THE EFFECTIVENESS OF AN ONLINE KNOWLEDGE MAP INSTRUCTIONAL PRESENTATION

A Dissertation in Educational Psychology

by Jamie L. Foor

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Abstract

In this study, I investigated the effectiveness of the knowledge map (k-map) instructional strategy compared to a text-based presentation in an online environment. K-maps consist of node-link representations of concepts that together form the content of a topic or domain. The benefits of using k-maps are that concepts and ideas are represented as nodes so the learner does not have as much text to process. Cognitive load was hypothesized to be reduced in the k-map condition because relationships among concepts and ideas are explicitly labeled by links; thereby freeing learners from the need to infer relationships. The k-map and text-based presentations used in this study represented the library research process. Two versions of the k-map and text presentations were created. One version included images that served as examples of concepts or ideas. The other version included descriptions of the examples rather than pictures. I hypothesized that participants receiving the k-map instruction would outperform participants receiving the text-based version on measures of recall, transfer, and cognitive load. The images were included to investigate the effect they would have in an already graphical k-map condition versus the less graphical text condition.

Participants included 208 lower division undergraduates from two universities. The sampling was designed to ensure that a wide range of reading skill was represented. I also investigated the reading skill level of the participants and how reading skill interacted with the type of instruction (k-map vs. text-based).

Contrary to predictions, the results indicated that participants did not benefit from the k-map presentation over the text condition in terms of total recall of ideas and recall of main ideas. Additionally, there were no main effects for condition on the transfer test; however, a significant interaction between condition and reading skills indicated that some participants performed
better in the text condition with images presentation than other conditions. Cognitive load measures indicated that the condition with traditional text and images was more efficient than receiving a k-map version in terms of transfer for participants with medium levels of reading skills. Further analysis indicated that despite this reduction in cognitive load, learners’ level of schema development for the topic was not significantly different.

The results of this study indicated that knowledge maps did not provide advantages over traditional text-based presentational methods in an online environment for learning about library research processes. Cognitive load measures indicated that the complexity of the k-map might have been too difficult for learners to process in the short instructional presentation. More research is needed to determine what design variables may help to alleviate this complexity in the application of k-map instruction to online learning for undergraduates.
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CHAPTER 1
INTRODUCTION

Online instruction is widely considered a standard form of instruction in many levels of education today and is continuing to grow in popularity. In higher education this trend is seen in terms of completely online courses as well as blended courses where learning takes place both in the classroom as well as online (Mayadas, Bourne, & Bacsich, 2009). There are positive aspects of implementing online learning environments, such as the ability to reach a greater number of students anytime and anywhere. However, instructional methods that worked well in face-to-face or traditional print formats may not translate effectively to an online environment or in multimedia formats. Design aspects of online multimedia instruction may require more planning and attention than traditional classroom lecture/demonstration delivery methods. For instance, the learner must interact with the instructional content on his or her own. If they do not understand the material, miss important points, or get caught up in tangential details, they may not acquire the skills or knowledge that the designer intended. Individual differences, such as prior knowledge and reading ability among learners, may interact with the various methods of online multimedia instruction. In this study, I focus on different ways to present information about the library research process in an online environment to undergraduate students with varied levels of reading comprehension skills.

One of the major advantages of online instruction is that the designer can more easily incorporate various formats of content. For example, text can be combined with graphics, graphics combined with audio, and multiple forms of graphics may be combined with both audio and text. The consequences of these combinations of presentation formats must be examined in order to prevent the learners from being overwhelmed with too many forms of representations.
(Ainsworth, Bibby, & Wood, 2002; Schnottz & Bannert, 2003). Each format of content that is used in an online presentation (e.g. text, audio, graphic, animation, video, etc.) may serve as a single or multiple representation of knowledge. If too many representations are offered, or if the representations are difficult to understand together, then the learner’s cognitive processes may be overloaded and learning may be hindered (Butcher, 2006; Stull & Mayer, 2007).

**Information Literacy Domain**

The domain of this study is information literacy. Information literacy is primarily concerned with an individual’s ability to a) understand sources of information in a diverse environment, b) locate, evaluate, and use information appropriately, and c) form a basis for lifelong learning (Association of College and Research Libraries, 2000). This study I focused on aspects of information literacy that relate to the library research process. More specifically, the library research process was directed towards lower-division (freshman or sophomore) college students who have little to no prior knowledge of the topic. The library research process is a strategy that is taught to inform students of library research practices, as well as give them an avenue to begin their own independent research. The process is broad in that it provides an outline of how a research problem or question should be approached and followed through to completion.

Introductory library research instruction is typically delivered in one 50-minute session at the college level (Jacobson & Mark, 2000; Owusu-Ansah, 2004; Parang, Raine, & Stevenson, 2000). This amount of time only allows for a cursory overview of the research process and in many cases does not allow for student hands-on practice. The move to online learning modules for library research instruction to supplement or replace classroom library instruction has become popular in the past decade (Ganster & Walsh, 2008; York & Vance; 2009).
The library research process is a step-by-step strategy that is well suited to graphical representation. Prior studies (Callison, 2001; Gordon, 2000) have demonstrated the effectiveness of the library research process depicted with concept mapping. Foor (2004) investigated this topic with a knowledge map graphical organizing system. A knowledge mapping system connects information contained in nodes with labeled links illustrating the relationships among nodes.

**Knowledge Mapping System**

Prior research has demonstrated that instruction with knowledge maps (k-maps) has produced better recall compared with text-based instructional methods (Nesbit & Adesope, 2006; O’Donnell, Dansereau, & Hall, 2002). K-maps present concepts within a topic or domain of learning in graphical nodes. These nodes are then linked together with labels describing the relationship between two concepts. O’Donnell, Dansereau, and Hall claim that k-maps reduce the amount of extraneous cognitive load placed on the learner by utilizing fewer words as well as graphically signaling the relationships among the various concepts. However, to date, no study has examined k-map instruction with a direct measure of cognitive load.

As well as reducing the extraneous cognitive load placed on a learner, expert-provided graphic organizers can also increase processing that directly relates to the development of new or higher level schema. Such processing is referred to as germane cognitive load (Sweller, van Merrienboer, & Paas, 1998). As the learner is interpreting an expert provided graphic organizer, they engage in activities directed towards selecting relevant information and organizing it in order to understand its structure (Stull & Mayer, 2007). A graphical organizer that scaffolds this type of processing is likely to leave the learner with enough cognitive resources to integrate the information into organized schemas.
Another advantage to designing instruction with k-maps is that it provides the novice learner with an easy-to-interpret outline of a domain or content area from an expert point of view. The k-map can serve as an external representation of the domain and can be used to a) activate relevant knowledge from the learner through perceptual processes, b) serve as a memory aid by the learner as they process new information, c) constrain the interpretation of information, and d) direct the learner’s cognitive processes as they progress through the instruction (Zhang 1997; Zhang & Norman, 1994).

Additionally, k-maps should not be as difficult to design or implement into instructional programs compared to other forms of computerized graphical representations (e.g., animations). This is not only important to the designer but to the learner as well. Research involving external representations has shown that novice learners often benefit from less complex graphics (Butcher, 2006; Dwyer, 1970; Keller, Gerjets, Scheiter, & Garsoffky, 2006) as well as static over animated forms of computer-based visualizations (Scheiter, Gerjets, & Catrambone, 2006).

Much of the research with k-maps has been focused with the map as the primary or sole instructional representation. Very few studies have looked at knowledge maps in an electronic environment or with other graphical forms of representation such as static pictures. To date, no study has evaluated the use of k-maps in a stand-alone computerized tutorial.

In a stand-alone electronic environment, a k-map could be used as a single representation of a domain or content area. Foer (2004) compared the effectiveness of a k-map versus PowerPoint as a lecture aid accompanying classroom instruction on the information research process. Students remembered significantly more ideas and more main ideas when the k-map accompanied the lecture rather than the PowerPoint. Usually, online tutorials designed to teach the information research process include many other types of representations. These
representations may include illustrations of information resources, database search screens, or Venn diagrams illustrating the use of Boolean operators for online database searching. A concern in this type of environment is whether or not all of these representations will work together to promote more effective learning (Ainsworth, 2006).

Before k-maps can be implemented in a highly graphical instructional environment, the designer must understand how these various forms of graphical representations interact with each other. More importantly, the designer must also understand how they interact with potential learners who possess a wide range of individual differences.

**Verbal Ability Differences and Knowledge Maps**

Based on the review of the literature by O’Donnell, et al. (2002) differences in performance may occur between low and high verbal ability participants as well as between low and high prior knowledge participants. Participants with low verbal ability typically have performed better with k-map based instruction compared to high verbal ability participants. Similar findings occur in regards to prior knowledge. Low prior knowledge students often benefit more from k-map based instruction than participants with high prior knowledge.

In a prior study, Foor (2004) found an unexpected trend indicating an opposite effect for verbal ability when comparing the use of k-maps versus PowerPoint with the topic of library research. While the interaction was not significant, there was a trend for higher verbal ability students who received k-map based instruction to score higher than their low ability counterparts on a library research transfer measure (see Appendix C for Foor’s 2004 verbal ability comparisons). One possible explanation for this finding is that the k-map designed in Foor’s study was primarily oriented horizontally and similar in visual orientation to reading. More typically, k-maps are oriented vertically (Evans & Dansereau, 1991) and thought to be
particularly helpful for lower verbal ability students, who are also usually less proficient in reading abilities.

O’Donnell (1994) reported an interaction between verbal ability and format of k-maps. She compared a k-map that was designed horizontally with a similar one that was designed in a vertical orientation. A statistically significant interaction was found for verbal ability level and map orientation on sentence completion tests that measured recall and inference generation. Low verbal ability participants in the vertical map group outscored low verbal ability students in the horizontal condition on the sentence completion tests. Low verbal ability participants in the vertical condition scored equally as well as high verbal ability students in the vertical condition. High verbal ability participants did not differ between conditions. O’Donnell proposed that the horizontal, left to right, nature of the k-map in the study was too similar to textual processing and thus hindered those participants with lower verbal skills.

Another interesting finding emerged from the Foor (2004) study in regard to verbal ability. The average verbal ability score obtained from the Quick Word Test (Borgatta & Corsini, 1964) was 30.50 out of a possible score of 100 points. Participants were stratified into high and low verbal ability groups by a median split. The average verbal ability score for the low participants was 24.98 while the average score for the high participants was 37.11. These participants were recruited from introductory composition classes at a small university in the Northeastern United States. In contrast, Meyer (Meyer & Poon, 1997; Meyer & Poon, 2001) typically found average Quick Word Test scores for college students to range from 41 to 46 out of 100 points. Based on a median split low verbal ability averages in these studies ranged from 33 to 34 and high verbal ability average ranged from 47.6 to 50.3. These participants were drawn from introductory educational psychology classes at a large university in the Northeastern United
States. These studies indicate that participants from the larger university scored on average 10 points higher than participants from the smaller university on the test of verbal skills. Because of this major difference in scores between students at these two universities, for the present study I recruited samples from both of these universities in order to ensure that a wide range of verbal skills were represented.

Online tutorials or presentations often require a considerable amount of text processing on behalf of the learner. Students with low reading skills may struggle to comprehend all of the material. Students in this study examined a complex k-map. It consists of six sections with approximately 186 nodes and 187 links. The k-map in the previous study (Foor), which proved difficult for low verbal ability students, had approximately 47 nodes and 51 links. While k-maps are expected to alleviate the text demands for lower ability students, a complex or inappropriate design may interfere with their ability to comprehend the instruction (Wiegmann, Dansereau, McCagg, Rewey, & Pitre, 1992). Therefore, I examined reading skill level as a factor in this study; participants were categorized into low, medium, and high reading skill levels.

**Purpose of the Present Study**

The main purpose of this study was to determine if a k-map instructional presentation of the library research process is superior to a traditional text-based instructional method in an online environment. Measures of recall, transfer, and mental effort were used in this investigation. Prior research has demonstrated that recall is particularly affected by the k-map format in a variety of instructional applications (O’Donnell, et al., 2002). Little extant research has examined transfer along with recall in studies about k-maps.

In this study, I also investigated the issue of how multiple forms of representations impacted the learner’s cognitive processes in an online environment. Four instructional
presentations with varying types of representations (e.g. text, nodes, links, and images) were examined. Mental effort measures were used to determine if the k-map reduced the cognitive load placed on the participants in comparison with text-based instructional methods and if the addition of concrete images to a k-map presentation would place unnecessary cognitive load on the learner.

In addition, in this study I addressed the issue of whether individual differences in reading skills interact with the online instructional methods. Past research indicates that the ability level of the learner may impact the effectiveness of the instructional method. Online instruction in an unfamiliar domain or content area may place excessive reading demands on the learner. Reading skill may not only impact retention and transfer performance, but also may affect the amount of mental effort that is required to process information from an online presentation.
CHAPTER 2

Literature Review

TCU Knowledge Mapping System

Dansereau (1978) and associates at Texas Christian University developed the knowledge mapping system used in this study. The k-map system utilizes a two-dimensional node-link mapping technique to connect concepts and ideas from a domain or content area of knowledge. The system operates on the premise that concepts or ideas are contained in the nodes, and the connecting links describe the relationship between the concepts or ideas contained in the nodes (Evans & Dansereau, 1991). The node-link concept structure is similar to the structure of how knowledge is represented in schema theory (Holley & Dansereau, 1984).

The most common type of knowledge map to use in a traditional instructional setting is an expert-generated knowledge map. An expert-generated map is produced by the instructor and provides an external representation of knowledge with which the user interacts. Expert-generated maps are useful for students who are unfamiliar with a domain (Dansereau & Newbern, 1997).

Advantages of Knowledge Maps

Past research with k-maps typically involved laboratory studies using college and university level participants. The overall results indicate that k-maps often benefit individuals with low prior knowledge in a domain as well as those with low verbal abilities (Lambiotte & Dansereau, 1992; Lambiotte, Skaggs, & Dansereau, 1993). K-maps have been shown to be effective in promoting the recall of main ideas over details (Dansereau, 1995; Rewey, Dansereau, & Peel, 1991). They are also effective when used as learning aids for processes or domains of knowledge (Dansereau & Newbern, 1997; Evans & Dansereau, 1991). The visual representation
of knowledge and signaling are two of the primary theoretical reasons why k-maps are effective in the presentation of new information.

**Visual representation of knowledge.** K-maps are proposed to create a visual representation of a domain that activates both verbal and visual processing systems that interact with each other (Hall & Blair, 1993; Hall, Hall, & Saling, 1999). Schnotz (2002) stated, “knowledge maps that visualize the macrostructure of a learning content can be considered a pictorial display of the corresponding knowledge structure” (p. 103). According to Lambiotte, Dansereau, Cross, and Reynolds (1989) the use of both verbal and visual processing systems brought about by k-maps can aid in both comprehension and retrieval. This reasoning is consistent with Paivio’s (1990) dual coding theory, in which knowledge is represented in both verbal and non-verbal formats. Stored knowledge can then be retrieved from verbal memory, non-verbal memory, or both formats of memory. The representation of knowledge in multiple formats is beneficial in that it has an additive effect of strengthening the associations of knowledge in memory.

**Benefits of Signaling.** K-maps contain nodes with explicit links that show the relationship between concepts and ideas from a domain or content area (Lambiotte, et al., 1989). This direct linking system provides a form of signaling (Lorch, 1989; Meyer, 1975), which can help focus the learner’s attention to the most important information that is being presented. Signaling can also occur indirectly by similarities or differences in node types or node layout. Nodes can be created with different shapes, styles, and colors. Nodes can also be grouped in arrangements that imply relationships. Node order, typically top to bottom, can indicate causal or temporal relationships among the ideas or concepts. These indirect forms of signaling in the k-
map system promote organizational structure that may help the learner to better organize information in memory and promote more effective storage and retrieval.

These potential signaling benefits of k-maps can be explained by Mayer’s (1996) selecting-organizing-integrating (SOI) model of text comprehension. According to the SOI model the learner must first select the important information from the text. Next, the learner must organize the newly selected information into a coherent, organized form in working memory. The final step is to integrate the newly organized knowledge from working memory with knowledge structures that already exist in long-term memory. Mayer (2003) has also applied this model to online learning in the cognitive theory of multimedia learning. Signaling has been found to promote learning in a number of online multimedia environments including animation, narration, and graph comprehension (Mautone & Mayer, 2001; 2007).

The extensive signaling that k-maps provide should benefit learners with little or no prior knowledge. The sample for the present study had participants with various levels of reading skill. Prior studies have shown that some level of reading skill may be necessary to take advantage of signaling. Meyer & Rice (1989) reported that verbal skills play an important role in the ability to utilize signaling in text. Younger adults with average verbal skills and older adults with high verbal skills comprehended text better when signaling helped them identify the relationships among major ideas in the text. However, older adults who had poorer verbal skills were unable to recognize and use the signals in the text to assist comprehension. Ozuru, Dempsey, and McNamara (2009) found that comprehension of text with high cohesion was dependent upon reading skill more so than prior knowledge. Cohesive texts are similar to signaling in that ideas are explicitly conveyed within the text. An important aspect of reading skill is to be able to “connect the various concepts or ideas contained in the text in a coherent manner” (p. 229). In
the Ozuru et al. study, the more skilled readers, regardless of prior knowledge level of the topic, benefited from text cohesion, whereas less skilled readers were unable to take advantage of the cohesiveness of the text.

**Prior Knowledge Differences and Knowledge Maps**

The amount of prior knowledge that the learner possesses about the topic of study has shown to affect performance when the k-map is used as a lecture or study aid. Lambiotte and Dansereau (1992) found that students who had low prior knowledge of a science topic benefited more when a k-map instructional aid accompanied the lecture compared to outline or list aids. Students who had high prior knowledge were not affected by the use of the k-map aid. Lambiotte, et al. (1993) found similar prior knowledge differences when k-maps were used as lecture and review aids. These results indicate that a graphical organizer like a k-map might not be as beneficial if the learner already has a structured knowledge base for the domain being taught.

**Knowledge Map Impact on Transfer of Knowledge**

One of the main issues in the present study is to determine if using an expert-generated k-map in an online environment improves transfer of library research process skills. Since k-maps have demonstrated superiority in recall of main ideas, the learner should have a well-organized structure of knowledge. How a learner organizes and represents knowledge is an important feature of their problem solving performance (Byrnes & Wasik, 1991; de Jong & Ferguson-Hessler, 1986; Lovett, 2002). According to Zeitz and Spoehr (1989) a “well-structured presentation of information about a complex device can affect the knowledge organization of the user, which can, in turn, result in superior performance involving the application of this knowledge in problem-solving” (p. 313).
K-maps have been shown to be superior to text in representing complex relationships in a domain or content area (Dansereau & Newbern, 1997). They are especially effective in presenting hierarchical relationships and sequential processes where the relationships between concepts do not have to be inferred (Lambiotte & Dansereau, 1992). Therefore, the k-map presentation should aid in organizing the learners’ knowledge of the library research process, which then should translate into more effective problem solving.

