.

Students' abilities to seek and use information for their learning can be studied in other contexts. The change patterns in students' conceptual knowledge that this study identified can be examined with different subject areas; age groups; ability levels; and learning tasks – especially learning tasks with a bounded topic or problem for which students, to be successful, must find and understand specific pieces of information. Students' use of information and of the cognitive skills they employ during the processes of information seeking and use could be different according to these different contexts.

How meaningful learning occurs might be different according to subject domains and levels of complexity in terms of the cognitive activities students must bring to bear. For example, in a more confined subject domain with more established knowledge structures, such as science, students' learning tasks often requires a specific knowledge domain and rely on narrower choices of sources. It is possible that less serendipity might occur as a characteristic of students' learning in this context.

Studying students' meaningful learning in the context of a more confined subject domain might allow researchers to evaluate whether information included in students' products is an accurate representation of the domain. If it is inaccurate, further research should examine the causes of students' misunderstandings in order to suggest some guidance to help students dismiss false information. For example, Small and Ferriera (1994) reported that middle school students who used a multimedia source, a laserdisc about Van Gogh, represented inaccurate knowledge about Van Gogh in their

pattern notes. These researchers speculated that students considered their inaccurate information as accurate because they could not find the information that disconfirmed their false belief. This finding certainly raises an issue in the context of information seeking and use regarding students' learning with electronic information, particularly information from the Web.

Involving less-advanced students in a study might also result in different findings. During data collection for this study, the teacher and the library media specialist repeatedly mentioned that the participating honors students were different from their other students because these students were much brighter and more responsible. Their performance as reflected in their documents generally satisfied the teacher's expectation. This could be because students in this study were able to use a variety of cognitive skills to produce their own products. Less-advanced students might have difficulties using all the necessary cognitive skills; research into their higher-order cognitive skills in particular and might show different patterns in gathering, selecting, organizing, integrating, and using information.

Younger students might also show different patterns of information use for meaningful learning. Because of their developmental stage, they might have some cognitive difficulties in using information fully and consequently might demonstrate different patterns of strategies and activities. Therefore, they might need more instructional guidance to achieve higher levels of learning.

. Finally, research should explore the characteristics of learning fostered by electronic environments and the ways in which information seeking and use for meaningful learning are fostered in these environments. The importance of structuring

the pieces of information gathered was emphasized as a way to foster meaningful learning in a Web environment by Neuman (2001, 2002), who recognizes it as crucial and suggests it as an important component of the instructional guidance students need in order to learn in such an environment. Other aspects of learning with information in such environments should also be identified and explored.

7.4. Finale

How do high school students' information seeking and use contribute to their meaningful learning experiences? Achieving meaningful learning has been explored by examining the processes of information seeking and use for a particular learning task. This study was exploratory, touching upon a series of aspects of students' information seeking and use in pursuit of meaningful learning:

- Students' perceptions and understandings about information and information sources;
- Students' strategies and activities for gathering, selecting, organizing, integrating, and using information during the processes of information seeking and use;
- Students' use of information to learn as reflected in their documents.

These threads were examined in chapters four, five, and six, respectively. Detailed findings for each were reported there, and more complex ideas drawn from the findings were found in the summary and conclusion sections of each chapter. The

purpose of this final chapter was to expand upon these chapters and to suggest overriding themes drawn from all the findings.

Students' dynamic learning in the context of information seeking and use is supported by two themes that inform all the findings, interactivity and serendipity. These are unique characteristics of dynamic learning, particularly within an electronic environment. While many of this study's findings corroborate the findings of other research, the findings extend that research by extending the view of information seeking and use to address meaningful learning experiences. This research attempted to go beyond looking at information gathering to consider the whole process of information seeking and use in pursuit of meaningful learning.

The information science, learning, and teaching fields do not have comprehensive knowledge of how learning in electronic environments occurs. This research offers one piece in the puzzle of our understanding of how information seeking and use contribute to meaningful learning. More research should be done in the future to understand more about how we use information to learn. The answers to this question will help us become more effective designers, learners, teachers, library media specialists.

APPENDIX A – FORMS RELATED TO PERMISSION FROM IRB (INSTITUTIONAL REVIEW BOARD)

UNIVERSITY OF MARYLAND, COLLEGE PARK
INSTITUTIONAL REVIEW BOARD

APPLICATION FOR INITIAL REVIEW OF RESEARCH USING HUMAN SUBJECTS

Name of Principal Investigator Dr. Delia Neuman Tel. No. 5-2054
(Not a student or fellow)

Name of Co-Investigator N.A. Tel. No. _____
(Not a student or fellow)

E-Mail Address of P.I. mn9@umail.umd.edu E-Mail Address of Co-P.I. _____

Campus Address of P.I. 4105 Hornbake South Wing Zip _____

Name of Student Investigator Jinsoo Chung Tel. No. _____
(Student, Fellow, Post-Doctoral Fellow)

Student Identification No. 511-11-2693

Department College of Info. Studies Project Duration (mo/yr - mo/yr) Feb - May 01

Project Title Information Use and Meaningful Learning

Funding Agency N.A.

Please attach a copy of your responses to question I - VI of the instructions (on page 2 of this document), including all related documents, such as questionnaires, interview questions, surveys, etc.

Please indicate whether this research should be exempt or non-exempt from further human subjects review and indicate which of the six exemption reasons (described on page 3 of this document) justifies an exemption status:

Exempt (list all possible categories) 2 Non-Exempt _____

If exempt, please briefly describe the reason(s) for exemption. Your notation is simply a suggestion to the IRB.

The research will use "interview procedures and observation of public behavior" and will not allow participants to be identified in any way. (category 2)

1/29/01 Delia Neuman
Date Principal Investigator (University of Maryland, College Park, employee)

_____ _____
Date Co-Investigator

1/29/01 Jinsoo Chung
Date Student Investigator

2/1/01 Eileen G. Abels
Date Department Chair or (One signature is required)
Departmental Human Subjects Review Committee Chair

IRB-1
2/98 OFFICE OF GRADUATE STUDIES

* PLEASE ATTACH THIS COVER PAGE TO EACH SET OF COPIES *
* SEND (4) COPIES WITH ONE CONTAINING ORIGINAL SIGNATURES *
You may send e-mail to irb@deans.umd.edu to inquire the status of applications.

1. Abstract

How does information seeking contribute to meaningful learning? It is a major research question that will be explored in this proposed research. Although successful information seeking should result in meaningful learning and should be assessed if meaningful learning is achieved, little is known about the relationship between information seeking and meaningful learning. As an effort in the school library media community to aid student learning to be meaningful, the national guideline, *Information Power* (1998), recognizes information literacy skills as critical and identifies nine standards. The proposed study aims to shed light on the issue of information skills in access, evaluation, and use of information in order to achieve meaningful learning.

Using cognitive learning theory, constructivism, and developmental theory together as a conceptual framework, this study explores the learners' perception of information and information sources, the gaps between different information structures of information sources and cognitive structures of learners, and the cognitive strategies that students use while learning from information.

This study will employ qualitative research methods in a naturalistic setting of the school, where student learning takes place. The main data sources include observation of students' information seeking, interviews with the students, and documents including concept maps drawn by students at the beginning and the end of their information seeking and students' search journal. All information collected in the study is confidential, and the student's name will not be identified at any time. During data collection, data analysis, and in final report, a pseudonym will be used instead of the student's real name.

All the policies of both the University of Maryland and Anne Arundel County Public Schools on the use of human subjects will be followed.

2. Subject Selection

Participants will be students, the library media specialist, and teachers. The Arundel High School was suggested as a research site for this study by the Director of Library Media & Instructional Technology in Anne Arundel County Public Schools. The library media specialist and assistant principal selected a group of five teachers. Students who will return their parents' signed consent forms to their teachers will participate this study. Students will not be selected based on any specific characteristics such as sex, race, ethnic origin, etc.

3. Procedures

The researcher and each teacher will select one assignment of his/her class. The study will be conducted for the periods (from February to May 2001) that students research for these assignments in the school media center. Observation, interviews, and documents that students will produce will be the main data sources for this study. Observation will be conducted regularly in the Library Media Center of Arundel High School. Interviews

with individual students will be conducted for about 15 minutes and audiotaped at two different points of times in the course of the students' assignment research. Both observation and interviews will be informal. Documents that students will produce include their concept maps, paragraph descriptions of their assignment topics, and their final products. Students' final products include their written assignments and the videotapes of their presentations. These three data collection methods will be used for students from each of five classes.

All the collected data will be entered to a word process program (MSWORD) and the files will be kept in the researcher's computer system and disks. The collected audiotapes and videotapes will be destroyed one year after the final report is published.

4. Risks and Benefits

There are no physical risks to the participants except those associated with computer usage which students will be required to use in order to finish their assignments by teachers. Care will be taken to ensure that student search habits are not divulged to teachers.

The outcome of the study will benefit teaching and learning of the information skills and enhance student learning.

5. Confidentiality

Privacy of participants will be protected by using assigned names (not the student's real name) during data collection and analysis and in final report.

Only the researcher will know the real identity of students and this information will not be revealed to anyone.

6. Information and Consent Forms

A copy of the study's proposal (draft) has been given to the Library Media Specialist at Arundel High School. Other teachers were given the study's abstract. For students and their parents/guardians, a consent form with the cover letter explaining the purpose of the study will be given. These consent forms will be collected by class teachers.