**Impact of Multiple Representations on the Learner**

Information can be presented to a learner in many different forms. Textual descriptions are a common form of representation. In a multimedia-based environment they may be combined with representations such as images or animations that depict information (Schontz & Bannert, 2003). These external representations can serve the function of reducing the mental effort that is required to process new knowledge (Masterman & Rogers, 2002). Larkin and Simon (1987) found that a diagrammatic external representation of information could reduce search processes and make recognition more effective compared to a sentential description of the same representation.

In typical introductory library research instruction, many representations are often utilized. Students with no prior knowledge of the research process are shown examples illustrating the concepts that are presented. The instructional conditions that will be compared in the present study include a single text-only representation of knowledge, text with static graphic representations, a k-map representation, and a k-map with static graphic representations. The text without images condition has only one type of representation. The text with graphics and k-map conditions have textual and image representations. According to Scaife and Rogers (1996) static graphical external representations are particularly well suited to promoting inference generation.
because of the visual system capacities of “object perception, search, and pattern-matching,” (p. 200).

Static images should be useful when dealing with novice learners who are unfamiliar with the content; however, they may interact in different ways depending on the learner’s reading skill level. According to Levin, Anglin, & Carney (1987; also Carney and Levin 2002) there are five types of illustrative representations that impact learning with accompanying text. The first level is the decorative function; these are illustrations that serve no cognitive purpose. The second level serves a representational function where the illustrations overlap with the text providing concrete support. This level has been found to have a minimal effect on learning. The next two levels have been found to have moderate to substantial effects. The interpretational function is when illustrations help the learner understand the text by clarifying difficult concepts or ideas. The organizational function provides a framework or structure to help the learner understand the text. The final function is transformation, where mnemonic illustrations are used; these have the greatest impact on memory.

Many of the accompanying illustrations used in this study are intended to be concrete representations of the accompanying text; for example an illustration of the Encyclopedia of Special Education is a concrete representation of the concept of “subject encyclopedias.” While this type of illustration may aid the low reading skilled learners, it may have the opposite effect on the higher reading skilled participants. If the reader does not need to rely on concrete representations, the illustration may be redundant and have a negative impact on learning (Carney & Levin, 2002).

Butcher (2006) examined the effect of diagram complexity with text-based materials. Representations demonstrating the workings of the human heart were used in a study involving
university students. The simple illustrations were not faithful representations of the heart’s anatomy, but simple diagrams representing the functional working of the heart. The complex diagrams were exact detailed representations of the heart’s anatomy that represented the detailed functional workings of the heart. Both diagrammatic representations were more effective than text in mental model development; however, the simpler diagrammatic representations were superior to the complex representations. The simple diagrams made it easier for the learners to integrate between verbal and visual information sources.

The k-map itself is a type of illustration that fits into two of Levin et al.’s (1987) classifications. The k-map in this study serves as an interpretational illustration that visually demonstrates a process. The k-map is also an organizational illustration that helps the learner organize information into a coherent structure. Both of these types of representations have been found to have moderate to substantial effects on learning in previous studies (Carney & Levin, 2002).

Novice learners have tended to have difficulty coordinating multiple representations, even when they are within the same conceptual domain (van Bruggen, Kirshner, & Jochems, 2002). When they are faced with interpreting more than one representation they tend to rely on more familiar ones instead of expending the mental effort that is require to relate them (Cook, 2006). Seufert (2003) found that signaling the relationships among multiple representations was effective only when the prior knowledge level of the learner was considered. The study compared directive (signaled) versus non-directive help in connecting external representations. Medium knowledge learners benefited the most from directive help. Directive help was detrimental to low knowledge learners recall performance, whereas high knowledge learner’s performance indicated that they did not require help.
In order for learners to benefit from the presentation of multiple external representations (MERs), they must be able to understand each individual representation, how the representation relates to the domain, and finally how the representations relate to each other (Ainsworth, Bibby, Wood, 1997). These tasks can be difficult for novice learners. Ainsworth (2006) developed the DeFT (Design, Functions, Tasks) model that considers the pedagogical function of representations and how they will interact to promote effective learning. According to her model MERs are effective when they a) compliment each other by providing additional support or information, b) constrain an interpretation of another representation, or c) are used to aid construction of deeper understanding.

The primary pedagogical function of the additional graphics used in the present study is to compliment representations provided by the text or the k-map. In this case learners with varying levels of reading skill may be able to choose the representation that is easier to understand. However, for learners with higher levels of reading skill, the additional representations may not be necessary for their comprehension of the topic. These representations may become redundant and actually have a negative impact on learning indicating an expertise reversal effect commonly found in cognitive load research (Kalyuga, Ayres, Chandler, & Sweller, 2003).

**Measurement of Cognitive Load**

Two methods of measuring cognitive load primarily have been used during the past 20 years. First, many researchers assessed performance based on recall or problem solving transfer in studies that compared alternative instructional methods. The assumption was that if performance improved then intuitively cognitive load was decreased enabling more schema development and better recall or transfer. However, it may not always be the case that cognitive
load was decreased as individual differences of the learners may influence performance as well as the type of performance task (Brunken, Plaas, & Leutner, 2003).

Paas and Van Merrienboer (1993) developed a more direct method of measuring cognitive load. In this method, a subjective measure of mental effort was combined with a measure of task performance. Mental effort was assessed using a 9-point rating scale that asked participants to rate the amount of effort they expended while completing the performance-testing phase. This rating was used to calculate the relationship between performance on a measure and the mental effort it took to complete the measure. If performance on a measure were higher than the mental effort it took to complete the measure, this would result in a positive number indicating high level of instructional efficiency. If the result was negative, it indicated a low level of relative efficiency where mental effort was higher than performance.

The distinctions between mental effort, performance, and relative efficiency add to the value of cognitive load theory. If performance is high, the assumption is that the learner is demonstrating understanding. However, if performance is high and mental effort is also high, the learner may not be ready to move to the next level of performance because they have not effectively developed the required cognitive schema or automaticity to perform a task without taxing mental effort. On the other hand, if performance is high and mental effort is low, then the learner has solved the problem relatively easily and is ready for more challenging instruction. In both cases performance may be the same, but the individual learners may not be at the same level of schema development.

**Three-dimensional instructional efficiency.** Paas, Tuovinen, Tabbers, and Van Gerven (2003) report that the original scale has been used in multiple ways in other studies where cognitive load is measured. The 9-point scale has been modified as a 7-point scale in several
studies. Some researchers have applied the scale during the course of instruction rather than at the testing phase. Tuovinen and Paas (2004) regard this method as evaluating the training or learning efficiency, whereas, the original calculation measures transfer efficiency.

In light of this new view of learning and transfer efficiency, Tuovinen and Paas (2004) proposed a new calculation of instructional efficiency that considers both components of cognitive load. This new 3-D calculation should be more sensitive to differences in student learning when compared to the use of just learning efficiency or just transfer efficiency. This approach would still consider test performance, but in relation to both learning effort and test effort.

Tuovinen and Paas (2004) retrospectively reviewed the use of two-dimensional and three-dimensional efficiency ratings in a study conducted by Tuovinen and Sweller (1999) that compared discovery learning and worked examples. The use of two separate efficiency measures: learning and transfer, originally led to different conclusions about the instructional conditions. Participants in the study were classified as either having prior knowledge or not having prior knowledge with a database program. Overall the worked example group was more efficient during the learning phase, but not in the transfer phase, regardless of knowledge level. Participants who received worked examples and had no prior knowledge displayed higher efficiency in the learning phase, but not significantly higher efficiency in the transfer phase. Participants who received worked examples and had prior knowledge were not more efficient in either stage.

When the 3-D efficiency rating was combined the two learning and transfer ratings it resulted in a more moderate overall finding (Tuovinen & Paas, 2004). The whole group effect for worked examples was not found this time, as the groups did not significantly differ. However,
the worked example effect was found for students with no prior knowledge, as the worked examples were significantly more efficient than discovery learning. The 3-D measure rating appears to be more stable as a more moderate finding occurred when both types of cognitive load measures were integrated. According to Tuovinen and Paas (2004), there still may be advantages to evaluating the learning and transfer phases separately. Researchers who are interested in determining if extraneous load is affecting learning may choose to measure mental effort at the learning phase. Van Gog and Paas (2008) recommend that the original efficiency measure that is assessed during the testing phase is still preferable to other methods of determining efficiency, especially when increasing germane load is the goal of the study. A rating of mental effort at the testing phase is indicative of how well the learner developed cognitive schema or automatic processes during the learning phase. Learners who expend less effort during the testing phase exhibit more effective learning than those who are expending more mental effort after they’ve already received the intervention.

One downside to the efficiency measure is that it cannot distinguish between the three types of cognitive load the participant is experiencing (Paas et al., 2003). However, no other measure of cognitive load can distinguish the different types of load either (van Gog & Paas, 2008). The design of the study must isolate the probable load based on the theoretical construct of the three types of cognitive load in order to predict whether it is being reduced or increased.

**Other methods of measuring cognitive load.** Indirect methods of measuring cognitive load have been attempted such as time-on-task, eye-tracking, heart rate, and pupil dilation (Brunken, et al., 2003; Paas et al., 2003). These measures have not shown as much success or sensitivity as the instructional efficiency method. A more direct method that may show promise is measuring brain activity; however, this is much more difficult to implement than traditional
measures (Brunken et al.). Another method that has been used in recent studies to assess cognitive load is the NASA-Task Load Index (NASA-TXL). In this measure participants give ratings of perceived: “performance; effort; frustration; and mental, physical, and temporal demands” (van Gog & Paas, 2008, p. 18). According to van Gog and Paas, this measure assesses much more than just cognitive load; although cognitive load based conclusions have been made with it.

Kalyuga and Sweller (2004) developed a method of assessment that combined cognitive load with the learner’s current level of schema development. This method, referred to as the “rapid assessment test,” assesses the learner’s knowledge of the first step in a problem-solving situation (van Merrienboer & Sweller, 2005). The first step the learner would use indicates the quality of schema development in the domain. Learners may be classified as pre-novice, novice, intermediate, advanced, or expert, and instruction is then presented to them at the appropriate level. This method has the most potential to be effective in adaptive learning environments.

The measurement of cognitive load is vital to the development of the theory as it stands today. Moreno (2006) provided commentary on studies testing the worked example effect that contradict previous findings from the cognitive load literature. Moreno commented on the lack of uniform design that explicitly linked cognitive load assumptions with the hypotheses and research questions. She also indicated that most of the studies did not use valid, reliable, or relevant measures of cognitive load and therefore the contradictory conclusions are questionable. In prior research involving k-maps, conclusions have been made about their capability of reducing cognitive load for novice learners in a domain without having directly measured it.
Hypotheses and Research Questions

In this study, I investigated whether a k-map instructional presentation of the library research process was superior to a traditional text-based instructional method in an online environment. Measures of recall, transfer, and mental effort were used in this investigation. Also, I investigated how multiple forms of representations impacted the learner’s cognitive processes in an online environment. Mental effort measures were used to determine if the k-map reduced the cognitive load placed on the participants in comparison with text-based instructional methods. Additionally, I examined whether or not individual differences in reading skills interacted with the online instructional methods. Three major hypotheses and three secondary research questions were investigated.

First, students who received library research instruction utilizing an online k-map presentation of the library research process were hypothesized to demonstrate greater recall of the overall content and the main ideas of the presentation compared to students who received the instruction via text-based online presentations. Second, students who received library research instruction utilizing an online k-map presentation of the library research process were expected to perform better on a library research transfer task than students who received the instruction via text-based online presentations. Third, students who received library research instruction utilizing an online k-map presentation of the library research process were hypothesized to have higher transfer efficiency scores than students who received the instruction via text-based online presentations.

Additionally, based upon the review of the literature and the goals of this study, the following three research questions also will be addressed:
(1) Does the inclusion of additional graphic representations (i.e., images) in an online k-map presentation interfere with learning or processing compared to a k-map without additional graphic representations?

(2) Does instruction with an online k-map presentation have a more positive effect on students with medium level reading skills compared to those with low or high readings skills for measures of recall, transfer, or efficiency?

(3) Does the application of learning efficiency help to further explain the amount or type of cognitive load that is placed on the learner by the instructional conditions?
CHAPTER 3

Method

Research Design

In order to determine if there were differences between the knowledge mapping instructional presentations and text-based instructional presentations the primary design was a 3-way factorial design with type of instruction 2 (text or k-map) as one factor, inclusion of images 2 (without or with) as a second factor, and reading skill level 3 (low, medium, or high) as the third factor. The main effect for type of instruction on the three types of dependent measures was of primary interest because it would test the three posited hypotheses that k-map instruction would be superior to the more traditional text-based method. The main effect for inclusion of images was examined to determine if the addition of an additional representation (i.e., images) affects processing in an online learning environment. The interaction between type of instruction and inclusion of images was investigated to test the first research question about possibility of overloading the learner with too much visual information with both k-maps and images.

Interactions with reading ability were also of interest to determine if students with medium level reading skills benefited more from the k-map instructional method than those students with higher or lower reading skills (research question two). A significant interaction may indicate that the k-map format was too difficult for students with low reading skills. In an online environment, instructional methods that rely primarily on high textual content may prove difficult for individuals with weaker reading skills. The opposite may be the case for highly skilled readers who may not need instructional scaffolding to comprehend the information.
Participants

The study initially included a total of 213 participants from two universities in the Northeastern United States. Data from four participants was not collected due to failure to follow directions during the study; one participant’s data was lost due to computer error. Characteristics of the 208 participants who completed the entire study are displayed in Table 1 (see Appendix D for the demographic questionnaire). Ninety-one participants were recruited from introductory psychology classes and a college study skills class at the small university and one hundred seventeen were recruited from an introductory educational psychology class at the large university. All participants received course related extra credit for their participation in the study.

Table 1
Participant Characteristics

<table>
<thead>
<tr>
<th></th>
<th>Age M (SD)</th>
<th>Freshman / Sophomore</th>
<th>Female</th>
<th>Caucasian</th>
<th>Prior Experience</th>
<th>Reading Skill M (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>University 1</td>
<td>19.64 (4.10)</td>
<td>92%</td>
<td>56%</td>
<td>70%</td>
<td>27%</td>
<td>8.12 (6.81)</td>
</tr>
<tr>
<td>n = 91</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>University 2</td>
<td>19.55 (2.49)</td>
<td>88%</td>
<td>85%</td>
<td>91%</td>
<td>45%</td>
<td>14.00 (6.65)</td>
</tr>
<tr>
<td>n = 117</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>19.59 (3.28)</td>
<td>89%</td>
<td>72%</td>
<td>82%</td>
<td>38%</td>
<td>11.43 (7.31)</td>
</tr>
</tbody>
</table>

*Reading skill was significantly different (p < .0005) between University 1 and University 2

Instructional Materials

The instructional presentation for this study was the content area of an introductory library research process that is in the domain of information literacy. The content area covers the five basic steps in the library research process: a) defining the information need, b) choosing appropriate information sources, c) identifying main idea concepts for use as keywords, d) developing a search strategy, and e) evaluating the results obtained from a search. Four
computerized instructional modules were developed for the study, two text-based versions (one with images and one without) and two k-map versions (one with images and one without).

Each version presented the research process in a parts-first or part-whole method that Mayer and Chandler (2001) found to be effective with novice learners in a new or complex domain. According to this method, the parts of a sequence should be described first and then the whole sequence can be taught. In the case of this study each of the five research steps was examined in depth with examples of the various segments. After all five segments were completed; a worked example of the whole process was presented to the participants. During the whole presentation of the worked example, participants in the k-map groups saw the same overall structure of the k-map that was introduced during the parts portion of the instruction. These additional viewings of the k-map structure were expected to reinforce the visual imagery of the k-map as well as the relationships among the concepts.

An effort was made to keep the content and application of the text and k-map versions as similar as possible. All versions of the instruction were developed from the same script that consisted of approximately 2,500 words and information was presented in the exact same order. For all instructional conditions, participants needed to click the “Continue” button 47 times in order to complete the instructional content (See Appendix E for the 46 screen displays of the text with images version and Appendix F for the 46 screen displays of the k-map with images version). There were differences in the amount of information that was displayed between the text and k-map presentations. More information remained on screens within the description of the steps in the k-map conditions compared to the text conditions. A comparison of screens 3 and 4 from the text-based version (See Appendix E Figures 8 and 9) and screens 3 and 4 from the k-map version (See Appendix F Figures 54 and 55) illustrate this point. In the k-map condition all
of the information describing the differences between overview/introduction type and in-depth information remains during the presentation of the description comparing a general audience with a scholarly/professional audience. In the text-based version the description of depth of information does not remain on screen during the description of audience type. Due to the nature of k-maps relying on nodes for basic concepts and links for their relationships, more information was presented on the same screen compared to the text-based versions.

**Text-based presentation.** The two versions serving as control conditions were text-based computerized instructional modules of the library research process. One version was text only and the other version contained text with images. The text only version presented the full 2,500-word script. The text with images version contained 15 images that replaced textually descriptive examples from the text only condition (see Appendix G for the text without images screens and Appendix H for the k-map without images screens). The layout for the text versions was initially created using PowerPoint and the final version maintained that look and functionality. Each screen began with a header that listed the five steps in the research process. The step being described was always emphasized in larger/bolder font at the top of the screen. Information was then presented in sentences or small paragraphs that were read from left to right, and followed one another from top to bottom. Information on some screens was displayed all at once. However, when screens contained several concepts with multiple paragraphs or sentences a portion of the information was presented at the top and when the participant selected “Continue” more information was added to the screen just below the previous information. No screens contained information that required either vertical or horizontal scrolling.

**Knowledge map presentation.** The two versions serving as experimental conditions contained the same information as the control, text-based conditions. However, the text was
primarily replaced with an expert-provided k-map that incorporated main ideas of the text into a series of nodes. The links between the main idea/concept nodes explicitly stated the relationship between the nodes. For example, in a series of steps in the research process the link between the nodes was labeled with the word “Next.” Some nodes provided examples of concepts and were labeled with the word “Example.” The k-map with images version included 15 images in place of textual nodes from the k-map only version; the labeled links remained the same. Both versions contained approximately 186 nodes with 187 links. The k-maps were initially created with Inspiration 8.0 and imported to Paint Shop Pro 8.1 for further editing.