See attached - Consent Form with Cover Letter.
Interview Guide to Students (Draft)

UNIVERSITY OF MARYLAND
COLLEGE OF LIBRARY AND INFORMATION SERVICES

Room 4105, Hornbake Library
College Park, Maryland 20742-4345
301.405.2033 TEL 301.314.9145 FAX
http://www.clis.umd.edu

January 24, 2001

Dear Parent/ Guardian:

We would like to include your child in a study of information seeking for meaningful learning. The study, which will be conducted at Arundel High School, has been approved by the appropriate Arundel personnel: Assistant principal Shelley Janes, Library Media Specialist Michele Tyrrell, and the teacher of your child's class.

The purpose of our study is to explore how students' information seeking contributes to meaningful learning. The study aims to shed light on the issue of information skills in access, evaluation, and use of information in order to achieve meaningful learning. These information skills are now recognized as critical by two national organizations – Association of American School Libraries and Association for Educational Communications and Technology.

This study will explore the learners' understandings of information and information sources, the gaps between the different structures of information sources and cognitive structures of learners, and the cognitive strategies students use while learning from information sources.

Observing and interviewing students are the main methods that will be used for this study. Interviews will be audiotaped. In addition, students' products for the class will be analyzed. All information collected in the study is strictly confidential, and no student's name will be identified at any time. During data collection, data analysis, and in final report, a pseudonym will be used instead of the student's real name.

I hope that you will consent to your child's participation in this study, which may contribute to students' learning in the future. Please carefully read, sign, and date the attached form and have your child return it to his/her teacher.

Thank you very much for your attention.

Sincerely,

Jinsoo Chung

Jinsoo Chung, Ph. D. Candidate
Delia Neuman, Ph. D.

UNIVERSITY OF MARYLAND
COLLEGE OF LIBRARY AND INFORMATION SERVICES

Room 4105, Hornbake Library
College Park, Maryland 20742-43
301.405.2033 TEL 301.314.9145 F
http://www.clis.umd.edu

INFORMED CONSENT FORM

Identification of Project	Title: Information Use and Meaningful Learning
Principal Investigator	Delia Neuman, Ph. D. College of Information Studies University of Maryland
State of Age of Participants	I state that I am the parent or legal guardian of the child, Name _____ Age _____
Purpose	The purpose of the research is to investigate the relationship of information skills and meaningful learning.
Procedures	The procedures involve three data collection methods - observation, interviews, and documents for a given period of time that is required to finish a class assignment. Interviews will be conducted at two points of time in the school during the period and will be audiotaped. Observation will be conducted regularly in the library media center in the school as students work on their assignments. Documents will include students' written products or presentations. Presentations will be videotaped.
Confidentiality	All information collected in the study is strictly confidential, and the child's name will not be identified at any time. During data collection, data analysis, and in final report, a pseudonym will be used instead of the child's real name. The audiotapes and videotapes will not be released to any other persons except for the researchers. Both tapes will be discarded one year after final report for this study is published.
Freedom to withdraw and to ask questions	I understand that I am free to ask questions or to withdraw from participation at any time without penalty.

I have read the statement of research purpose and procedures. I give my consent for the above named child to participate in this research.

Jinsoo Chung, Ph.D. Candidate
Delia Neuman, Ph. D.
College of Information Studies
University of Maryland
4105 Hornbake Bldg. South
College Park, MD 20742
Phone) 310-405-2054

Name of Parent/ Guardian _____

Signature of Parent/Guardian _____

Date _____

IRB APPROVED
VALID UNTIL
FEB 28 2004
UNIVERSITY OF MARYLAND
COLLEGE PARK

APPENDIX B – LETTERS RELATED TO PERMISSION FROM AACS (ANNE ARUNDEL COUNTY PUBLIC SCHOOLS)

January 24, 2001

Dr. Timothy Dangle
Coordinator of Research
Anne Arundel County Public Schools
2644 Riva road
Annapolis, MD 21401

Dear Dr. Dangle,

I am writing to you to secure the County's formal permission to undertake a study at Arundel High School during the coming semester. I have already obtained permission from Shelley Janes, Assistant Principal, and Michele Tyrrell, Library Media Specialist, to work in the school. Enclosed is a copy of the abstract of my dissertation research to give you an idea of my focus. I will send you a copy of my full proposal, which has been approved by my dissertation committee, if you wish.

This will be an important first step in my research career. I hope to get your formal permission letter soon.

Thank you very much for your attention.

Sincerely,

Jinsoo Chung
Ph. D. Candidate
College of Information Studies
University of Maryland

CC: Shelley Janes, Assistant Principal, Arundel High School
Michele Tyrrell, Library Media Specialist, Arundel High School

2644 Riva Road, Annapolis, Maryland 21401 410/222-5000 • 410/222-5500 (TDD) • 301/970-8644 (WASH)
Carol S. Parham, Ed.D., *Superintendent of Schools*

May 31, 2001

Ms. Jinsoo Chung
Room 4105, Hornbake Library
College Park, MD 20742-4345

Dear Ms. Chung:

This letter grants permission to Jinsoo Chung to conduct a research study at Arundel High School exploring how students' information seeking contributes to meaningful learning.

Anne Arundel County Public Schools supports research that extends our knowledge of the learning process. Approval by the Research Office is contingent upon approval by the school principal, involved instructional staff, and the students selected and their parents. As with any research study, the participation of the school and students is voluntary during any portion of the study.

Please share your findings with us after the completion of your dissertation. I wish you well as you complete the requirements for your Ph. D. in Library and Information Services.

Sincerely,

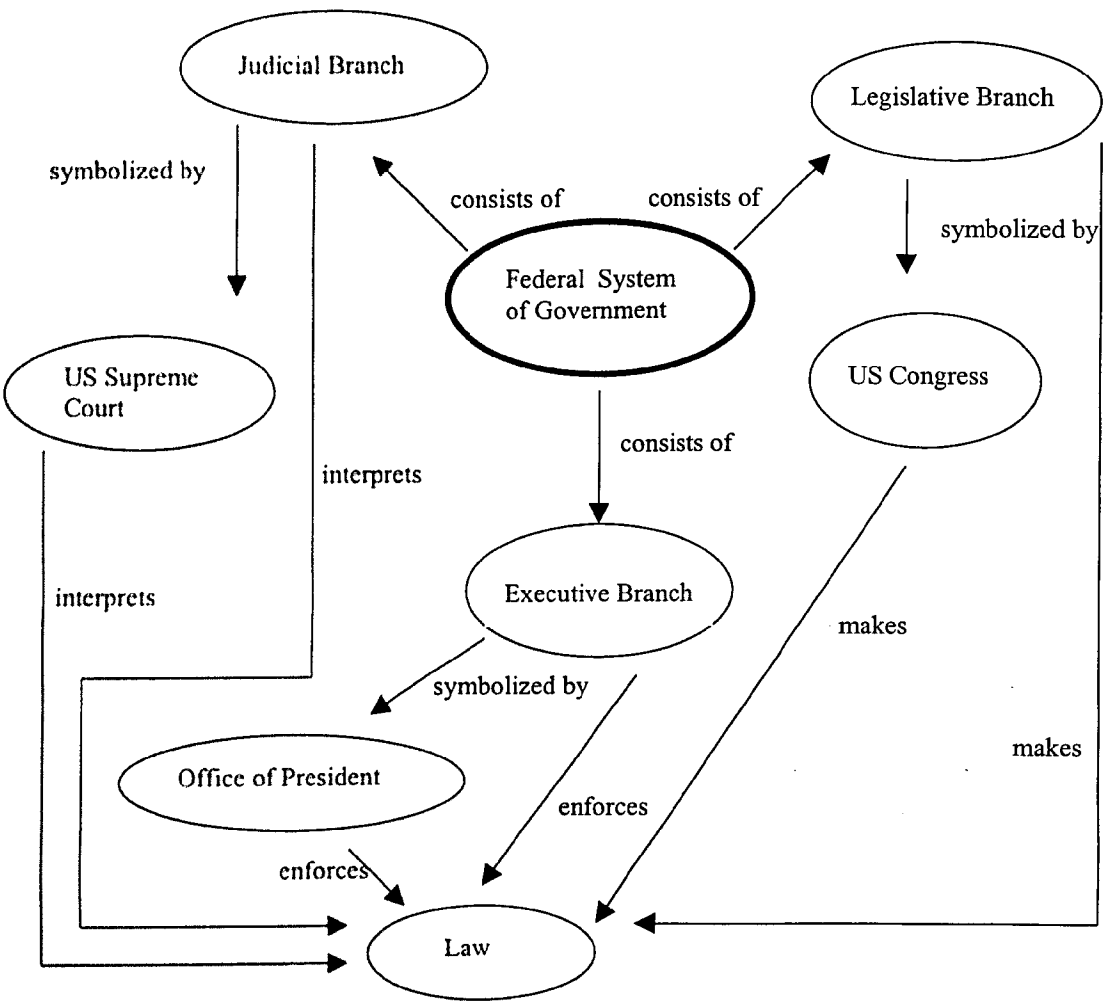
Timothy R. Dangel, Ph. D.
Coordinator of research

APPENDIX C – MATERIALS RELATED TO CONCEPT MAPPING INSTRUCTIONS

CONCEPT MAPPING

A concept map is a picture of a set of related ideas. It consists of labeled ovals and lines. The ovals show concepts. The lines show the relationships between and among the concepts.