The k-map was designed in a hierarchical stacked-map format where each step or sub-step of the process was presented on a single screen and then further steps were presented on subsequent screens (Wiegmann et al., 1992). The k-map presentation included a total of 19 different screens for the six sections. The nature of the k-map design allows some nodes and links to remain present on several or all of the screens. The five basic steps remained on the top of the screen at all times. The step that was currently being reviewed was enhanced so the participant knew which step was being explained.

Other main idea nodes and links were able to remain on the screen as deeper or comparative sub-topics were being described. The presentation of information in Step 2 illustrates this; following the description of magazines, the nodes for the basic characteristics of a magazine remained on the screen while the description of journals was presented. This information was described in a similar fashion in the text version; however, the learner did not have the option to refer back to the magazine description while learning about journal characteristics.
The k-map was created in a top-down fashion that is typical of knowledge maps developed in the TCU system (Evans & Dansereau, 1991). The five steps of the research process were read from left to right; however, descriptions of each of the five steps were read from top to bottom. When there were multiple concepts within a step or sub-step they were be read from left to right. In the k-map conditions participants were instructed to read from top to bottom. They were also prompted to select “Continue” to bring up new information that was presented below previous concepts and instructed to read them from left to right. This process was implemented to segment the content that was presented under each step in the research process. It was believed that this would help alleviate processing demands and also serve to direct the learner’s attention to the relevant portions of the instruction (Blankenship & Dansereau, 2000). As new information was added, previous steps remained so that the learner could refer back to information as they were developing an understanding of the concepts.

The linking system in the k-map also serves a purpose. Each link is named so that the learner can quickly understand the relationship between the concepts. There are three different link categories that were used in the construction of the k-maps in this study (Dansereau & Newborn, 1997). Links that represented actions such as “Leads To,” “Next,” and “Results In” and links that represented a description such as “Characteristic,” “Definition,” and “Type” were solid lines with an ending arrowhead. Links that illustrated a point such as a “Comment” or an “Example” were dashed lines. The intention of the different link types was to give a visual message as to the type of relationship that is being described.

The final design aspect of the k-map was node size, shape, and color. An attempt was made to keep node size and shape as consistent as possible. Many nodes throughout the map contained three or fewer words; however, some nodes, particularly examples and comments,
contained full sentences and were larger than typical nodes. More attention was paid to the color-coding scheme of node types than the size or shape of node. Color-coding in graphical presentations has been shown to have a positive effect on performance (Lamberski & Dwyer, 1983). Hall and Sidio-Hall (1994) also demonstrated that students benefited from studying k-maps that utilize color-coding compared to black and white k-maps. Due to the fact that any one completed segment of the instruction had one to two-dozen nodes, color-coding and overall look of the screen were important. The color scheme was selected from the available colors in Paint Shop Pro 8.1. Colors were chosen that did not interfere with the visual display of the text within the nodes, i.e. dark colors were not chosen. All node types were given a unique color. While there are several factors that were considered in the design of the expert-provided k-map, the overriding design adhered to the Gestalt principles of symmetry, proximity, and good configuration (Dansereau & Newbern, 1997).

**Individual Difference Measures**

**Reading Skill.** Reading skill was measured with the first half of the Davis Reading Test, Form 1B (Davis & Davis, 1957). The test consists of seven short passages with 40 multiple-choice items (see Appendix H). Items are designed to give an overall score for level of comprehension that includes a) answering explicit questions, b) understanding main ideas, c) drawing inferences, d) recognizing tone or mood, and d) following structure (Rosner, 1968). The test is given with a 20-minute time limit and is scored with a correction for guessing. The correction for guessing was scored as total correct responses minus one-fourth the number of incorrect responses. In this experiment the print version of the Davis Reading Text was replicated in a computerized program, each passage and all corresponding questions were
presented within the same screen. Once participants continued to the next screen they were not able to return to any previous passages or questions.

In this study, the Davis Reading Test had a mean raw score of 16.19 ($SD = 6.36$) and mean score of 11.43 ($SD = 7.31$) with the correction for guessing. Approximately 66% of the participants completed the whole test within the 20-minute time limit, while only 5.8% of participants completed less than two-thirds of the test. The test had a high Cronbach’s $\alpha$ of .807 (Cronbach, 1951). The test was significantly correlated with self-reported SAT Reading scores ($r = .62$, $p = .01$). Scores on the Davis Reading Test were divided into thirds in order to assign reading skill levels. Seventy-three participants scoring between 0 and 8 were considered low skilled readers and 68 participants scoring between 9 and 14 were considered medium skilled readers. There were 67 high skilled readers whose scores ranged from 15 to 36.

**Related Knowledge Test.** A six-item multiple choice information literacy and library research knowledge assessment (see Appendix I) was given at the outset of the program in order to determine the participants’ level of related knowledge within the topic. The experimenter developed the test with questions taken and modified from the Project SAILS (Standardized Assessment of Information Literacy Skills) test bank. Project SAILS (2009) is one of two standardized tests designed to specifically assess the information literacy standards designed by the Association of College and Research Libraries (2000). The six items used in this study represent knowledge included in the domain of information literacy, but is not knowledge related to the library research process taught in this study.

The mean of the six-item related knowledge test was 2.07 ($SD = 1.34$) with a low Cronbach’s $\alpha$ of .350. The related knowledge test had a small statistically significant correlation
with self-reported prior library instruction experience of \( r_{pb} = .18 \) \((p = .01)\) and had a moderate correlation with performance on the transfer test of \( r = .37 \) \((p = .01)\).

**Study Time.** The amount of time that it took each individual participant to complete the instructional portion of the study was collected as an indicator of study time. Participants were required to manually input the time from the computer screen right before they began the instructional content and then again at the end of each of the six instructional sections. Total time was calculated in minutes. The mean study time for all participants was 14.38 minutes \((SD = 5.01)\). An Analysis of Variance (ANOVA) was conducted to determine if there were differences for study time between the instructional conditions. A significant main effect was found, \( F(1,196) = 4.24, MSE = 104.46, p = .04 \), indicating that participants in the text conditions \((M = 15.1, SD = 5.2)\) spent more time studying the material compared to participants in the k-map conditions \((M = 13.6, SD = 4.7)\).

**Dependent Measures**

The three main dependent measures were recall of information from the library research presentation, a library research transfer task, and learning/transfer efficiency measures corresponding to the recall and transfer measures. The efficiency measures are considered to give an indication of the cognitive load placed on the learner.

**Free Recall Task.** Participants were presented with a blank text box with the following instructions at the top:

Based on the instruction you have just received write down as much as you can remember. The goal is to see how much information you remember as well as your understanding of the information presented in the instruction so please write in complete sentences or paragraphs, rather than listing words.
The free recall of ideas measure yielded two scores: a) the total number of ideas recalled, which consisted of the sum of each idea remembered and b) the number of main ideas recalled, which captured the most important ideas and excluded detailed accounts of examples.

Scoring of this measure was conducted with Meyer’s (1975, 1985) prose analysis system. This system is based on the organization of the text that is being analyzed and the rhetorical relationships of the content. This system is sensitive to the learner’s organization of knowledge and “represents and scores both inferred and explicit relationships in text” (1985, p. 31) rather than just the recall of propositions.

Prior k-map studies have used a modified version of Meyer’s (1975) system that was developed by Holley, Dansereau, McDonald, Garland, and Collins (1979). Their version gives scores for noun and verb propositions that are recalled as well as the completeness and accuracy of the recall (e.g., Chmielewski & Dansereau, 1998; Moreland, Dansereau, & Chmielewski, 1997). The original Meyer’s (1975, 1985) prose analysis scoring system was used to score recall in this study because of its focus on the organization of content and identification of main ideas based on this organization.

I scored the recalls blind to group affiliation. Participant’s propositions on the recalls were matched to a scoring key (see Appendix J for the recall scoring key). The scoring key, representing the content structure for the library research process information, contained 478 idea units including 154 main ideas and 324 details. The main ideas consisted of the five steps in the research process as well as major sub-steps within each step. The idea units from the library research presentation contained twice as many details compared to main ideas due to the fact that numerous examples were given for each step in the process. The library examples accounted for approximately 169 of the detail level idea units, leaving 155 detail level idea units that related to
the library research process. To test for rater reliability approximately 10% of the recalls were scored by a second rater. Inter-rater reliabilities of $r = .94$ ($p = .01$) for total recall and $r = .91$ ($p = .01$) for recall of main ideas were found.

**Library Research Transfer Test.** The library research transfer test was created with questions taken and modified from a standardized information literacy test. The test consisted of 12 items representing different aspects of the research process instructional program (see Appendix K). The items were selected from the Project SAILS (2005) test bank. Items in the test bank are based on the Information Literacy Standards developed by the Association of College and Research Libraries (2000). The questions were selected to correspond with the instruction that was presented. The 12 items for the library research transfer test were piloted with a sample of 80 students from the smaller university before the study began (see Appendix L for details). Participants were given instruction about the library research process in library orientation class and then administered the library research transfer test. Cronbach’s $\alpha$ for the pilot study was .670.

Comparisons on performance and reliability statistics for the library research transfer test are displayed in Table 2 for pilot study at university 1 (smaller university), current study at university 1, and current study at university 2. Comparing the pilot sample to the two university samples in the current study (rows 2 & 3 in Table 2), the findings from university 1 were more similar to those of the pilot study than the findings from university 2. The transfer test did not perform the same way with the second university. At university 2 the Cronbach’s $\alpha$ of .304 for the transfer test was much lower. In the current study, participants at university 2 significantly outscored participants at university 1 on the transfer test ($F(1,206) = 28.29$, $MSE = 124.25$, $p <$
As can be noted in Table 2, students in university 2 scored higher and were less variable in their performance than students in university 1 on the transfer test.

Table 2

Comparisons for the 12-Item Library Research Transfer Test

<table>
<thead>
<tr>
<th>Sample</th>
<th>Number</th>
<th>Mean</th>
<th>SD</th>
<th>Range</th>
<th>Variance</th>
<th>Cronbach’s α</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pilot (University 1)</td>
<td>n = 80</td>
<td>6.95</td>
<td>2.58</td>
<td>2-12</td>
<td>6.66</td>
<td>.670</td>
</tr>
<tr>
<td>University 1</td>
<td>n = 91</td>
<td>7.37</td>
<td>2.52</td>
<td>1-11</td>
<td>6.37</td>
<td>.640</td>
</tr>
<tr>
<td>University 2</td>
<td>n = 117</td>
<td>8.93</td>
<td>1.69</td>
<td>4-12</td>
<td>2.86</td>
<td>.304</td>
</tr>
<tr>
<td>Study Total</td>
<td>n = 208</td>
<td>8.25</td>
<td>2.23</td>
<td>1-12</td>
<td>4.97</td>
<td>.569</td>
</tr>
</tbody>
</table>

Cognitive load efficiency measures. A subjective measure of mental effort was collected in order to determine the instructional efficiency of the presentation methods. Mental effort was assessed using a 9-point rating scale developed by Paas and van Merrienboer, (1993). The measure asked participants to rate the amount of effort they expended while completing the six separate parts of the instruction and responding to each of the 12 items on the transfer test. The phrasing of the question matched the particular section that the participant was working on, e.g., “How easy or difficult was the instruction in Step 3 to understand?” Participants were given nine response choices to choose from: 1) extremely easy, 2) very easy, 3) moderately easy, 4) slightly easy, 5) neither easy nor difficult, 6) slightly difficult, 7) moderately difficult, 8) very difficult, 9) extremely difficult. This same rating measure was given to participants during the transfer test. The phrasing was changed to “How easy or difficult was this question to answer?”

Since the rating was given six different times during the instruction an overall mean score was calculated. Mean scores were also calculated for the 12 ratings of the transfer test. To calculate efficiency the participants’ subjective mental effort and performance scores are necessary. Efficiency (E) is calculated as the difference between performance (P) and subjective
mental effort (R). Each score is converted to a z-score and is calculated as $E = P - R / \sqrt{2}$ (Tuovinen & Paas, 2004). The assumption is that if performance (P) is higher than mental effort, (R) it would result in a positive number indicating high level of relative efficiency. If the result is negative, it indicates that mental effort was high and performance was low resulting in a low level of relative efficiency. The use of the denominator $\sqrt{2}$ is merely applied to allow the researcher to plot efficiency comparisons on a chart. Tuovinen and Paas (2004) also reported that high reliability coefficients (Cronbach’s $\alpha = .90$) are generally found with this scale and that the scale exhibits decent convergent, construct, and discriminate validity.

Tuovinen and Paas (2004) referred to efficiency measured at the time of instruction as learning efficiency and efficiency measured at the time of testing as transfer efficiency. This terminology was used in the current study. Learning efficiency scores were calculated for total recall, and transfer. An efficiency score for recall of main ideas was also calculated and a statistically significant correlation of $r = .987$ ($p < .0005$) was found with total recall. Therefore, only the results for the total recall were analyzed. Z-scores were obtained from the combined ratings of the 6 measurement points during the instruction and were used for (R) in the formula. Z-scores were obtained from the recall measure and the library research transfer measure. A single transfer efficiency score was calculated using the library research transfer test (P) z-scores as mentioned above. The (R) mental effort rating was the z-score of the mean rating gathered at the time of the library research transfer test.

An additional three-dimensional efficiency measure was also calculated using transfer test (P) z-scores minus effort at instruction (R) z-scores minus effort at testing (R) z-scores divided by the square root of three. The 3-D efficiency measure combines the ratings of effort at both the instructional and the testing phases. This measure has been used as a more stable
indicator of cognitive load with the integration of mental effort from the two occasions with one performance measure (Tuovinen & Paas, 2004). In this study, the 3-D efficiency measure was used as an exploratory measure of cognitive load. It did not add any further understanding of cognitive load beyond what was reported for the learning and transfer efficiency measures. (See Appendix M for 3-D efficiency of transfer results).

**Procedure**

The four computerized versions of the instructional program were presented to students. The programs were created and delivered with Snap Surveys (2010) software. All phases of data collection and instruction for the study were completed within the Snap Survey program. The study took participants a mean time of approximately 53 minutes to complete (standard deviation was approximately 11 minutes). The study sessions were held at computer labs with Apple Macintosh computers (minimum 2.66GHz processors) with either 17” or 24” flat panel monitors.

Participants completed consent forms as they arrived at the computer labs. Attendance was taken for assigning course-related extra credit. No identifying information was collected during the actual study session. Before entering, participants were also given a brief statement informing them of the rules and particular features of the computerized program. They were also reminded to study the material as they progressed because they would be asked questions relating to the instructional content. Participants were then randomly assigned to a numbered computer with one of the four instructional programs preloaded. Participants completed the study at their own pace with the exception of the final portion which was a timed reading skills test. Participants were only allowed to move forward in the computerized instructional program. There were no opportunities to go back to any screen they already completed. The “back” button
was removed from the program in order to prevent participants from returning to the instructional content during completion of the posttests.

The initial screen of the computerized program presented rules of the study session and features of the computerized program. Next participants filled out demographic information and then completed a related library knowledge test. This pre-instructional portion of the study took participants approximately five to ten minutes to complete. The instructional content was presented next. The first part of the instruction included a brief training session on how the information would be presented (See Appendix N for text and k-map training examples). While participants in the text versions did not require training prior research has shown that training is effective for students who are learning with k-maps (O’Donnell, et al., 2002). The instruction was segmented into six parts. At the conclusion of each part participants were asked to rate the ease or difficulty of instruction and enter the time displayed on the computer. The instructional portion of the study took approximately 15 minutes.

Following the instructional content participants were given the free recall task and then the 12-item library research transfer task. After each question in the 12-item transfer task participants were asked to rate the ease or difficulty to answer each question. These two measures combined took approximately 10 to 15 minutes to complete. The final part of the session was the 20-minute timed reading comprehension test. After reading the instructions for the reading skills test participants were asked to raise their hand and let the administrators know when they were ready to begin. The administrators then gave them a post-it note with the beginning and ending times noted. The administrators also recorded the times on a session chart. If the participant did not finish voluntarily before or at the designated ending time of the reading skills test, the study administrators informed them that their time was up and told them to stop
working and submit their data. During the entire session the study administers monitored participants’ progress. At the conclusion of the study session, data from each participant’s program was submitted via email to the study administrator.
CHAPTER 4

Results

To examine the hypotheses and research questions, three-way analyses of variance (ANOVAs) were conducted on each of the dependent measures. The three factors included type of instruction 2 (text or k-map), images 2 (without or with), and reading skill level 3 (low, medium, or high). All post hoc comparisons of reading level or instructional conditions were analyzed with Tukey HSD procedures. All statistical tests in this study were assessed with an alpha level of $p < .05$ (exact probability levels are reported, except for those of .000 that are reported as $p < .0005$).

Did K-maps Lead to Greater Recall Than Text Presentation?

**Overall content remembered.** In order to determine if overall recall was higher in the k-map condition, a three-factor (type of instruction, images, and reading skill) ANOVA was conducted for total recall scores. The main effect for type of instruction on total recall was statistically significant, $F(1,196) = 4.23$, $MSE = 2794.07$, $p = .04$, with the text condition outperforming the k-map condition. There was no significant main effect for inclusion of images. Table 3 shows overall means and standard deviations of recall scores for type of instruction and inclusion of images.

Table 3
*Means (Standard Deviations) of Recall Measures for Instructional Conditions*

<table>
<thead>
<tr>
<th>Recall Measures</th>
<th>Type of Instruction</th>
<th>Images Included</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Text ( n = 104 )</td>
<td>K-Map ( n = 104 )</td>
</tr>
<tr>
<td>Total Recall</td>
<td>49.27 (31.33)</td>
<td>41.94 (26.02)</td>
</tr>
<tr>
<td>Main Ideas</td>
<td>37.71 (22.98)</td>
<td>34.12 (19.93)</td>
</tr>
</tbody>
</table>
The main effect for reading skill level was statistically significant, \( F(2, 196) = 23.84, \ MSE = 15734.59, p < .0005. \) Table 4 shows means and standard deviations of recall measures at the three levels of reading skill. Post hoc comparisons for reading skill level indicated that high participants significantly outscaled medium participants (Tukey \( \alpha = .001 \)) and low participants (Tukey \( \alpha < .0005 \)); medium participants also outscaled low participants (Tukey \( \alpha = .002 \)). There were no statically significant interactions for total recall. Cell means and standard deviations for the total recall of instructional conditions at each reading skill level are presented in Table 5.

Table 4  
Means (Standard Deviations) of Recall Measures for Reading Skill Level  
<table>
<thead>
<tr>
<th>Recall Measures</th>
<th>Reading Skill</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High (n = 67)</td>
</tr>
<tr>
<td>Total Recall</td>
<td>61.85 (28.32)</td>
</tr>
<tr>
<td>Main Ideas</td>
<td>48.03 (19.62)</td>
</tr>
</tbody>
</table>

Table 5  
Means (Standard Deviations) of Total Recall for Type of Instruction by Reading Skill Level  
<table>
<thead>
<tr>
<th>Reading Skill</th>
<th>Text (No Images)</th>
<th>Text (With Images)</th>
<th>K-Map (No Images)</th>
<th>K-Map (With Images)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>54.23 (33.21)</td>
<td>44.31 (28.80)</td>
<td>42.96 (29.73)</td>
<td>40.92 (21.94)</td>
</tr>
<tr>
<td>High</td>
<td>75.06 (28.98)</td>
<td>62.11 (25.71)</td>
<td>60.82 (33.08)</td>
<td>44.54 (13.50)</td>
</tr>
<tr>
<td>Medium</td>
<td>54.93 (33.79)</td>
<td>43.57 (28.66)</td>
<td>42.83 (26.66)</td>
<td>43.19 (25.33)</td>
</tr>
<tr>
<td>Low</td>
<td>33.95 (24.02)</td>
<td>27.05 (22.95)</td>
<td>25.24 (17.58)</td>
<td>35.67 (22.70)</td>
</tr>
</tbody>
</table>

Main ideas remembered. Another similar three-factor (type of instruction, inclusion of images, and reading skill) ANOVA was conducted for recall of the main ideas of library
instruction. The main effects for type of instruction and inclusion of images were not significant (see Table 3 for means and standard deviations). The main effect for reading skill level was significant, $F(2,196) = 23.49$, $MSE = 8827.85$, $p < .0005$ (see Table 4 for means and standard deviations). Post hoc comparisons indicated that participants with high reading skill significantly outsourced medium readers (Tukey $\alpha = .001$) and low readers (Tukey $\alpha < .0005$), with medium participants also outscoring low participants (Tukey $\alpha = .002$). There were no statistically significant interactions for main idea recall. Cell means and standard deviations of the main ideas for instructional conditions at each reading skill level are presented in Table 6.

Table 6

<table>
<thead>
<tr>
<th>Reading Skill</th>
<th>Text No Images</th>
<th>With Images</th>
<th>K-Map No Images</th>
<th>With Images</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>41.33 (23.75)</td>
<td>34.10 (21.82)</td>
<td>34.65 (21.89)</td>
<td>33.58 (17.96)</td>
</tr>
<tr>
<td></td>
<td>n = 52</td>
<td>n = 52</td>
<td>n = 52</td>
<td>n = 52</td>
</tr>
<tr>
<td>High</td>
<td>56.39 (21.44)</td>
<td>47.47 (18.37)</td>
<td>46.82 (21.64)</td>
<td>38.85 (11.70)</td>
</tr>
<tr>
<td></td>
<td>n = 18</td>
<td>n = 19</td>
<td>n = 17</td>
<td>n = 13</td>
</tr>
<tr>
<td>Medium</td>
<td>40.27 (21.59)</td>
<td>32.29 (19.56)</td>
<td>35.67 (20.87)</td>
<td>35.33 (19.31)</td>
</tr>
<tr>
<td></td>
<td>n = 15</td>
<td>n = 14</td>
<td>n = 18</td>
<td>n = 21</td>
</tr>
<tr>
<td>Low</td>
<td>27.89 (19.58)</td>
<td>22.05 (19.77)</td>
<td>21.41 (15.84)</td>
<td>27.72 (19.27)</td>
</tr>
<tr>
<td></td>
<td>n = 19</td>
<td>n = 19</td>
<td>n = 17</td>
<td>n = 18</td>
</tr>
</tbody>
</table>

Contrary to the prediction of the first hypothesis, k-maps did not lead to greater overall recall of ideas over text. Type of presentation did not affect the amount of main ideas recalled about the library research process. The predicted particular benefit of k-maps for medium ability readers was also not found.

**Impact of study time.** Due to the unexpected findings of better overall recall for text rather than k-maps and no differences on main ideas, a post-doc investigation controlled the effect of the time participants spent studying the instructional presentation. An analysis of covariance (ANCOVA) was performed on the dependent recall measures with study time used as
a covariate. When study time was controlled for, the main effect of type of instruction for total recall was not statistically significant $F(1,196) = 2.69$, $MSE = 1706.95$, $p = .10$. Similar ANCOVAs were conducted for all of the dependent measures. Study time was used as a covariate for recall of main ideas, the library transfer test, and effort and efficiency measures. The main effect of type of instruction remained non-significant for recall of main ideas. Also, covarying study time had no impact on the analyses of the other dependent measures. The findings remained the same and will not be discussed further.

**Did images reduce k-map effects for recall?** A research question was posed to assess whether or not the addition of concrete images to a k-map presentation would negatively impact learners. In this analysis only the two k-map conditions, without images and with images, were compared. Table 7 presents means and standard deviations of the two k-map conditions by reading skill level for total recall and recall of main ideas. There were no main effects of image condition for total recall or recall of main ideas. There was a significant main effect for reading skill level for total recall, $(F(2,98) = 6.78$, $MSE = 4020.85$, $p = .002)$ and for main ideas, $(F(2,98) = 7.85$, $MSE = 2748.90$, $p = .001)$. Post hoc comparisons indicated that for total recall, the only significant differences were between the high reading skill participants outscoring the low reading skill participants (Tukey $\alpha = .001$). For recall of main ideas, high reading skill participants outscored low skill participants (Tukey $\alpha < .0005$) with medium skill participants also outscoring the low skill participants (Tukey $\alpha = .039$). There were no significant interactions for either total recall or recall of main ideas. These results indicate that the concrete images included with the k-map presentation in this study were not detrimental to total recall or recall of main ideas.
Table 7
*Means (Standard Deviations) of K-map Groups for Recall Measures by Reading Skill Level*

<table>
<thead>
<tr>
<th>Reading Level</th>
<th>K-map Condition</th>
<th>No Images</th>
<th>With Images</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Reading Level</td>
<td>All</td>
<td>High</td>
</tr>
<tr>
<td>Total Recall</td>
<td>All</td>
<td>42.96 (29.73)</td>
<td>60.82 (33.08)</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>40.92 (21.94)</td>
<td>44.54 (13.49)</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>n = 52</td>
<td>n = 17</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>n = 52</td>
<td>n = 13</td>
</tr>
<tr>
<td>Main Ideas</td>
<td>All</td>
<td>34.65 (21.89)</td>
<td>46.82 (21.64)</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>33.58 (17.96)</td>
<td>38.85 (11.70)</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>n = 52</td>
<td>n = 17</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>n = 52</td>
<td>n = 13</td>
</tr>
</tbody>
</table>

**Did K-maps Lead to Better Performance on the Transfer Test?**

It was predicted that participants who received instruction via the k-map presentations would outperform those who received instruction via text-based presentations on a transfer test of the library research process. To determine the effectiveness of the type of instruction, inclusion of images, and reading skill level, a three-factor ANOVA was conducted for the library research transfer test. There were no statistically significant main effects for type of instruction or inclusion of images. Table 8 shows means and standard deviations of transfer scores for the instructional conditions. A statistically significant main effect was found for reading skill level, $F(2,196) = 36.96, MSE = 133.92, p < .0005$. Post hoc comparisons indicated that high reading skill participants significantly outscored medium participants (Tukey $\alpha = .015$) and low participants (Tukey $\alpha < .0005$), with medium participants also outscoring low participants.
(Tukey $\alpha < .0005$). Table 9 shows the means and standard deviations for transfer scores at the three reading skill levels. Contrary to predictions, instruction with a k-map presentation did not result in greater transfer scores compared to a text-based presentational method. The inclusion or exclusion of images also had no impact on transfer performance.

Table 8
*Means (Standard Deviations) on Transfer Test for Instructional Conditions*

<table>
<thead>
<tr>
<th>Type of Instruction</th>
<th>Images</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Text $n = 104$</td>
<td>K-Map $n = 104$</td>
<td>No $n = 104$</td>
</tr>
<tr>
<td>Transfer Test Score</td>
<td></td>
<td>8.22 (2.24)</td>
<td>8.28 (2.23)</td>
<td>8.23 (2.22)</td>
</tr>
</tbody>
</table>

Table 9
*Means (Standard Deviations) on Transfer Test for Reading Skill Levels*

<table>
<thead>
<tr>
<th>Reading Skill</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>High $n = 67$</td>
<td>Medium $n = 68$</td>
<td>Low $n = 73$</td>
</tr>
<tr>
<td>Transfer Test Score</td>
<td>9.51 (1.39)</td>
<td>8.59 (1.78)</td>
<td>6.78 (2.41)</td>
</tr>
</tbody>
</table>

The only statistically significant interaction was the three-way interaction between presentation, images, and reading skill level, $F(2,196) = 4.03$, $MSE = 14.61$, $p = .019$. Means and standard deviations for type of instruction, inclusion of images, and reading skill level are presented in Table 10.
Table 10
Means (Standard Deviations) of Transfer Test by Instructional Condition and Reading Skill Level

<table>
<thead>
<tr>
<th>Reading Skill</th>
<th>Text No Images</th>
<th>Text With Images</th>
<th>K-Map No Images</th>
<th>K-Map With Images</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>8.13 (2.14)</td>
<td>8.31 (2.35)</td>
<td>8.33 (2.32)</td>
<td>8.23 (2.17)</td>
</tr>
<tr>
<td></td>
<td>n = 52</td>
<td>n = 52</td>
<td>n = 52</td>
<td>n = 52</td>
</tr>
<tr>
<td>High</td>
<td>9.50 (1.25)</td>
<td>9.42 (1.26)</td>
<td>9.82 (1.33)</td>
<td>9.23 (1.83)</td>
</tr>
<tr>
<td></td>
<td>n = 18</td>
<td>n = 19</td>
<td>n = 17</td>
<td>n = 13</td>
</tr>
<tr>
<td>Medium</td>
<td>8.00 (1.69)</td>
<td>9.79 (1.19)</td>
<td>8.50 (1.51)</td>
<td>8.29 (2.10)</td>
</tr>
<tr>
<td></td>
<td>n = 15</td>
<td>n = 14</td>
<td>n = 18</td>
<td>n = 21</td>
</tr>
<tr>
<td>Low</td>
<td>6.95 (2.44)</td>
<td>6.11 (2.21)</td>
<td>6.65 (2.74)</td>
<td>7.44 (2.26)</td>
</tr>
<tr>
<td></td>
<td>n = 19</td>
<td>n = 19</td>
<td>n = 17</td>
<td>n = 18</td>
</tr>
</tbody>
</table>

Figure 1 displays the mean transfer scores of the four instructional conditions by reading skill level. Individual ANOVAs were conducted for the instructional conditions at each reading skill level. There were no statistically significant differences found between instructional conditions for participants at the high and low reading skill levels. A statistically significant main effect for type of instruction was found for participants at the medium reading skill level, $F(3,64) = 3.15, MSE = 9.11, p = .03$. Post hoc comparisons indicated that at the medium skill level text with images significantly outperformed text without images (Tukey $\alpha = .03$). No other groups differed at the medium reading skill level.

Follow-up ANOVAs were conducted to determine differences among reading skill levels for each of the four instructional conditions. The results indicated significant reading skill level differences for the text without images condition, $F(2,49) = 8.56, MSE = 30.31, p = .001$. Post hoc comparisons indicated that the high reading skill participants outscored low participants (Tukey $\alpha < .0005$). Also, there were significant differences among reading skill levels for the text with images condition, $F(2,49) = 26.59, MSE = 73.15, p < .0005$. Both high (Tukey $\alpha < .0005$) and medium (Tukey $\alpha < .0005$) reading skill participants outscored low participants. In the k-
map without images condition, there were significant reading skill level differences, $F(2,49) = 11.35$, $MSE = 43.30$, $p < .0005$. Participants in the high (Tukey $\alpha < .0005$) and medium (Tukey $\alpha = .019$) reading skill levels outscored participants in the low level. For the k-map with images condition there were no significant differences found among the three reading skill levels (see Figure 1).

Thus, the research question anticipating the stronger positive effects of k-maps over text for medium level readers than for high or poor readers was not found. Contrary, to the expected interaction related to medium level readers another interaction involving them was found. For medium level readers alone, text with images yielded superior scores on the transfer test than text without images (see Figure 1).

Figure 1. Mean Transfer Test Scores for the Instructional Conditions by Reading Skill Level
These results indicate that while an overall effect for type of instruction was not found for performance on a library research transfer test, the statistically significant interaction indicated that participants at the medium reading skill level benefited from instruction with text and images compared to a text only presentation. The post hoc analysis also indicated that while high reading skill participants typically outperformed low reading skill participants, this was not the case for the k-map with images condition. When students received a k-map with images, the direction of the means was in the expected order, but the differences among ability groups were not statistically significant. The analysis for the transfer test indicates no support for the hypothesized superiority of k-map instruction for transfer of the library research process. Overall, there were no significant differences between the instructional conditions for transfer.

**Did Instruction with K-maps Reduce Cognitive Load?**

Efficiency scores were used to measure cognitive load. The main efficiency score was transfer efficiency, which is the difference between scores on the transfer test and mental effort expended during the transfer test (test effort). Two additional scores were calculated indicating the learning efficiency of the instructional methods. The learning efficiency measures were computed as the difference between performance on the dependent measures (total recall and transfer test) and mental effort expended during the instruction (instructional effort). Means and standard deviations of the main idea efficiency analysis are found in Appendix O (Table 20). Van Gog and Paas (2008) considered their original transfer efficiency measure to be the more useful indicator of cognitive load, as this measure would be more indicative of schema development for the knowledge being tested.

A multiple analysis of variance (MANOVA) was conducted for the effort and efficiency scores. Statistically significant effects were found for type of instruction, (Wilks’ $\lambda = .91$), $F(4,$
193) = 4.92, \( p = .001 \), reading skill (Wilks’ \( \lambda = .66 \)), \( F(8, 386) = 11.00, p < .0005 \) and the three-way interaction between instruction, images, and reading skill level (Wilks’ \( \lambda = .89 \)), \( F(8, 386) = 2.79, p = .005 \). There were no significant differences for inclusion of images or any of the two-way interactions. Table 11 presents efficiency scores for the dependent measures as well as effort measured at time of instruction and at the transfer test.

Main effects for type of instruction were found for instructional effort, learning efficiency of total recall, and learning efficiency of the transfer test as indicated in table 11. There was a main effect for reading skill level for all of the measures. Reading skill level was the only significant main effect for both transfer effort (\( F(2,196) = 4.226, \text{MSE} = 4.80, p = .015 \)) and transfer efficiency (\( F(2,196) = 21.95, \text{MSE} = 24.32, p < .0005 \)). There were significant three-way interactions for instructional effort (\( F(2,196) = 7.28, \text{MSE} = 10.02, p = .001 \)), learning efficiency of total recall (\( F(2,196) = 4.87, \text{MSE} = 4.87, p = .009 \)), and learning efficiency of the transfer test (\( F(2,196) = 8.22, \text{MSE} = 8.37, p < .0005 \)).

Table 11
Means (Standard Deviations) of Effort and Efficiency Ratings by Group

<table>
<thead>
<tr>
<th>Dependent Measures</th>
<th>Type of Instruction</th>
<th>Images Included</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Text n = 104</td>
<td>K-Map n = 104</td>
</tr>
<tr>
<td>Test Effort(^b)</td>
<td>3.34 (1.06)</td>
<td>3.48 (1.10)</td>
</tr>
<tr>
<td>Transfer Efficiency(^b)</td>
<td>0.04 (1.14)</td>
<td>-0.04 (1.19)</td>
</tr>
<tr>
<td>Instructional Effort(^a,b,c)</td>
<td>2.85 (1.10)</td>
<td>3.49 (1.35)</td>
</tr>
<tr>
<td>Learning Efficiency of Total Recall(^a,b,c)</td>
<td>0.27 (1.11)</td>
<td>-0.27 (1.12)</td>
</tr>
<tr>
<td>Learning Efficiency of Transfer Test(^a,b,c)</td>
<td>0.18 (1.09)</td>
<td>-0.17 (1.21)</td>
</tr>
</tbody>
</table>

\(^a\)Type of instruction main effect significant (\( p < .05 \))
\(^b\)Reading skill level main effect significant (\( p < .05 \))
\(^c\)Three-way interaction (type of instruction, images, reading skill level) significant (\( p < .05 \))
**Transfer effort and efficiency.** Transfer efficiency was measured as the difference between performance on the transfer test (z-scores) and the mean ratings of effort at the time of the transfer test (z-scores). This measure gives an indication of the learner’s knowledge state when they actually need to utilize their knowledge to answer test questions. As reported above, the only significant main effect for mental effort expended during testing and transfer efficiency was found for reading skill level. For mental effort ratings, the results of the post hoc comparison indicated that high reading skill participants ($M = 3.09$, $SD = .89$) reported significantly less effort than low participants ($M = 3.60$, $SD = 1.13$), Tukey $\alpha = .013$ (See Table 12 for means and standard deviations of mental effort by instructional condition and reading skill level). There was also a trend for high participants to report less effort than medium participants ($M = 3.51$, $SD = 1.14$), Tukey $\alpha = .056$. For transfer efficiency the post hoc comparisons indicated that high reading skill participants (Tukey $\alpha < .0005$) and medium participants (Tukey $\alpha = .0005$) were more efficient than low participants. High reading skill participants were also more efficient than medium participants (Tukey $\alpha = .006$). Table 13 provides means and standard deviations for the transfer efficiency scores for type of instruction by reading skill.