<An example of Concept Map on the American Federal Government: Taken from Jonassen (2000): *Computers as mindtools for schools*>



A concept map can show many kinds of relationships. Here are some examples (adapted from Fisher, 1988 in Jonassen (2000): *Computers As Mindtools For Schools*);

1. Symmetry

is same as
is independent of
is equal to

is opposite to
is synonym
is near to

is similar to

2. Inclusion

has parts/ is part of
composed of/ is part in
has example/ is example of

contains/ is contained in
includes/ is included in

3. Characteristic

has characteristic/ is characteristic of
has type/ is type of
describes/ is described by
implies/ is implied by
has disadvantage/ is disadvantage of
has size/ is size of

has property/ is property of
defines/ is defined by
models/ is modeled by
has advantage/ is advantage of
has function/ is function of
is above/is below

4. Action

causes/ is caused by
solves/ is solution for
increases/ is increased by
impedes/ is impeded by
determines/ is determined by

uses/ is used by
decreases/ decreased by
destroys/ is destroyed by
influences/ is influenced by
enables/ is enabled by

acts on/ is acted on by
generates/ is generated by
originates from/ is origin of
requires/ is required by
sends to/ receives from

employs/ is employed by
modifies/ is modified by
provides/ is provided by
regulates/ is regulated by

5. Process

has output/ is output of
has subprocess/ is subprocess of
depends on/ has dependent

has result/ results from
has process/ is process in
concludes/ is concluded by

begins/ is begun by

6. Temporal

precedes/ follows

Instruction for Concept Mapping

1. What is main your topic?
   Draw a large oval to represent it. Label the oval.

2. What concepts are related to your main topic?
   Draw a small oval for each concept. Label each oval.

3. What are the relationships between and among those concepts?
   Draw lines to show these relationships.
   Label each line with the kind of relationship it shows.

4. Continue to add more ideas or change ideas and the relationships between and among ideas as you build your map.

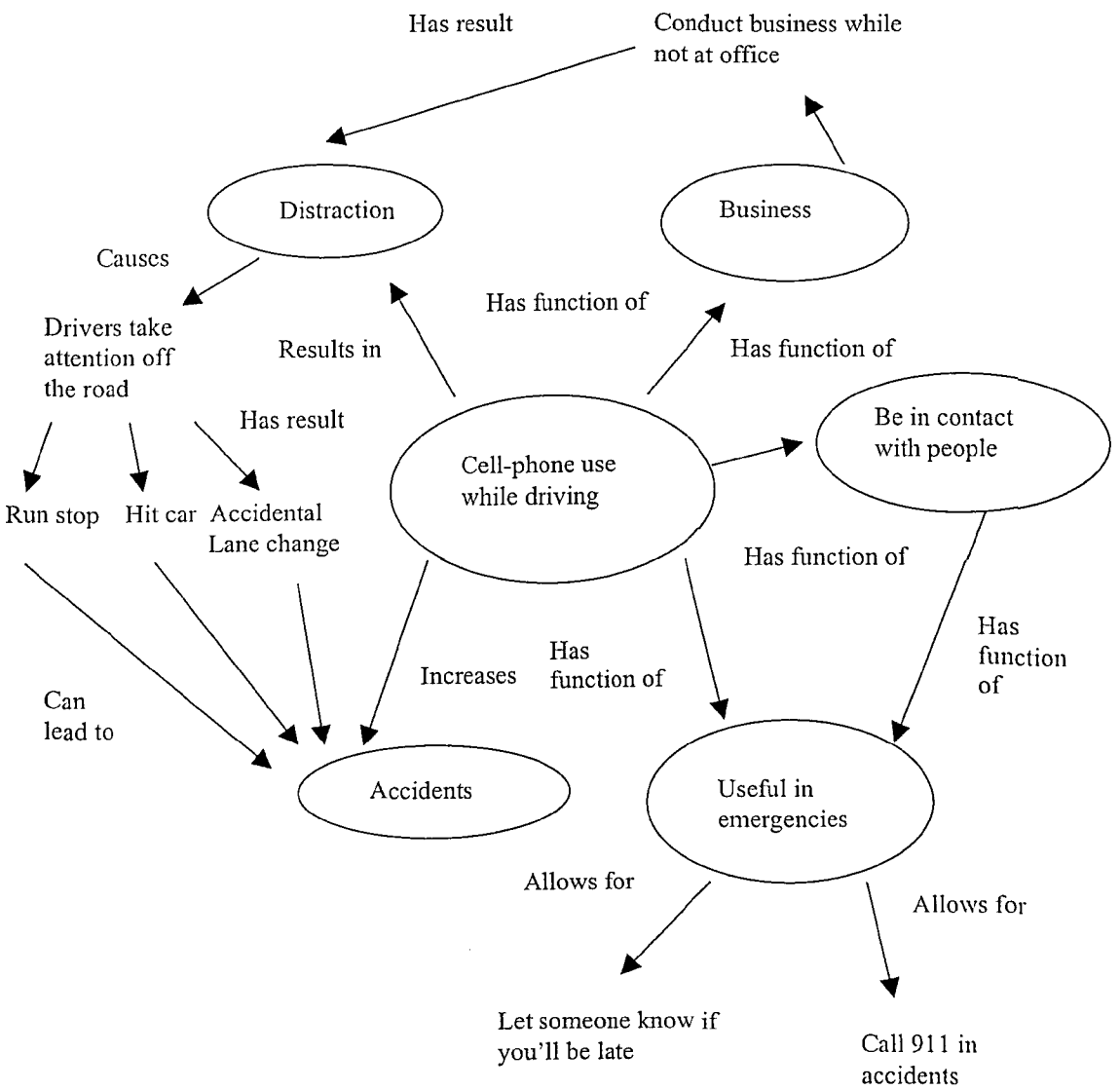
APPENDIX D – FORM FOR STUDENTS' RESEARCH JOURNAL

Form for Research Journal

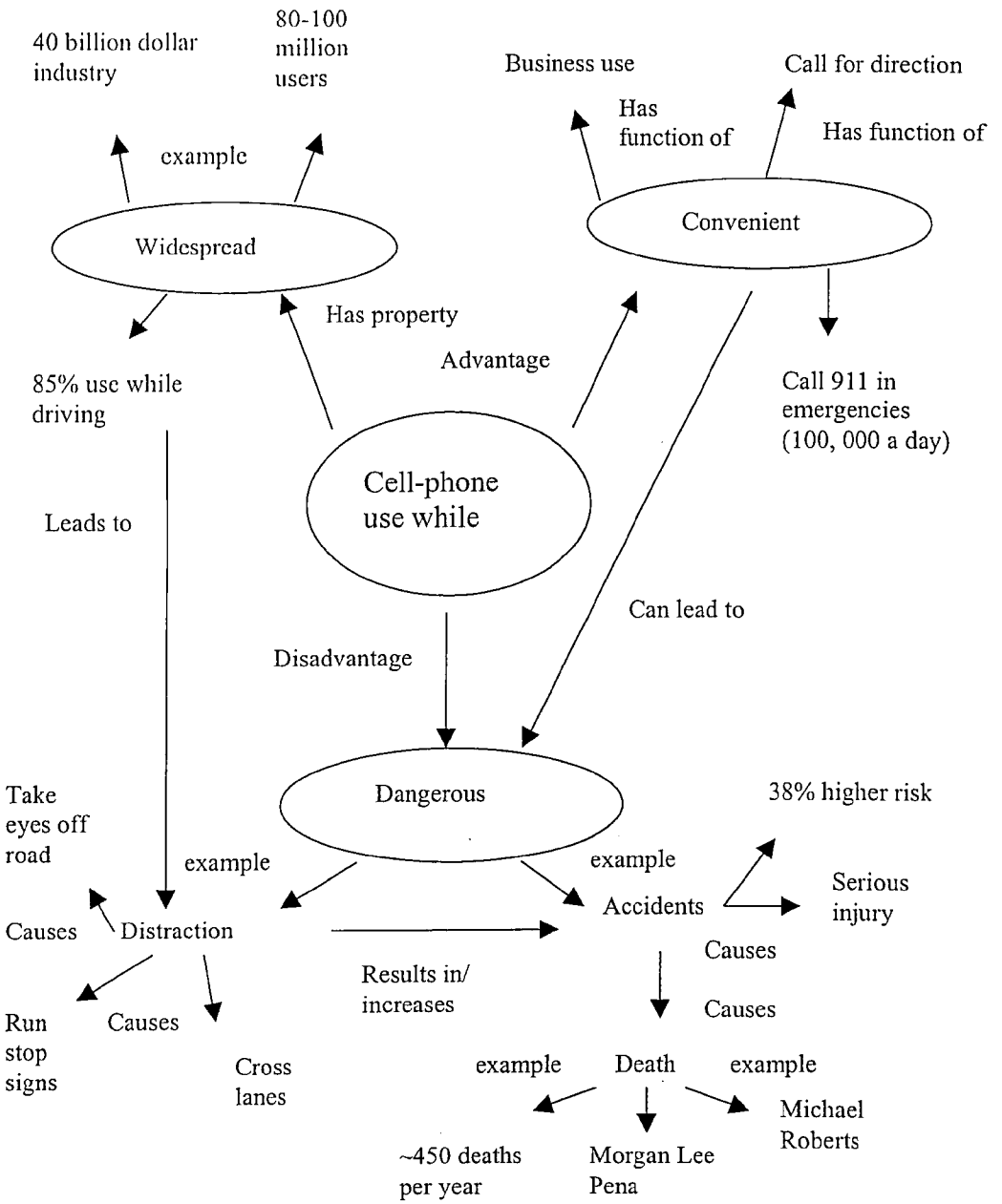
Date	Your Goal	Source Title & pages	Located in	What's used for search (if it's a system, write the name)	How it was found	Helpful for what aspect of a topic	Difficulties in searching and understanding the info found (specifically)
(sample)							
1/1/01	to find info how WWII was started	"world war II" pp.20-25	Public Library	Online catalog	Using keyword search "world war II"	will help identify which countries initially involved	1. Searching with "WWII" didn't give any info/ I had to use full name, world war II 2. Vocabulary used was difficult – "cold war"