**Table 12**

*Means (Standard Deviations) of Mental Effort Rating at Time of Testing by Group*

<table>
<thead>
<tr>
<th>Reading Skill</th>
<th>Text No Images</th>
<th>Text With Images</th>
<th>K-Map No Images</th>
<th>K-Map With Images</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No Images</td>
<td>With Images</td>
<td>No Images</td>
<td>With Images</td>
</tr>
<tr>
<td>All</td>
<td>3.47 (1.12)</td>
<td>3.20 (0.99)</td>
<td>3.50 (1.16)</td>
<td>3.46 (1.06)</td>
</tr>
<tr>
<td></td>
<td>n = 52</td>
<td>n = 52</td>
<td>n = 52</td>
<td>n = 52</td>
</tr>
<tr>
<td>High</td>
<td>3.29 (0.91)</td>
<td>2.71 (0.89)</td>
<td>3.10 (0.91)</td>
<td>3.33 (0.74)</td>
</tr>
<tr>
<td></td>
<td>n = 18</td>
<td>n = 19</td>
<td>n = 17</td>
<td>n = 13</td>
</tr>
<tr>
<td>Medium</td>
<td>3.88 (1.25)</td>
<td>3.33 (1.07)</td>
<td>3.67 (1.15)</td>
<td>3.23 (1.08)</td>
</tr>
<tr>
<td></td>
<td>n = 15</td>
<td>n = 14</td>
<td>n = 18</td>
<td>n = 21</td>
</tr>
<tr>
<td>Low</td>
<td>3.31 (1.17)</td>
<td>3.61 (0.84)</td>
<td>3.70 (1.34)</td>
<td>3.80 (1.18)</td>
</tr>
<tr>
<td></td>
<td>n = 19</td>
<td>n = 19</td>
<td>n = 17</td>
<td>n = 18</td>
</tr>
</tbody>
</table>
Table 13
Means (Standard Deviations) of Transfer Efficiency for Type of Instruction by Reading Skill Level

<table>
<thead>
<tr>
<th>Reading Skill</th>
<th>Text</th>
<th></th>
<th>K-Map</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No Images</td>
<td>With Images</td>
<td>No Images</td>
<td>With Images</td>
</tr>
<tr>
<td>All</td>
<td>-0.08 (1.14)</td>
<td>0.15 (1.14)</td>
<td>-0.03 (1.32)</td>
<td>-0.04 (1.05)</td>
</tr>
<tr>
<td></td>
<td>n = 52</td>
<td>n = 52</td>
<td>n = 52</td>
<td>n = 52</td>
</tr>
<tr>
<td>High</td>
<td>0.47 (0.61)</td>
<td>0.82 (0.76)</td>
<td>0.70 (0.94)</td>
<td>0.36 (0.81)</td>
</tr>
<tr>
<td></td>
<td>n = 18</td>
<td>n = 19</td>
<td>n = 17</td>
<td>n = 13</td>
</tr>
<tr>
<td>Medium</td>
<td>-0.39 (1.20)</td>
<td>0.55 (0.77)</td>
<td>-0.09 (1.06)</td>
<td>0.12 (1.03)</td>
</tr>
<tr>
<td></td>
<td>n = 15</td>
<td>n = 14</td>
<td>n = 18</td>
<td>n = 21</td>
</tr>
<tr>
<td>Low</td>
<td>-0.35 (1.31)</td>
<td>-0.82 (1.04)</td>
<td>-0.70 (1.56)</td>
<td>-0.51 (1.09)</td>
</tr>
<tr>
<td></td>
<td>n = 19</td>
<td>n = 19</td>
<td>n = 17</td>
<td>n = 18</td>
</tr>
</tbody>
</table>

Results of the transfer efficiency measure do not support the third hypothesis that the k-map instruction would lead to higher transfer efficiency scores, an indication that the instructional method would provide a cognitive load advantage for the learner. No significant differences were found between the types of instruction participants received. There were also no significant interactions between type of instruction and reading skill level that may indicate an advantage for specific types of learners.

**Instructional effort and learning efficiency.** Mental effort ratings were collected at the time of instruction and related to the total recall measure and the transfer test for an indicator of learning efficiency. This method of measuring efficiency has also been used as an indicator of cognitive load (Paas, et al. 2003). The value of this method is believed to be in determining whether extraneous cognitive load is impacting learning (Tuovinen & Paas, 2004). I used this method in this study as an exploratory method of measuring cognitive load. With the highly graphical and complex k-map design there was the potential for extraneous features of the instructional design to impact learning as well. Significant three-way interactions were found for the instructional effort rating and both learning efficiency measures. Follow-up ANOVAs for
each were conducted to determine differences within instructional conditions and reading skill levels.

**Instructional effort.** Follow-up on the significant 3-way interaction for instructional effort was conducted comparing reading levels within the four instructional conditions and instructional conditions within the three reading levels. Table 14 shows instructional effort means and standard deviations of the instructional conditions by reading skill level. Figure 2 displays the mean instructional effort scores of the instructional conditions by reading skill levels. The only significant differences among reading levels within instructional condition was for the text with images group, $F(2,49) = 12.16, \text{MSE} = 12.74, p < .0005$. Participants whose reading skill levels were high (Tukey $\alpha < .0005$) and medium (Tukey $\alpha = .007$) reported significantly lower effort ratings compared to participants with low reading skills. There were significant differences between instructional conditions at two of the reading levels: low ($F(3,69) = 4.70, \text{MSE} = 7.63, p = .005$) and high ($F(3,63) = 3.71, \text{MSE} = 3.76, p = .016$). At the low reading level, the text without images group reported less effort than the k-map without images group (Tukey $\alpha = .006$). At the high reading level, the text with images group reported less effort than the k-map group without images (Tukey $\alpha = .035$) and k-map group with images (Tukey $\alpha = .029$) groups. There were no significant differences between conditions at the medium reading level.
Table 14
Means (Standard Deviations) of Mental Effort Rating at Time of Instruction by Group

<table>
<thead>
<tr>
<th>Reading Skill</th>
<th>Text</th>
<th></th>
<th></th>
<th>K-Map</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No Images</td>
<td>With Images</td>
<td>No Images</td>
<td>With Images</td>
<td>No Images</td>
<td>With Images</td>
</tr>
<tr>
<td>All</td>
<td>2.82 (0.96)</td>
<td>2.89 (1.23)</td>
<td>3.66 (1.37)</td>
<td>3.33 (1.03)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>n = 52</td>
<td>n = 52</td>
<td>n = 52</td>
<td>n = 52</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>2.69 (0.77)</td>
<td>2.18 (0.80)</td>
<td>3.11 (1.30)</td>
<td>3.22 (1.14)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>n = 18</td>
<td>n = 19</td>
<td>n = 17</td>
<td>n = 13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medium</td>
<td>3.07 (0.87)</td>
<td>2.63 (0.83)</td>
<td>3.67 (1.14)</td>
<td>3.60 (1.62)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>n = 15</td>
<td>n = 14</td>
<td>n = 18</td>
<td>n = 21</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>2.75 (1.19)</td>
<td>3.78 (1.31)</td>
<td>4.19 (1.54)</td>
<td>3.10 (1.03)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>n = 19</td>
<td>n = 19</td>
<td>n = 17</td>
<td>n = 18</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 2. Mean Mental Effort at Instruction Ratings for the Instructional Conditions by Reading Skill Levels
**Learning efficiency of total recall.** Follow-up on the significant 3-way interaction for instructional efficiency of total recall was conducted comparing reading levels within the instructional conditions and instructional conditions within the reading levels (see Table 15 for means and standard deviations; Figure 3 displays the interaction effect of the instructional conditions at the reading skill levels). Differences among reading levels was found for the text without images condition, \( F(2,49) = 5.91, \text{MSE} = 5.06, p = .005 \). High reading skill participants were more efficient than low participants (Tukey \( \alpha = .004 \)). Reading level differences were found in the text with images condition, \( F(2,49) = 16.72, \text{MSE} = 15.28, p < .0005 \). High (Tukey \( \alpha < .0005 \)) and medium (Tukey \( \alpha = .006 \)) reading skill level participants were more efficient than low participants. Reading level differences were also found for the k-map without images condition, \( F(2,49) = 7.24, \text{MSE} = 9.03, p = .002 \). Participants with high reading skill level were more efficient than low participants (Tukey \( \alpha = .001 \)). There were no differences among reading levels for the k-map with images condition.

Table 15
**Means (Standard Deviations) of Total Recall Learning Efficiency for Type of Instruction & Reading Skill Level**

<table>
<thead>
<tr>
<th>Reading Skill</th>
<th>Text No Images</th>
<th>Text With Images</th>
<th>K-Map No Images</th>
<th>K-Map With Images</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>0.41 (1.01)</td>
<td>0.13 (1.19)</td>
<td>-0.33 (1.25)</td>
<td>-0.20 (0.99)</td>
</tr>
<tr>
<td>High</td>
<td>0.99 (0.76)</td>
<td>0.95 (0.72)</td>
<td>0.41 (1.42)</td>
<td>-0.05 (0.50)</td>
</tr>
<tr>
<td>Medium</td>
<td>0.29 (1.05)</td>
<td>0.26 (0.94)</td>
<td>-0.33 (0.95)</td>
<td>-0.29 (1.22)</td>
</tr>
<tr>
<td>Low</td>
<td>-0.04 (0.96)</td>
<td>-0.83 (1.15)</td>
<td>-1.05 (0.93)</td>
<td>-0.20 (0.97)</td>
</tr>
<tr>
<td>n = 52</td>
<td>n = 52</td>
<td>n = 52</td>
<td>n = 52</td>
<td>n = 52</td>
</tr>
<tr>
<td>n = 18</td>
<td>n = 19</td>
<td>n = 17</td>
<td>n = 13</td>
<td></td>
</tr>
<tr>
<td>n = 15</td>
<td>n = 14</td>
<td>n = 18</td>
<td>n = 21</td>
<td></td>
</tr>
<tr>
<td>n = 19</td>
<td>n = 19</td>
<td>n = 17</td>
<td>n = 18</td>
<td></td>
</tr>
</tbody>
</table>
Significant differences were found for instructional conditions within the high ($F(3,63) = 4.28, MSE = 3.69, p = .008$) and low ($F(3,69) = 4.16, MSE = 4.24, p = .009$) reading skill levels. There were no significant differences between instructional conditions at the medium reading skill level. At the high reading skill level, the text without images (Tukey $\alpha = .017$) and text with images (Tukey $\alpha = .02$) conditions were more efficient than the k-map with images condition. At the low reading skill level, the text without images condition was more efficient than the k-map without images condition (Tukey $\alpha = .02$).
**Learning efficiency of the transfer test.** Follow-up on the significant 3-way interaction for learning efficiency of the transfer test was conducted comparing reading levels within the four instructional conditions and instructional conditions within the three reading levels (see Table 16 for means and standard deviations; Figure 4 displays the interaction effect between instructional conditions and readings skill levels). An effect for reading level was found for the text without images condition, $F(2, 49) = 4.84, MSE = 3.59, p = .016$. High reading skill participants were more efficient than low participants (Tukey $\alpha = .017$). A reading level effect was found for the text with images condition, $F(2, 49) = 31.16, MSE = 21.49, p < .0005$. Participants in the high (Tukey $\alpha < .0005$) and the medium (Tukey $\alpha < .0005$) reading skill groups were more efficient than low participants. An effect was also found for the k-map without images condition, $F(2, 49) = 9.15, MSE = 10.95, p < .0005$. High reading skill participants were more efficient than low participants (Tukey $\alpha < .0005$). There was a trend for medium reading skill participants to be more efficient than low participants (Tukey $\alpha = .056$). There was no significant effect for reading level in the k-map with images condition.

<table>
<thead>
<tr>
<th>Reading Skill</th>
<th>Text</th>
<th></th>
<th>K-Map</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No Images</td>
<td>With Images</td>
<td>No Images</td>
<td>With Images</td>
</tr>
<tr>
<td>All</td>
<td>0.16 (0.95)</td>
<td>0.18 (1.23)</td>
<td>-0.24 (1.26)</td>
<td>-0.09 (1.17)</td>
</tr>
<tr>
<td></td>
<td>n = 52</td>
<td>n = 52</td>
<td>n = 52</td>
<td>n = 52</td>
</tr>
<tr>
<td>High</td>
<td>0.66 (0.54)</td>
<td>0.92 (0.53)</td>
<td>0.53 (0.93)</td>
<td>0.29 (1.04)</td>
</tr>
<tr>
<td></td>
<td>n = 18</td>
<td>n = 19</td>
<td>n = 17</td>
<td>n = 13</td>
</tr>
<tr>
<td>Medium</td>
<td>-0.02 (0.90)</td>
<td>0.79 (0.61)</td>
<td>-0.20 (0.68)</td>
<td>-0.22 (1.36)</td>
</tr>
<tr>
<td></td>
<td>n = 15</td>
<td>n = 14</td>
<td>n = 18</td>
<td>n = 21</td>
</tr>
<tr>
<td>Low</td>
<td>-0.17 (1.13)</td>
<td>-1.02 (1.15)</td>
<td>-1.07 (1.52)</td>
<td>-0.22 (1.02)</td>
</tr>
<tr>
<td></td>
<td>n = 19</td>
<td>n = 19</td>
<td>n = 17</td>
<td>n = 18</td>
</tr>
</tbody>
</table>
Comparing instructional conditions by reading skill level, there was no instruction effect for the high reading skill participants. There was a significant effect for low reading skill participants, $F(3, 69) = 2.99, MSE = 4.40, p = .037$. However, there were no significant differences between conditions in the follow-up comparisons. There was a significant effect for instruction at the medium reading skill level, $F(3, 64) = 3.63, MSE = 3.46, p = .018$. The text with images condition was significantly more efficient than the k-map without images (Tukey $\alpha = .031$) and the k-map with images (Tukey $\alpha = .019$) conditions.
The results of the learning efficiency measures indicated that high reading skill participants were generally more efficient than low reading skill participants. However, this was not the case for participants who received k-map with images instruction, as no reading skill differences were found within that condition. For learning efficiency of total recall there were group differences within the high and low reading skill levels, generally favoring the text condition. The only difference between conditions for the learning efficiency of transfer was at the medium reading skill level favoring the text with images over the k-map without images group.
CHAPTER 5
Discussion

This study evaluated the application of a knowledge map graphical organizing strategy in an online environment. The k-map strategy, developed by Dansereau (1978) and his colleagues at TCU, has proven to be an effective learning strategy under many instructional conditions. The goal in the current investigation was to implement the k-map design as an online instructional presentation of the library research process to lower-division undergraduate students. The library research process, to which the k-map instruction was applied, is a step-by-step strategy for finding information on an unfamiliar topic utilizing various research tools and database search strategies. Procedural type instructions are well suited for application to the k-map process. The library research process is commonly applied as online stand-alone tutorials.

**Recall of the Library Research Process**

In order to fully evaluate the online application of the k-map, several dependent measures were evaluated. The first was a recall measure that yielded a total score plus a component main ideas score. Recall is typically used to evaluate k-maps in studies (Nesbit & Adesope, 2006). K-maps have been found to be effective in promoting better recall and, in particular, better recall of main ideas. The first hypothesis of this study predicted that participants who received an online k-map presentation would recall more total ideas and more main ideas compared to those receiving a text-based online presentation.

The results did not support the main hypothesis that participants in the k-map condition would demonstrate greater overall recall and in particular greater recall of main ideas. The finding for overall recall for type of instruction was in the opposite direction that was expected, but no differences were found between the two conditions for recall of main ideas. There were
significant differences in study time between the two conditions. Participants in the text-based condition spent significantly more time studying the presentation compared to participants in the k-map condition. When study time was controlled for, there were no significant differences between the instructional conditions for total recall and there remained no differences for recall of main ideas. Main idea units are believed to have greater importance on the organization of memory for a topic. In terms of remembering the most important information that may aid transfer of knowledge to problem solving, there appeared to be no real differences between the instructional methods in this study.

Comparing college level students over a wide range of reading skill was a major goal of this study. A research question was posed to investigate the effect that the instructional methods have on learners with differing reading skills. A reading skill test was chosen for this study due to the large amount of text to be read in the control conditions. Participants were recruited from two different universities where evidence of skill differences was previously found. They were divided into three reading levels (high, medium, and low) based on scores on the Davis Reading Test. Prior k-map research (see O’Donnell, et al., 2002) and, in particular, a study by Foor (2004), indicated that instruction provided with the k-map graphical organizer may benefit participants at a medium reading level the most from this sample of participants. Furthermore, there may not be an advantage for participants at either higher or lower reading skill levels.

In order to determine if the k-map presentation method benefited participants at the medium ability level more than the text, an interaction effect would be expected. There were no significant interactions for total or main idea recall. Higher ability readers remembered significantly more than medium ability participants. Both high and medium ability readers recalled more than low ability participants. These results indicated that reading skills had a
stronger impact on recall performance than the type of instruction and that reading skill affected recall regardless of instructional variations.

A second research question was posed to investigate whether or not concrete images would interfere with processing from a k-map presentation. Many basic instructional programs are presented with some combination of text and images or graphics. Library research instruction, whether online or in person, includes images and demonstrations that illustrate certain resources or search methods and strategies. The inclusion of images in k-maps might lead to too many graphical representations and potentially confuse the learner. There were many factors to consider when including static images in a highly graphical k-map. First of all, image size must be considered. Second, the image must fit in with the flow of the k-map or it may disrupt the organizational structure. Finally, the image must also serve a particular purpose. If it does not add cognitive value, then according to the Levin, et al., (1987) classification, it may actually interfere with learning. However, whether or not an image adds cognitive value may not be the deciding factor for its inclusion. According to Ainsworth’s (2006) DeFT Model, how the images relate to the text may also determine if their inclusion will be beneficial or detrimental to learning. The concrete images included in the presentations of the current study were placed at the detail level. It was believed that they would serve in a complimentary role to the text or informational nodes they were accompanying.

The results indicated that there were no statistically significant differences for overall recall between the k-map with images condition and the k-map without images condition. Inclusion versus exclusion of images with k-maps also had no effect on the recall of main ideas. Therefore, it appears that the inclusion of images did not interfere with or aid memory in any meaningful ways for participants receiving a k-map based instructional presentation.
These combined results for recall did not support the first hypothesis that instruction with an online k-map presentation of the library research process would promote greater overall recall and recall of main ideas. The results did not support the prediction that participants with moderate reading skills would benefit more from k-maps than those with more or less reading skills. There are several possible explanations of why the hypothesized findings did not occur.

It was largely unknown how the construction of the k-map would affect learning in an online environment. K-map construction has been studied extensively in print conditions but only minimally in computerized conditions. Steps were taken to construct the map with research-based guidelines such as hierarchical design, consistent color scheme, and a layout that adhered to basic Gestalt principles. Due to limitations of presenting material on a computer screen, the size of the map was restricted to what could be comfortably read in a single screen, without scrolling vertically or horizontally. The stacked-map design was employed. The goal was to present each individual step of the research process as a single image on the screen. However, even in presenting just one step of the process on the screen at one time, the design seemed complicated and difficult to comprehend. In order to overcome this, each step was segmented with only a portion of the k-map step displayed at one time. The learner had control of when they would continue to display the next portion of the k-map or move on to the next step.

One concern with the stacked map design was whether or not it was too long to make an impression on memory. There may have been too many k-map configurations on the various screens for the participants to make any kind of visual representation in memory of the steps in the library research process. Participants also did not have the option of going back and reviewing sections of the map since the “back” option was removed in this study. This may also have prevented participants from connecting ideas from the various steps and sub-steps. It was
hoped that the worked example that reviewed the whole process, in the original k-map format, would reinforce the visual image of the steps. This would be consistent with the dual coding theory (Paivio, 1990), that participants in the k-map condition were expected to create additional representations of knowledge aiding their performance. However, evidence from the recall scores did not support the hypothesized superiority for k-maps.

Another concern with the design of the study was the amount of training participants received on studying the k-map. In typical k-map studies, training on how to use the k-maps would take place before participants would study the k-maps (O’Donnell, et al., 2002). The training provided in this study was brief, consisting of three screens, about a relatively familiar topic, football. It covered the basics of reading a k-map from top-to-bottom and left-to-right. The training also explained how information would be presented in segments with new information complimenting existing information. These basic instructions may not have provided enough training to illustrate how participants should utilize the k-maps to learn about the library research process, a more novel topic that was presented with much more complexity.

In fact, the entire time spent on instruction may have been too short for students to become familiar with the k-map method and make lasting memory differences. Participants in the k-map condition spent approximately 13.6 minutes studying the instructional content, significantly less time than participants in the text condition ($M = 15.1$). It may take more study time for the learner to become familiar with the structure of the map and comprehend all the relationships among concepts of the library research process. For the content area of library research instruction, a typical introductory session may last up to 45 minutes. The previous study (Foer, 2004), where k-maps as lecture aids promoted learning of the library research process, allotted 40 minutes to the instructional content. However, in an online environment, the
instructor or designer may not have control of how long students spend studying the material. Therefore, if k-maps do require more study time and effort compared to reading text, this instructional strategy may not be a good candidate to implement as an online presentational method where students control their own study pace.

Another possible explanation for the difference in study time between the text-based and k-map presentations is that the process of reading the text controlled the pace of the presentation and forced the text-based participants to attend to the presentation longer. The k-map presentations used fewer words and much less descriptive text compared to the narrative text version of the instruction. Since the k-map was segmented with small amounts of the map appearing on the screen with each click, participants may have been more likely to click quickly through the presentation, processing the information at a shallow level.

One of the strengths of the k-map system is that relationships among the concepts are explicitly signaled by the linking system and indirectly signaled through node layouts and characteristics. In comparison with a text-based description of a topic, a k-map should have a distinct advantage in signaling important information and relationships. However, the text-based instructional presentation that was created for this study resembles a structured outline that has some built-in signaling features. The text-based version was originally created as a PowerPoint presentation. Ideas were typically presented in one to two sentences at a time. There were some direct signaling features used such as numbering and bulleted to present sub-points of topics. The layout also has sub-points indented and spaced that would indicate the hierarchical nature of the text. This PowerPoint-type presentation style was done to compare k-maps to typical authentic online instructional tutorials. These design features of the text-based version may have cancelled out the signaling advantage of the k-map. In regards to Mayer’s (2003) cognitive
theory of multimedia learning, both instructional presentation methods provided levels of signaling that may have aided the participant’s ability to recognize and select the most important information. Information in both presentation methods was structured similarly, which also may have helped participants organize the new information in a way that aided storage and retrieval.

**Transfer of the Library Research Process**

The second measure was a library research transfer test. The test used in this study consisted of 12-items that were taken from a standardized information literacy test (Project SAILS, 2005). Several of the items were intended to measure the application of knowledge with real-life type research problems. An important aspect of learning from an online instructional tutorial is to not only remember the information about the topic, but also be able to apply it to authentic research scenarios. The method of scoring the recalls used in this study identifies top-level idea units (main ideas) that indicate a strong organization of memory. A strong organization of knowledge is an important aspect of problem solving (Zeitz & Spohr, 1989). Therefore, participants who recall more main ideas should also perform better on a transfer test. Previous k-map studies have not evaluated learning with an applied measure of transfer. The second hypothesis of this study predicted that participants receiving the online k-map instruction would outscore participants receiving the online text-based instruction on a library research transfer test.

The results of the transfer test analysis indicated that, overall, there were no performance differences for type of instruction or for the inclusion of images. There were significant differences at all three reading skill level levels. However, there was also a significant three-way interaction between type of instruction, images, and reading skill level. The participants who
ranked at the medium level in reading skill and received the text with images presentation outsourced other medium reading skill level participants in the text without images condition.

The second hypothesis predicting that participants who received instruction with the k-map method would outperform those receiving the text-based method in a measure of transfer was not supported. The results also indicated that the inclusion of images did not have a negative impact on learning from k-maps, as there were no significant differences between participants in the k-map with images and without images conditions on the transfer test.

The most interesting finding about transfer was from the interaction indicating that participants at the medium reading skill level were affected differently than participants at the high or low reading skill levels. This finding was contrary to the hypothesis that medium reading skill level participants would benefit from a k-map based instructional presentation. The participants who received the text with images condition benefited over those receiving text without images. This boost in performance was not supported by the belief that recalling more main ideas from the instruction would lead to better transfer performance. The text with images group had lower mean scores for both main ideas and details compared to the text without images group (see Table 6 for Main Idea recall comparisons). Inspection of the individual questions of the 12-item test indicated that the text with images group had a higher percentage of correct scores on many of the questions compared to the text without images group.

There were a few problems with the transfer measure that was used in this study. First, the measure was only piloted in one of the two universities sampled for this study. The overall reliability for the test was low (Cronbach’s α = .569) and there were large differences for reliability between the two university samples. For the university with low reliability, the total scores ranged from 4 to 12, with 94% scoring 7 or higher and 40% scoring 10 or higher. For this
sample, which also had significantly higher reading skills, there may not have been enough questions to appropriately test their knowledge of the library research process after instruction.

The unique results for the participants with medium reading skill, who received text with images, was not explained by their recall performance or by an examination of the individual test questions. The effort and efficiency measures provided some clues as to why they performed better compared to other participants at this reading skill level.

**Cognitive Load of the Instructional Presentations**

The final dependent measures relate to the cognitive load placed on the learner by the instructional method. Past studies have concluded that k-maps reduce the amount of cognitive load placed on the learner based on the results of superior recall performance. K-maps should be effective in reducing cognitive load if they are designed well (O’Donnell, et al., 2002). Utilizing the node/link system helps reduce the reading demands placed on the learner compared to instructional methods that rely heavily on text. The signaling with explicit links allows the learner to see relationships between concepts that are directly connected to each other. With explicit linking, the learner does not have to infer conceptual relationships as they would when comprehending extensive amounts of text. Prior to the current investigation, no study involving k-maps had utilized a direct measurement of cognitive load to support the claim that k-maps alleviate mental effort of processing information. Cognitive load was assessed in this study by measuring transfer efficiency and learning efficiency.

Transfer efficiency was applied at the time of testing. It represents the difference between performance on the transfer test and the mental effort expended completing the test. If mental effort is low and performance is good, then it indicates that the learner has a well-developed cognitive schema for the topic being tested. The results of the transfer efficiency measure
indicated no differences between the instructional conditions and no differences for instruction within the reading skill levels. These results do not support the third hypothesis that online instruction with k-maps would lead to higher transfer efficiency scores. The mental effort ratings along with the transfer scores indicate that the level of schema development of the participants is at a similar level regardless of instructional condition.

Learning efficiency scores were calculated for total recall and the transfer test. This score represents the difference between performance on the dependent measure and mental effort at the time of instruction. This efficiency calculation is intended to give an indication of the amount of extraneous cognitive load that the instructional method places on the learner. Extraneous cognitive load refers to design features of the instruction that either aid or deter from learning.

The results of the learning efficiency scores for total recall indicated that there may be an advantage for the text versions to be more efficient, but the advantage varied based on reading skill level. The text-based presentations were more efficient for high reading skilled participants compared to the k-map with images. Text without images was also more efficient than k-map without images for the less skilled readers. Participants receiving a text-based presentation at the medium reading skill level had positive efficiency scores whereas participants receiving a k-map presentation had negative efficiency scores. However, the differences were not statistically significant. The learning efficiency scores may relate to the extraneous cognitive load placed on the learner. These results indicate that the k-map design, which is believed to alleviate reading demands of text-based materials, was not necessary for highly skilled readers. The significant difference between text-based conditions and the k-map with images condition suggests that the addition of images to the k-map may have provided redundant information that interfered with processing. While there was no significant interaction indicating a performance difference
comparing the text without images and the k-map with images group, there was a large difference in total recall scores. For readers at the medium and low skill reading level, the results were not conclusive enough to determine that one method reduced extraneous cognitive load over the other.

The results for the learning efficiency of transfer scores did not indicate as strong an advantage for text-based groups compared to the k-map conditions. However, the results did show that at the medium reading skill level, participants receiving the text with images presentation were more efficient than participants in either of the k-map conditions. The medium level text with images condition outperformed the text without images condition on the transfer test, but did not have significantly higher efficiency scores. This result provides some evidence that these participants perceived ease of effort during the instructional presentation positively affected their performance on the transfer test. However, in conjunction with the other efficiency measures, less instructional effort does not conclusively explain why their performance stood out. The transfer efficiency score was higher for the text with images group compared to the other groups, but there was no significant interaction to determine that they were significantly better.

**Summary**

In general, many of the hypotheses and predictions of this study were not confirmed. The k-map-based online instructional tutorial of the library research process did not improve performance for participants at any reading skill level compared to a text-based tutorial. The strongest performance conclusion was that participants with moderate reading skills benefited from a text with images presentation on a transfer test. The text-based presentation with images was probably the most familiar type of presentational method for college students. Low mental
effort and high learning efficiency scores for participants in this group suggested that they felt comfortable with the way the information was presented and that this affected their performance. However, it is unclear whether or not this method had a truly distinct advantage for this group. Their mental effort rating during the test and their transfer efficiency scores were not significantly better than participants in other conditions within the medium reading skill level. This may be an indication that while they exhibited better performance on the transfer measure, their cognitive schema may not be as well developed in relation to participants in the other conditions. Finally, there was a significant type of instruction effect for study time with participants in the text condition spending more time studying the instruction than participants in the k-map condition. The advantage for this group may have been related to the extra study time spent on the instruction. Replication is needed for the advantage for transfer found for moderate-level readers when reading text with images versus text without images. The finding was not predicted and the transfer measure had reliability problems, particularly for the subsample with many moderate and high readers from the larger university.

Some expectations of the study were confirmed. The results seem to indicate that participants with higher reading skills found the more familiar text-based instructional methods easier to comprehend. The cognitive scaffolding that the k-map versions were predicted to provide may have been an unnecessary complication. The strong reading level differences with the various dependent measures also suggested that less skilled readers struggled with all of the presentation formats when compared to high and medium skilled readers. However, less skilled readers did not always significantly differ from high or medium participants in the k-map with images condition. No reading skill level differences were found for measures of transfer or learning efficiency. Inspection of the means showed that the high reading skill participants had
the lowest scores of the four conditions while the low reading skill participants had the highest score of the four conditions. This evidence may suggest that the images combined with the k-map hindered performance of the high level participants, while providing a boost to the less skilled participants.

The evidence from this study is not strong enough to conclude that the text-based method is superior to the k-map method for all potential learners that may be in need of library research instruction. In the current study, the k-map presentation may have been too long or contained too much information. There is still value in determining if k-maps can be used to represent the overall steps in the library research process without perhaps using them to promote all of the detailed information and explanations that go into library research instruction. A k-map design that is less complex may help those students who normally struggle with text-based presentations.

There were some unexpected findings in this study. The value of this study was that, while recall scores could not account for performance on the transfer test, efficiency measures as indicators of cognitive load may have. The ease and familiarity of the text with images presentation may have aided participants’ performance on the library transfer test. While it appeared as though k-maps increased the amount of cognitive load placed on the learner, the extra processing effort may have led to more effective processing directed at the development of schema.

There were also several findings indicating no significant differences between the text-based and the k-map presentational methods. This indicates that the text-based method did not hold many advantages over the k-map method, especially when study time was factored in. This
may indicate that modest design changes to make the k-map less confusing and cluttered could make this a viable instructional method in an online environment.

**Limitations of the Present Study**

One of the limitations of this study was that the text-based presentation, which served as the control version, included some design features that typically benefit students in a similar way to what k-maps do. The text-based presentation included forms of signaling and organization that may have aided learners’ comprehension of the material and organization of knowledge for the library research process. The text-based presentation method was constructed this way in order to be typical of instruction a college student would encounter in an online environment. Perhaps positive differences would have been found for the k-map condition if a stricter text condition without organization had been used.

One issue was the length of the instructional presentation and the amount of time participants spent studying the material. Participants knew ahead of time that the study would take approximately 60 minutes and there were no expectations given about how long they should study the material. Participants who received the k-map presentation spent an average of 13.6 minutes studying the content of the k-map presentation. With a total of 46 k-map screen images to click through, the average time spent between clicks would be less than 20 seconds. This may have been especially cumbersome in the k-map condition since the learners would need to orient themselves to the k-map when new information appeared after each click. The new nodes and links typically came below or to the right of previous information. In the text conditions, new information always appeared at the bottom of the screen.
The length of the entire study and the demands on the participants also are limitations of this study. Throughout the session, participants were given three separate assessments of their knowledge of library research as well as a 20-minute timed reading test. The strongest findings occurred in relation to the reading skill level of the participants. The Davis Reading Test was used to measure reading skill level; however, it proved to be a difficult test, especially coming at the end of the study session. The mean raw score was 16.19 ($SD = 6.36$) out of 40 while the mean score with correction for guessing was 11.43 ($SD = 7.31$). The time constraint may have also affected participants’ performance on the test. While two-thirds of the participants completed the entire test, the difficulty and length of the test combined with time pressure may not give an accurate assessment of participants’ reading ability. The test demonstrated strong evidence of reliability ($Cronbach \alpha = .807$) and a significant correlation ($r = .62$) with self-reported SAT reading scores. However, implications about reading skill must be taken with caution as this test may have captured more than just reading ability from the participants, such as conscientiousness.

Limited training in using k-maps also may have been an issue. Participants who have been trained to use k-maps perform better than those who have not had sufficient training (O’Donnell, et al., 2002). There was a very brief training scenario provided in this study. This scenario may not have been enough to teach participants in the k-map conditions how to use the k-map structure and relationships. Training may be a major obstacle in implementing k-maps in an online environment. Unless students will be receiving continued instruction with k-maps, there may not be a willingness to learn how to use a k-map when other choices may be available that do not require training time.
Another limitation involved testing the impact of images on learning with a k-map presentation. While the results indicated no real performance differences, there may not have been as many images as would typically be found in an online instructional program. In this study, the number of images in the k-map was reduced from the number initially planned due to the limitations of screen size and k-map configuration. However, the images that were used did serve the purpose of illustrating concepts in ways that may be familiar to college level students. The inclusion of images should only be based on what is necessary to promote learning.

Another limitation was the low reliability of the transfer measure. This was unexpected from the pilot data and particularly low for participants at the second university. The low reliability, combined with the small number of questions, may call in to question any conclusions made about transfer performance. While the questions used in this study were taken from a standardized information literacy test, the number and range of questions used only represented a small portion of the overall test.

**Educational Implications**

The overall implication of this study is that design features and the target audience of an online instructional method must be carefully considered in order to provide the most effective instruction. Prior research with k-maps has shown that it is an effective strategy in many learning applications when basic design principles are followed (O’Donnell, et al., 2002). A unique contribution of this study may be that an online k-map strategy is not more effective than a text-based presentation when the length of the presentation is long with large numbers of k-map screens. The results indicated that a simple, organized textual presentation of information promoted recall. The inclusion of images within the text also promoted better transfer for some participants. The attempt to implement a complex graphical organizer did not prove more
effective in terms of recall or transfer. When applying complex graphical presentations, instructional designers should use the least complex design that will meet the learner’s needs. Also when implementing a presentational method such as a k-map, sufficient training should be provided or scaffolded so that the learner will benefit from it.

In terms of presenting the library research process in an online environment, the k-map presentation demonstrated similar effectiveness for transfer when compared to a lecture/demonstration-based presentation conducted during the pilot study. Undergraduates in introductory English composition classes were given a 40-minute presentation of the same content that was included in the current study during the pilot study of the transfer test (See Appendix L). A comparison of the mean transfer test scores (See Table 2) indicated that participants receiving the lecture/demonstration in the pilot study had a mean score of 6.95, while participants in the k-map and text conditions in the current study from same university (university 1) had a mean score of 7.37. The subset of 46 participants who received the k-map condition at university 1 had a mean score of 7.54 ($SD = 2.53$). A post hoc analysis comparing the pilot sample and the k-map sample in the current study did not reveal significant differences: participants receiving the online presentation of the k-map scored similarly on the transfer test to participants receiving classroom instruction. In terms of transfer, an online k-map presentation can be as effective as other more traditional methods.

The results of this study indicate that when it comes to assessing the effectiveness of online instructional methods with lower-division college students, individual differences must be taken into account. For this particular study, reading skill level differences were much greater than instructional methods, in terms of performance. Online learning often involves instruction where the learner is entirely responsible for acquiring knowledge from a presentation. If the
presentation method is based primarily on text, highly skilled readers may benefit whereas less skilled readers may be at a disadvantage. This study suggests that high skilled readers do not require strategies intended to aid comprehension, such as the graphical organizing k-map and concrete images. These participants did, however, benefit from a presentation method that provided textual signaling and was organized. Medium skilled readers appeared to benefit from a text presentation that included signaling, organization, and contained concrete images. The less skilled readers struggled with all of the presentational methods compared to those designated as high or medium skilled; however, their performance did not differ on many measures when they received the k-map with images presentation. This presentation method contained the highest amount of signaling and cognitive scaffolds, and the findings suggests that less skilled readers may benefit from a less complex k-map design than was used in this study.

**Future Research**

One question that still remains after this study is under what conditions would a complex graphical organizer work in an online environment? Future research with k-maps may involve creating less complex designs or designs that rely on the k-map structure for top-level information, but more traditional text-based presentation for detail-level information and examples. An unanswered question about this study was whether the training provided was sufficient enough for learners to understand and take advantage of studying a k-map. Perhaps more effort is needed to train participants on effective ways to learn with k-maps. Audio narration may be useful to help provide training or scaffolding in the use of the k-map strategy.

From this study it could not be determined if the segmentation of the k-map that was used, alleviated confusion for learners. K-maps are typically presented as a whole map, where all mapped content is on a single page or as a stacked map where the mapped content is presented
on successive pages. In this study the map was presented as a stacked k-map where each step of
the research process served as a separate map image. However, due to the nature of presenting
the k-map in an online environment it also was segmented. The learner was presented with a
portion of the k-map and would choose when to add more content to the k-map until the step was
completed. A comparison of online instruction of k-map with and without segmentation could
answer this question.

None of the measures used in this study could directly pinpoint how the learners were
interacting with the various instructional presentations. Eye-tracking methodology is a research
tool that could be used to determine how people learn within multimedia environments (Mayer,
2010). The use of eye-tracking may be able to help determine the specific features of the text-
based or k-map based presentations that learners found useful or were attending to when viewing
each segment. This method could prove useful for identifying design features that led to the
interactions between reading skill and the instruction methods. This would be especially helpful
for designing a k-map that is less complex and may be able to contain images or textual
representations from which less skilled readers might benefit.