APPENDIX E – EXAMPLES OF STUDENTS' CONCEPT MAPS

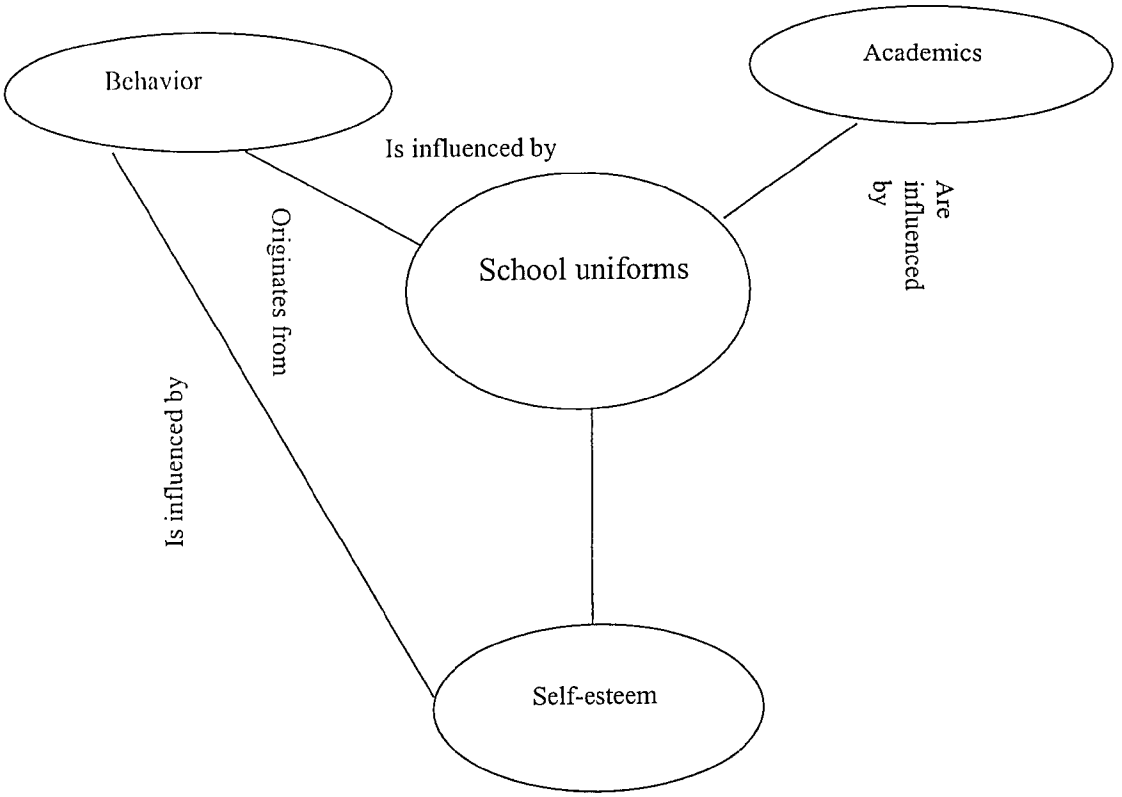
S5's initial concept map (redrawn by the researcher)