Finally, a more thorough study of individual differences could be examined. The use of
the Davis Reading Test resulted in strong effects; however, it proved to be a difficult test for
these participants. The use of a different reading measure or an intelligence test may help
determine the specific nature of these strong effects. An attempt in this study was made to
control prior knowledge through the sampling technique. However, the prior knowledge scale
used in the study did not provide reliable results. A research design comparing levels of prior
knowledge also may provide insight into important individual differences that affect online
learning with k-maps.
References


Project SAILS (Standardized Assessment of Information Literacy Skills), (2005). Sails items and skills sets. Kent State University.


APPENDIX A

IRB APPROVAL

Date: June 16, 2010
From: Joyel D. Moeller, IRB Administrator
To: Jamie L. Poor
Subject: Results of Review of Proposal - Expedited (IRB #34082)
Approval Expiration Date: June 15, 2011
“Library Research Instruction in an Online Environment”

The Institutional Review Board (IRB) has reviewed and approved your proposal for use of human participants in your research. By accepting this decision, you agree to obtain prior approval from the IRB for any changes to your study. Unanticipated participant events that are encountered during the conduct of this research must be reported in a timely fashion.

Attached is/are the dated, IRB-approved informed consent(s) to be used when recruiting participants for this research. Participants must receive a copy of the approved informed consent form to keep for their records.

If signed consent is obtained, the principal investigator is expected to maintain the original signed consent forms along with the IRB research records for this research at least three (3) years after termination of IRB approval. For projects that involve protected health information (PHI) and are regulated by HIPAA, records are to be maintained for six (6) years. The principal investigator must determine and adhere to additional requirements established by the FDA and any outside sponsors.

If this study will extend beyond the above noted approval expiration date, the principal investigator must submit a completed Continuing Progress Report to the Office for Research Protections (ORP) to request renewed approval for this research.

On behalf of the IRB and the University, thank you for your efforts to conduct your research in compliance with the federal regulations that have been established for the protection of human participants.

Please Note: The ORP encourages you to subscribe to the ORP listserv for protocol and research-related information. Send a blank email to: L-ORP-Research-L-subscribe-request@lists.psu.edu

JDM/jdm
Attachment
cc: Bonnie J. Meyer
APPENDIX B

CONSENT FORM

Title of Project: Library Research in an Online Environment

Principal Investigator: Jamie Foor, Lock Haven University
G29 Stevenson Library
Lock Haven, PA 17745
(570) 484-2856; jlf105@psu.edu

Advisor: Dr. Bonnie Meyer, Pennsylvania State University
204 CEDAR Building
University Park, PA 16802
(814) 865-4368; bjm8@psu.edu

Purpose of the Study: The purpose of this research study is to investigate the effectiveness of different online instructional methods of the library research process.

Procedures to be followed: You will be given an online library research skills presentation. This will be accompanied by a reading skill assessment as well as a library research questionnaire and exercise.

Discomforts and Risks: There are no risks in participating in this research beyond those experienced in everyday life.

Benefits: By participating in this study you have the opportunity to increase your knowledge and skills of the library research process. The knowledge and skills you acquire might assist you in your future research needs throughout your academic career. This information may also increase your critical thinking skills as they relate to the research process. This research might provide a better understanding of how students learn from instruction presented online. The information from this study might benefit future students who experience instruction in an online format.

Duration: It will take approximately 60 minutes to complete the study.

Statement of Confidentiality: Your participation in this research is confidential. No personally identifiable information will be collected from you. Your confidentiality will be kept to the degree permitted by the technology used. No guarantees can be made regarding the interception of data sent via the Internet by any third parties. The Pennsylvania State University’s Office for Research Protections and Institutional Review Board, and the Office for Human Research Protections in the Department of Health and Human Services may review records related to this project.

Right to Ask Questions: If you have questions about your rights as a research participant, please contact Jamie Foor at (570) 484–2856 with questions, complaints or concerns about this research. If you have any questions, concerns, problems about your rights as a research participant or would like to offer input, please contact The Pennsylvania State University’s Office for Research Protections (ORP) at (814) 865-1775. The ORP cannot answer questions about research procedures. Questions about research procedures can be answered by the research team.
Compensation: Participants will receive 3 extra credit points for their course. As an alternative, you may request to do an article review instead of participating in the study to earn the 3 extra credit points.

Voluntary Participation: Your decision to be in this research is voluntary. You may decline to answer specific questions. You can withdraw from the study at any time by notifying the principal investigator.

You must be 18 years of age or older to take part in this research study. If you agree to take part in this research study and the information outlined above, please sign your name and indicate the date below. You will be given a copy of this consent form for your records.

Participant Signature ____________________________ Date ____________________________

Investigator Signature ____________________________ Date ____________________________
APPENDIX C

VERBAL ABILITY FINDINGS FOR Foor (2004)

TABLE 4.1
Means and Standard Deviations of Main Idea Recall by Type of Instruction and Verbal Ability

<table>
<thead>
<tr>
<th>Verbal Ability</th>
<th>PowerPoint</th>
<th>Knowledge Map</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Low</td>
<td>20.38</td>
<td>8.80</td>
</tr>
<tr>
<td></td>
<td>n=24</td>
<td>n=31</td>
</tr>
<tr>
<td>High</td>
<td>18.13</td>
<td>8.74</td>
</tr>
<tr>
<td></td>
<td>n=24</td>
<td>n=22</td>
</tr>
</tbody>
</table>

The MANOVA yielded a significant main effect for type of instruction, $\lambda(2, 96) = 5.34$, $p < 0.01$, but did not yield a significant main effect for verbal ability level $\lambda(2, 96) = 0.20$, $p > 0.05$. Univariate tests revealed significant effects for total recall $F(1, 97) = 9.93$, $p < 0.01$, and main idea recall $F(1, 97) = 10.20$, $p < 0.01$. There was no significant interaction for type of instruction and verbal ability interaction, $\lambda(2, 96) = 1.24$, $p > 0.05$.

TABLE 4.2
Means and Standard Deviations for Library Exercise 1 by Group

<table>
<thead>
<tr>
<th>Verbal Ability</th>
<th>PowerPoint</th>
<th>Knowledge Map</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Low</td>
<td>50.29</td>
<td>8.93</td>
</tr>
<tr>
<td></td>
<td>n=24</td>
<td>n=27</td>
</tr>
<tr>
<td>High</td>
<td>47.25</td>
<td>9.80</td>
</tr>
<tr>
<td></td>
<td>n=22</td>
<td>n=20</td>
</tr>
</tbody>
</table>

The MANOVA yielded no significant main effects for type of instruction, $\lambda(2, 88) = 0.45$, $p > 0.05$, or verbal ability level $\lambda(2, 88) = 0.35$, $p > 0.05$. There was also no significant main effect for a type of instruction x verbal ability interaction $\lambda(2, 88) = 1.29$, $p > 0.05$. 
APPENDIX D
DEMOGRAPHIC QUESTIONNAIRE

University:
  o  Lock Haven University
  o  Pennsylvania State University

Semester Standing:
  o  Freshman
  o  Sophomore
  o  Junior
  o  Senior
  o  Other, Please explain __________

Major _________________________

Gender:
  o  Male
  o  Female

Age: ______

Current GPA: ______

SAT Scores:
    Reading __________
    Math __________
    Writing __________

Race / Ethnicity:
○ American Indian
○ Asian
○ African American
○ Hispanic
○ Caucasian
○ Other ____________

Are you a native speaker of English?
○ Yes
○ No

Have you ever had a library instruction session before?
○ Yes
○ No

If yes what did it cover? Select all that apply:
○ Database searching
○ Web page evaluation
○ Subject resources (e.g. finding information on the Civil War; searching an education database…)
○ Library tour
○ Other, Please describe __________________________
APPENDIX E

TEXT WITH IMAGES PRESENTATION OF THE LIBRARY RESEARCH PROCESS

Figure 5. Text Screen 1 – Introduction

Introduction to Library Research

This presentation outlines the five main steps in the research process.

These steps include:

1. Defining your topic
2. Choosing your resources
3. Identifying search terms
4. Applying a search strategy
5. Evaluating your findings

Each of these steps will be covered in detail throughout this lesson.

Figure 6. Text Screen 2 – Step 1, Types of Information

Step 1: Defining Your Topic

Before you begin to search for information you need to determine what type of information you need.

In most cases you can make this determination by considering the following two questions:

1. Do you need information that gives an overview / introduction to a topic OR do you need more specific / in-depth information?

2. Do you need information that is intended for a general audience OR a scholarly / professional audience?
Figure 7. Text Screen 3 – Step 1, Depth of Information

**Step 1: Defining Your Topic**

2: Choose Resources  
3: Identify Search Terms  
4: Apply Search Strategy  
5: Evaluate Findings

Before you begin to search for information you need to determine what type of information you need.

In most cases you can make this determination by considering the following two questions:

1. Do you need information that gives an overview / introduction to a topic OR do you need more specific / in-depth information?

   Example:
   Do you need introductory information about the disease diabetes?
   -- What are the causes?
   -- How long does it last?

   OR

   Do you need in-depth information about treatment options for type II diabetestes?
   -- How do high stress levels affect the management of the disease?
   -- How do nutrition and exercise help control the disease?

Figure 8. Text Screen 4 – Step 1, Type of Audience

**Step 1: Defining Your Topic**

2: Choose Resources  
3: Identify Search Terms  
4: Apply Search Strategy  
5: Evaluate Findings

Before you begin to search for information you need to determine what type of information you need.

In most cases you can make this determination by considering the following two questions:

2. Do you need information that is intended for a general audience OR a scholarly / professional audience?

   Example:
   Do you need information for parents about child behaviors? (General Audience)
   -- How can I get my child to go to bed on time?
   -- What can I do to get my child to eat more vegetables?

   OR

   Do you need information about the best practices in child development? (Scholarly / Professional)
   -- Is "time-out" an effective behavior management strategy?
   -- Is there a link between children's television viewing and obesity?
Figure 9. Text Screen 5 – Step 2, Types of Resources

Step 2: Choosing Your Resources

1: Define Topic 2: Choose your resources 3: Identify Search Terms 4: Apply Search Strategy 5: Evaluate Findings

The next step is to decide what type of information resources you should use.

The most frequently used library resources include books and periodicals.

There are two general types of books found in a library:

-- Reference Books
-- Monographs

The two main types of periodical information include:

-- Magazine Articles
-- Scholarly Journal Articles

Figure 10. Text Screen 6 – Step 2, Reference Books

Step 2: Choosing Your Resources - Reference Books

1: Define Topic 2: Choose your resources 3: Identify Search Terms 4: Apply Search Strategy 5: Evaluate Findings

Reference books

-- Often contain general or factual information. This information is useful for answering basic questions about a topic.
-- Reference books are most often consulted when someone is learning about an unfamiliar topic.
Reference books

-- Often contain general or factual information. This information is useful for answering basic questions about a topic.

-- Reference books are most often consulted when someone is learning about an unfamiliar topic.

There are two main types of reference books:

-- General reference books including dictionaries and encyclopedias.

-- Specialized reference books such as encyclopedias, handbooks, etc.

Reference Books are often useful for finding the following types of information:

-- A definition of a concept
Figure 13. Text Screen 9 – Step 2, Reference Books Part IV

**Step 2: Choosing Your Resources - Reference Books**

1: Define Topic  
3: Identify Search Terms  
4: Apply Search Strategy  
5: Evaluate Findings

Reference Books are often useful for finding the following types of information:

---

A definition of a concept

**Inclusion** refers to the placement of students who display one or more disabilities in age-appropriate classrooms.

---

Basic factual information

**Inclusion** is based on the belief that children with disabilities benefit from being educated with students who do not display disabilities.

---

Data or statistic

The 1990 Individuals with Disabilities Education Act (IDEA) established standards for eligibility, types of services, and procedural safeguards.

Figure 14. Text Screen 10 – Step 2, Monographs

**Step 2: Choosing Your Resources - Monographs**

1: Define Topic  
3: Identify Search Terms  
4: Apply Search Strategy  
5: Evaluate Findings

A monograph:

---

Is typically a book devoted to a single topic or a specific area within a topic.

You may find a general book that covers a variety of mental illnesses.

---

**OR**

**A book about a specific mental illness such as schizophrenia.**
**Figure 15. Text Screen 11 – Step 2, Monographs Part II**

**Step 2: Choosing Your Resources - Monographs**

<table>
<thead>
<tr>
<th>1: Define Topic</th>
<th>2: Locate Resources</th>
<th>3: Identify Search Terms</th>
<th>4: Apply Search Strategy</th>
<th>5: Evaluate Findings</th>
</tr>
</thead>
</table>

A monograph:

-- Is typically a book devoted to a single topic or a specific area within a topic.

You may find a general book that covers a variety of mental illnesses.

![Mental Health and Mental Illness](image1.png)

OR

![Schizophrenia](image2.png)

-- Is often much more in-depth and comprehensive than a reference book.

A monographic book about a specific mental illness such as schizophrenia.

-- A monographic book about a specific mental illness typically covers a single class or type of disease and contains more detailed information than a reference book would.

**Figure 16. Text Screen 12 – Step 2, Magazine Articles**

**Step 2: Choosing Your Resources - Magazines**

<table>
<thead>
<tr>
<th>1: Define Topic</th>
<th>2: Locate Resources</th>
<th>3: Identify Search Terms</th>
<th>4: Apply Search Strategy</th>
<th>5: Evaluate Findings</th>
</tr>
</thead>
</table>

Magazine articles can be obtained for nearly any topic.

Some of the common characteristics of magazine articles include:

-- Articles provide basic information intended for individuals with no expertise in the area.

-- Articles are usually written by a staff writer, who may not be an expert in the field.
Figure 17. Text Screen 13 – Step 2, Magazine Articles Part II

**Step 2: Choosing Your Resources - Magazines**

1. Define Topic  
2. Identify Search Terms  
3. Apply Search Strategy  
4. Evaluate Findings

Magazine articles can be obtained for nearly any topic. Some of the common characteristics of magazine articles include:

-- Articles provide basic information intended for individuals with no expertise in the area.

-- Articles are usually written by a staff writer, who may not be an expert in the field.

-- Articles may represent a particular point of view or opinion.

-- Magazine articles are typically not used for college level research.

On the Cover

172 THE SECRET TO A BLISSED-OUT BABY: Confusing advice to soothe little ones

156 TEACH OPTIMISM: The road to tough but helping kids doesn’t have to be.

38 TANTRUM TIMERS: Tips for managing children’s behavior

149 RAISE A KID WHO LOVES TO READ: 5 quick ideas for a life-long hobby

206 SHOULD YOUR CHILD SEE A CHIROPRACTOR? Experts weigh in about whether this practice is good for kids

Figure 18. Text Screen 14 – Step 2, Journal Articles

**Step 2: Choosing Your Resources - Journals**

1. Define Topic  
2. Identify Search Terms  
3. Apply Search Strategy  
4. Evaluate Findings

Journal articles are the most appropriate resource when you need reliable, in-depth information intended for a scholarly/professional audience.

-- They are written by specialists in a field and are based on research they have conducted.

_Aging, Neuropsychology, and Cognition, Vol 1(2), 2000_

Table of Contents

Aging-Related Changes in Event-Cued Visual & Auditory Memory  
Soo L. L. — University of Yukon

Competence in Everyday Activities as Predictor of Cognitive Risk  
Jason C. Allain — North Carolina State University

Fluency, Familiarity, Aging, and the Illusion of Truth  
Colleen M. Parks — University of California

Jeffrey P. Toth — University of North Carolina

Aging, Task Complexity & Efficiency: Influence of Working Memory  
Paul Verhaeghen — Southern University

96
Figure 19. Text Screen 15 – Step 2, Journal Articles Part II

**Step 2: Choosing Your Resources - Journals**

1: Define Topic 3: Identify Search Terms 4: Apply Search Strategy 5: Evaluate Findings

Journal articles are the most appropriate resource when you need reliable, in-depth information intended for a scholarly/professional audience.

-- They are written by specialists in a field and are based on research they have conducted.

*Aging, Neuropsychology, and Cognition, Vol 3(2), 2006*

Table of Contents

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*Competence in Everyday Activities as Predictor of Cognitive Risk*
Sharon L. Willis—Pennsylvania State University

*Fluency, Familiarity, Aging, and the Hacian of Truth*
Colleen M. Parks—University of California

*Jeffrey F. Voss—University of North Carolina*

*Aging, Task Complexity & Efficiency: Influence of Working Memory*
Paul Verhaeghen—Syracuse University

-- Journal articles are peer-reviewed.

This means the articles are selected by an editorial board to ensure the information is valid & reliable.

-- Journal articles are based on a considerable amount of research by the authors.

Because they are based on research—the articles typically have extensive bibliographies at the end of the article.

Figure 20. Text Screen 16 – Steps 1 & 2, Types of Information & Resources

**Step 1: Defining Your Topic** & **Step 2: Choosing Your Resources**

1: Define Topic 3: Identify Search Terms 4: Apply Search Strategy 5: Evaluate Findings

Once you have identified what type of information you need this will lead you to choosing the appropriate resources. For instance:

When you need an overview or introductory type information you will choose reference books as your resource.

-- Reference books provide general information. They are useful for answering basic questions or when you are learning about an unfamiliar topic.

When you need more in-depth information you will choose monographs as your resource.

-- Monographs are devoted to broad or specific topics. They provide more in-depth information compared to reference books.
Figure 21. Text Screen 17 – Steps 1 & 2, Audience & Resources

**Step 1: Defining Your Topic** & **Step 2: Choosing Your Resources**

<table>
<thead>
<tr>
<th>3: Identify Search Terms</th>
<th>4: Apply Search Strategy</th>
<th>5: Evaluate Findings</th>
</tr>
</thead>
</table>

Once you have identified what type of information you need this will lead you to choosing the appropriate resources. For instance:

When you need an overview or introductory type information you will choose reference books as your resource.

-- Reference books provide general information. They are useful for answering basic questions or when you are learning about an unfamiliar topic.

When you need more in-depth information you will choose monographs as your resource.

-- Monographs are devoted to broad or specific topics. They provide more in-depth information compared to reference books.

When the information you need is intended for a general audience you will choose magazine articles as your resource.

-- Magazine articles provide basic information written by non-experts. They are intended for a general audience and may represent an opinion.

When you need scholarly or professional information you will choose journal articles as your resource.

-- Journal articles are written by specialists in a field, are peer reviewed, and based on extensive research.

---

Figure 22. Text Screen 18 – Step 3, Identify Search Terms

**Step 3: Identifying Search Terms**

<table>
<thead>
<tr>
<th>1: Define Topic</th>
<th>2: Choose Resources</th>
<th>4: Apply Search Strategy</th>
<th>5: Evaluate Findings</th>
</tr>
</thead>
</table>

The most common way to begin your information search is to use an electronic database.