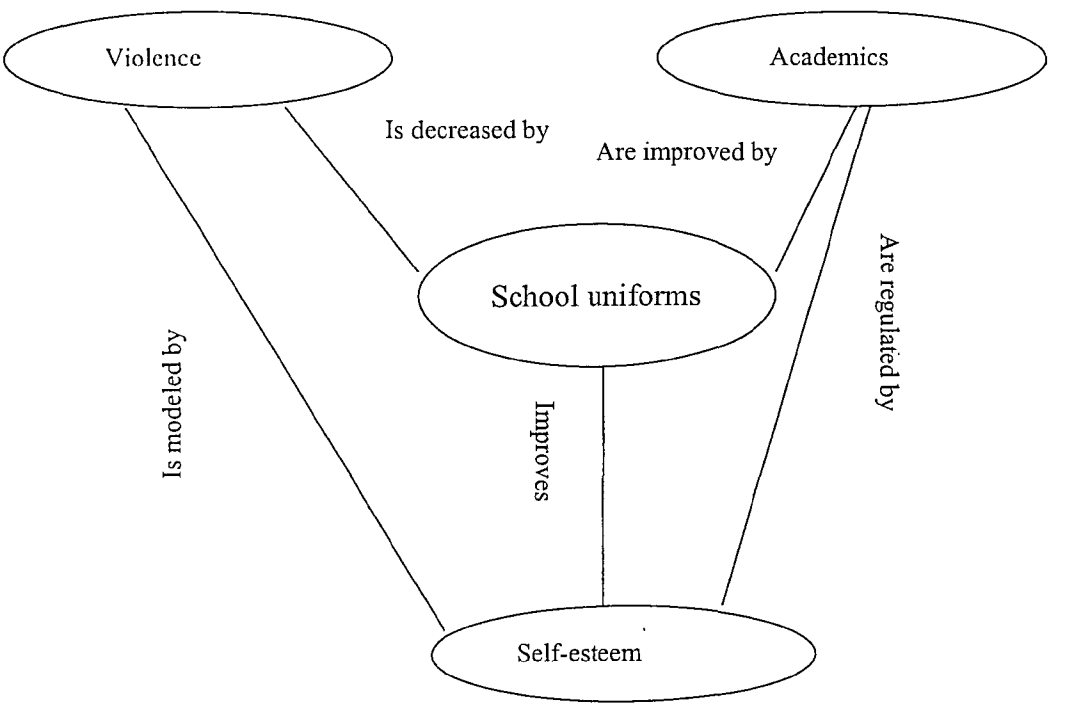
S5's final concept map (redrawn by the researcher)



S17's initial concept map (redrawn by the researcher)



S 17's final concept map (redrawn by the researcher)



APPENDIX F – INTERVIEW GUIDES FOR STUDENTS

Interview Guide for Students: Initial Interviews

1. (With the concept map the student created) How did you come up with these concepts? When and where did you learn these concepts?

2. Do you understand what you have to do for this assignment? Is there any vocabulary that you don't understand in the assignment description?

3. Do you have a plan for your research for your assignment? If you do, what is your plan?

4. How are you going to find the information that you need? Where would you find that information? Do you know how to use the sources you mentioned?

5. How do you think information is organized in these information sources? What are the ways that you can find the information in the sources? (By topics? By date? Other ways?)

6. From your experience, do you find it easy or difficult to get the information you need? If you find it difficult, what is difficult and why? If you find it easy, what's easy and why?

7. What are your definitions of "information" and "information sources"? In other words, what do you think is considered "information" and what is an "information sources"?

Interview Guide for Students: Final Interviews

1. (With concept maps students created)
   1-1. What does the map show about the changes in your understanding of these concepts from your first map?

   1-2. How did the changes in your understanding occur (from searching/ selecting/ organizing/ using information)? What activities and strategies were involved?

   1-3. How did you come up with each new concept? How did you learn those concepts? (from searching/ selecting/ organizing/ using information)

2. How did you know that you had enough information to work with?

3. Was all the information you collected useful for your understanding of the topic? For the assignment itself?

4. How did you gather the information you needed? What were your activities and strategies in gathering information?

5. How did you select the information you needed from the information you collected? What were your criteria?

6. How did you organize the information? What were your strategies in organizing?

7. How are you going to use the information for your final product? What will be your strategies?

8. Are there any changes in your definitions of "information" and "information sources"? How has your understanding been changed since the last time we talked?

9. Are there any changes on your understandings in how information is organized in a source? Will you be able to gather information more effectively and efficiently the next time you have an assignment? Why or why not?

APPENDIX G – INTERVIEW GUIDES FOR THE TEACHER AND THE LIBRARY MEDIA SPECIALIST

Interview Guide for the Teacher

1. What did you expect from students to learn in doing this assignment? What were your objectives?

2. There were a variety of topics that your students chose. Did you have any topic preferences?

3. Do you think the students' research process affect quality of their work? If so, how?

4. What did you think of students' performance? Did you satisfy with their work?

4. What do you think were the most appropriate sources for your students to use? What did you think of the sources that students used?

5. How did you think that my presence affected their behavior and their performance for the written portions of assignment and speeches?

6. What should I have asked that I didn't ask?

Interview Guide for the Library Media Specialist

1. What were your goals in having students use library sources for the students?
2. How do you try to support students' research? What were your strategies?
3. What are the students' problems using sources in doing research?
4. How do you see students gather information?
5. Did you see students develop any strategies in gathering information?
6. Which strategies do you think students should learn to develop?
7. What do you see as students' criteria for selecting information?
8. How do you think that they judge relevance of the information?
9. Were you able to see students' strategies for organization information?
10. How do you think the research process affects students' progress in learning?
11. Do you think that students understand what information and sources are?
12. What should I have asked that I didn't ask?

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