Databases can be used to locate information in book or article format.

In order to search a database you need to use the most appropriate keywords or search terms.

Let’s consider again the following research question:

-- What effect does music have on teenagers’ behavior?
Figure 23. Text Screen 19 – Step 3, Choose Keywords

Step 3: Identifying Search Terms

1: Define Topic  2: Choose Resources  4: Apply Search Strategy  5: Evaluate Findings

The most common way to begin your information search is to use an electronic database.

Databases can be used to locate information in book or article format.

In order to search a database you need to use the most appropriate keywords or search terms.

Let’s consider again the following research question:

→ What effect does music have on teenagers’ behavior?

From this question we can identify three main concepts that we would need to use in a database search:

→ Music, Teenagers, and Behavior

Keywords are also necessary because most databases do not recognize long phrases or complete sentences.

→ Example: a search typed in as “effect of music on behavior” retrieves 0 citations in a database.

Figure 24. Text Screen 20 – Step 3, Identify Related Terms

Step 3: Identifying Search Terms

1: Define Topic  2: Choose Resources  4: Apply Search Strategy  5: Evaluate Findings

The three main ideas will serve as the foundation for our database search. However, in order to make our search as effective as possible we will also want to consider any alternative terms in case our original terms do not work.

The use of synonyms or related terms may actually make the search more effective.

Consider the following alternatives to our main ideas: music -- teenagers -- behavior:

Specific types of Music that might negatively influence behavior such as Rap or Heavy Metal could also be considered.

You will also want to consider synonyms and related terms for Teenagers such as Youth, Juveniles or Adolescents.

Behavior could also be described by particular types that music might influence such as violence, suicide, drug use or sex.

You may need to try several variations of terms until you come up with the keywords that will work the best -- It is helpful to consider the possibilities before you begin your search.
Figure 25. Text Screen 21 – Step 2, Database Search Fields

In order to search a database you need to use the most appropriate keywords or search terms.

Databases often search for keywords within the following fields:

<table>
<thead>
<tr>
<th>Title</th>
<th>Subject Headings</th>
<th>Abstract</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core music preference indicate mental health status in young people?</td>
<td>Australian Journal of Public Health In the late 1990s, the media linked the substance of hard drugs and the drug mental status. No research had been done to assess the impact of these drugs on mental health.</td>
<td>In the aftermath of the double suicide of two teenagers in 2007, the media linked the substance of hard drugs and the drug mental status. No research had been done to assess the impact of these drugs on mental health.</td>
</tr>
</tbody>
</table>

Figure 26. Text Screen 22 – Step 3, Subject Headings

In order to search a database you need to use the most appropriate keywords or search terms.

Databases often search for keywords within the following fields:

<table>
<thead>
<tr>
<th>Title</th>
<th>Subject Headings</th>
<th>Abstract</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core music preference indicate mental health status in young people?</td>
<td>Australian Journal of Public Health In the late 1990s, the media linked the substance of hard drugs and the drug mental status. No research had been done to assess the impact of these drugs on mental health.</td>
<td>In the aftermath of the double suicide of two teenagers in 2007, the media linked the substance of hard drugs and the drug mental status. No research had been done to assess the impact of these drugs on mental health.</td>
</tr>
</tbody>
</table>

After you’ve conducted a search and found a relevant citation, the best way to identify additional search terms is to use the subject headings.

Subject headings are uniform descriptions of a topic or concept.
Figure 27. Text Screen 23 – Step 4, Search Strategy Operators

Step 4: Applying Search Strategy
1: Define Topic  2: Choose Resources  3: Identify Search Terms  5: Evaluate Findings

Once you have chosen the appropriate terms to use in a database search, you will use a search strategy that will enable you to find the results you need.

There are 3 common search strategy operators that are used to effectively search an electronic database.

AND

→ Limits the results of a search by combining one or more search terms.

OR

→ Expands results by searching synonyms and related concepts at the same time.

Truncation

→ Shortens a term and searches variations of a root word — This expands results by searching alternate word endings and plurals.

Figure 28. Text Screen 24 – Step 4, AND Search

Step 4: Applying Search Strategy - AND
1: Define Topic  2: Choose Resources  3: Identify Search Terms  5: Evaluate Findings

The AND operator is used to combine two or more terms in order to find only records about the topic you are looking for.

This reduces the number of results you retrieve by identifying only the citations that contain all of the terms that were chosen.

Example Research Question:

Should inclusion practices be used at the preschool level?

→ A keyword search for inclusion retrieves 30,965 citations.

→ A keyword search for preschool retrieves 15,758 citations.
Figure 29. Text Screen 25 – Step 4, AND Search Part II

**Step 4: Applying Search Strategy - AND**

1: Define Topic  2: Choose Resources  3: Identify Search Terms  5: Evaluate Findings

The AND operator is used to combine two or more terms in order to find only records about the topic you are looking for.

This reduces the number of results you retrieve by identifying only the citations that contain all of the terms that were chosen.

**Example Research Question:**

Should inclusion practices be used at the preschool level?

-- A keyword search for inclusion retrieves 30,905 citations.
-- A keyword search for preschool retrieves 15,758 citations.

A keyword search with both of the terms combined:

-- inclusion AND preschool retrieves 48 citations.

Figure 30. Text Screen 26 – Step 4, AND Search Part II

**Step 4: Applying Search Strategy - AND**

1: Define Topic  2: Choose Resources  3: Identify Search Terms  5: Evaluate Findings

The AND operator is used to combine two or more terms in order to find only records about the topic you are looking for.

This reduces the number of results you retrieve by identifying only the citations that contain all of the terms that were chosen.

**Example Research Question:**

Should inclusion practices be used at the preschool level?

-- A keyword search for inclusion retrieves 30,905 citations.
-- A keyword search for preschool retrieves 15,758 citations.

A keyword search with both of the terms combined:

-- inclusion AND preschool retrieves 48 citations.

Adding more terms continues to limit the number of citations retrieved:

-- inclusion AND preschool AND evaluation retrieves 5 citations.
Figure 31. Text Screen 27 – Step 4, OR Search

Step 4: Applying Search Strategy - OR

1: Define Topic  
2: Choose Resources  
3: Identify Search Terms  
5: Evaluate Findings

Another search strategy is the OR search, which is useful for searching synonyms and related concepts at the same time.

-- The OR operator will expand the results of a search by using additional keywords.

Looking at the same example as the previous search:

Should inclusion practices be used at the preschool level?

In this example we can also consider the term kindergarten which is a concept that is related to preschool.

A keyword search for (kindergarten OR preschool) retrieves 20,461 citations.

Figure 32. Text Screen 28 – Step 4, OR Search Part II

Step 4: Applying Search Strategy - OR

1: Define Topic  
2: Choose Resources  
3: Identify Search Terms  
6: Evaluate Findings

Another search strategy is the OR search, which is useful for searching synonyms and related concepts at the same time.

-- The OR operator will expand the results of a search by using additional keywords.

Looking at the same example as the previous search:

Should inclusion practices be used at the preschool level?

In this example we can also consider the term kindergarten which is a concept that is related to preschool.

A keyword search for (kindergarten OR preschool) retrieves 20,461 citations.

We can expand the results of our previous search by adding the related concept kindergarten along with the keyword preschool.

-- inclusion AND preschool retrieved 48 citations.

-- inclusion AND (preschool OR kindergartner) retrieves 76 citations.
Figure 33. Text Screen 29 – Step 4, Or Search Part III

Step 4: Applying Search Strategy - OR

Another search strategy is the OR search, which is useful for searching synonyms and related concepts at the same time.

-- The OR operator will expand the results of a search by using additional keywords.

Looking at the same example as the previous search:

Should inclusion practices be used at the preschool level?

In this example we can also consider the term kindergarten which is a concept that is related to preschool.

A keyword search for (kindergarten OR preschool) retrieves 20,461 citations.

We can expand the results of our previous search by adding the related concept kindergarten along with the keyword preschool.

-- inclusion AND preschool retrieved 48 citations.

-- inclusion AND (preschool OR kindergarten) retrieves 76 citations.

Note that the keywords in an OR search must be enclosed within parenthesis.

The addition of the concept kindergarten with preschool resulted in more citations compared to just preschool alone.

Figure 34. Text Screen 30 – Step 4, Truncation

Step 4: Applying Search Strategy - Truncation

The final search strategy operation is to truncate a term. Truncation shortens or cuts off a word at the end. In a database search this will allow for all possible variations of the word root to be considered in the search. This is useful for searching alternate word endings, especially plurals.

Here are a few examples of how the truncation symbol at the end of a word will find various forms of the word:

-- child* = child, child(ren), child(ren’s), child(hood)

The symbol may vary between databases, but the asterisk is most commonly used to apply truncation to a search term.

The result of a truncation search is that the search will be expanded with the inclusion of additional variations of a word and will result in an increase in citations.
Figure 35. Text Screen 31 – Step 4, Truncation Part II

Using our previous example:

Should inclusion practices be used at the preschool level?

We can apply truncation to the term inclusion as it is sometimes used as the phrase "inclusive schools".

-- inclus* = inclus(ion) & inclus(ive)

Figure 36. Text Screen 32 – Step 4, Truncation Part III

Using our previous example:

Should inclusion practices be used at the preschool level?

We can apply truncation to the term inclusion as it is sometimes used as the phrase "inclusive schools".

-- inclus* = inclus(ion) & inclus(ive)

By applying truncation to a search term we have expanded the number of citations retrieved.

There are 34 more citations that use the word inclusive instead of inclusion.

-- inclusion AND preschool = 48

-- inclus* AND preschool = 82
Figure 37. Text Screen 33 – Step 5, Evaluate Findings

Step 5: Evaluating Your Findings

1: Define Topic  2: Choose Resources  3: Identify Search Terms  4: Apply Search Strategy

After you’ve identified your topic, selected your sources, identified your search terms, and conducted a database search, you will need to evaluate your findings.

-- If the information you found matches your information need then you have successfully conducted the research process and your search is complete.

-- If the information you retrieved does not match your information need, then you can retrace the five steps in the research process to diagnose any possible errors or omissions that occurred along the way.

Figure 38. Text Screen 34 – Step 5, Evaluate Information Sources

Step 5: Evaluating Your Findings

1: Define Topic  2: Choose Resources  3: Identify Search Terms  4: Apply Search Strategy

Answering the following three questions will help determine what steps in the process you need to reevaluate.

1. Are the information sources inadequate?

   If you need basic information or information that is easy to understand you will want to consult a reference book or search for magazine articles.

   If the information you found is insufficient you will want to locate a more in-depth monograph or a journal article.
Figure 39. Text Screen 35 – Step 5, Evaluation of Results & Topics

Step 5: Evaluating Your Findings

1: Define Topic  2: Choose Resources  3: Identify Search Terms  4: Apply Search Strategy

Answering the following three questions will help determine what steps in the process you need to reevaluate.

2. Do your database results match your initial topic?

You will need to reevaluate the terms you selected.

-- Did you select only the main ideas?
-- Are there more appropriate related terms?

Did you find at least one relevant citation?

-- Examine the abstract and subject headings to identify more relevant terms to search with.

Figure 40. Text Screen 36 – Step 5, Evaluation of Amount of Results

Step 5: Evaluating Your Findings

1: Define Topic  2: Choose Resources  3: Identify Search Terms  4: Apply Search Strategy

Answering the following three questions will help determine what steps in the process you need to reevaluate.

3. Did you retrieve too many or too few database results?

Are you using the correct search strategy operators?

-- AND combines terms reducing the number of citations you will retrieve.

-- OR searches alternate words and increases the number of results retrieved.

-- Truncation searches alternate forms of words or word endings—increases the number of results retrieved.
Figure 41. Text Screen 37 – Worked Example Step 1, Type of Information

**Reviewing the 5 Step Library Research Process**

Research Scenario:

Prepare a 5-minute persuasive speech for your intro speech class.

Topic:

Should Major League Baseball ban steroid users?

**Step 1: Define Your Topic**

What type of information do you need?

– Overview/Introduction or In-depth?
  
  You will need some basic information about steroids & opinions about whether or not these players should be eligible.

Figure 42. Text Screen 38 – Worked Example Step 1, Audience

**Reviewing the 5 Step Library Research Process**

Research Scenario:

Prepare a 5-minute persuasive speech for your intro speech class.

Topic:

Should Major League Baseball ban steroid users?

**Step 1: Define Your Topic**

What type of information do you need?

– Overview/Introduction or In-depth?
  
  You will need some basic information about steroids & opinions about whether or not these players should be eligible.

– General Audience/Scholarly Professional Audience
  
  You will be giving facts and opinions that should be directed towards a general audience.
Figure 43. Text Screen 39 – Worked Example Step 2, Books

Reviewing the 5 Step Library Research Process

Research Scenario:
Prepare a 5-minute persuasive speech for your intro speech class.

Topic:
Should Major League Baseball ban steroid users?

Step 2: Choose Resources

What type of resources should I use?
-- Books: Reference OR Monographs
    A reference book would be a good source for information about the effects of using steroids or a statistic such as the percentage of athletes who use steroids.

Figure 44. Text Screen 40 – Worked Example Step 2, Periodicals

Reviewing the 5 Step Library Research Process

Research Scenario:
Prepare a 5-minute persuasive speech for your intro speech class.

Topic:
Should Major League Baseball ban steroid users?

Step 2: Choose Resources

What type of resources should I use?
-- Books: Reference OR Monographs
    A reference book would be a good source for information about the effects of using steroids or a statistic such as the percentage of athletes who use steroids.

-- Periodicals: Magazine Articles OR Journal Articles
    Magazine articles would be a good source of information written for a general audience and would also provide varying opinions about the ethics of banning players or the impact that professional athletes have on children.
Figure 45. Text Screen 41 – Worked Example Step 3, Identify Keywords

**Reviewing the 5 Step Library Research Process**

**Topic:**

Should Major League Baseball ban steroid users?

**Step 3: Identify Search Terms**

Identify the main concepts from the research question:

-- The terms baseball, ban, and steroid represent the main concepts from the topic.

---

Figure 46. Text Screen 42 – Worked Example Step 3, Identify Related Terms

**Reviewing the 5 Step Library Research Process**

**Topic:**

Should Major League Baseball ban steroid users?

**Step 3: Identify Search Terms**

Identify the main concepts from the research question:

-- The terms baseball, ban, and steroid represent the main concepts from the topic.

Identify related concepts and synonyms for each of the main ideas:

-- You can also use sports as a broader term for baseball.

-- Another term that is used in place of ban is suspend.

-- A phrase that includes steroids as well as other type of drugs is "performance enhancing drugs"
Figure 47. Text Screen 43 – Worked Example Step 4, AND Search

Reviewing the 5 Step Library Research Process

Topic:
Should Major League Baseball ban steroid users?

Step 4: Apply Search Strategy - AND

Choose the main concepts as keywords from your topic:
-- A database search for the keyword baseball yields 110,207 citations.
-- A database search for the keyword steroids yields 40,014 citations.

Combine the two terms with an AND search:
-- baseball AND steroids = 1,912 citations

Add additional term to AND search:
-- baseball AND steroids AND ban = 44 citations

Figure 48. Text Screen 44 – Worked Example Step 4, OR Search

Reviewing the 5 Step Library Research Process

Topic:
Should Major League Baseball ban steroid users?

Step 4: Apply Search Strategy - OR

Consider including related concepts that were identified in Step 3.
-- Suspend is another concept that can be used in place of ban.

Apply the OR search with ban or suspend to the original AND search.
-- baseball AND steroids AND (ban or suspend) = 68 citations
Reviewing the 5 Step Library Research Process

Figure 49. Text Screen 45 – Worked Example Step 4, Truncated Search

Topic:

Should Major League Baseball ban steroid users?

Step 4: Apply Search Strategy - Truncation

The previous search can still be improved with the application of truncation to one of the terms.

- The root word suspen* can have multiple endings such as suspen(d), suspen(ds) or suspen(sion).

Apply truncation to the term suspen in the search.

- baseball AND steroids AND (ban or suspend) = 66 citations
- baseball AND steroids AND (ban or suspen*) = 138 citations

Figure 50. Text Screen 46 – Worked Example Step 5, Evaluate Findings

Reviewing the 5 Step Library Research Process

Step 5: Evaluate Your Findings

If the information you retrieved matches the information you needed then your search is complete.

If the information you retrieved does not match the information you need then you need to retrace your steps through the library research process. You can do this by considering the following three questions:

1. Are the information sources adequate?
   Match information needed (Step 1) with the appropriate resources (Step 2)

2. Do your database results match your initial topic?
   Reevaluate the keywords you selected (Step 3)

3. Did you retrieve too many or too few database results?
   Check your search operators -- AND -- OR -- Truncation (Step 4)
APPENDIX F

K-MAP WITH IMAGES PRESENTATION OF THE LIBRARY RESEARCH PROCESS

Figure 51. K-Map Screen 1 – Introduction

The Library Research Process

Figure 52. K-Map Screen 2 – Step 1, Types of Information
Figure 53. K-Map Screen 3 – Step 1, Depth of Information

Figure 54. K-Map Screen 4 – Step 1, Type of Audience
Figure 55. K-Map Screen 5 – Step 2, Types of Resources

Figure 56. K-Map Screen 6 – Step 2, Reference Books
Figure 57. K-Map Screen 7 – Step 2, Reference Books Part II
Figure 58. K-Map Screen 8 – Step 2, Reference Books Part III
Figure 59. K-Map Screen 9 – Step 2, Reference Books Part IV
Figure 60. K-Map Screen 10 – Step 2, Monographs

Step 2: Choose Resources: “What type of information resources should you use?”

Type

Books
- Type
  - Reference
    - General / Factual Information
    - Answer basic questions
    - Learn about unfamiliar topic
  - Monographs
    - Devoted to broad or specific topics
    - Comprehensive coverage

Step 3: Identify Search Terms

Step 4: Apply Search Strategy

Step 5: Evaluate Findings
Figure 61. K-Map Screen 11 – Step 2, Monographs Part II

Step 1: Define Your Topic

Step 2: Choose Resources: “What type of information resources should you use?”

Step 3: Identify Search Terms

Step 4: Apply Search Strategy

Step 5: Evaluate Findings

Books

Reference

General / Factual Information

Answer basic questions

Learn about unfamiliar topic

Monographs

Devoted to broad or specific topics

Comprehensive coverage

Characteristics

Type

Type

Characteristics

Example

Broad -- Mental Illnesses

Specific -- Schizophrenia

Comment

Monographs typically contain more detailed information than reference books.
Figure 62. K-Map Screen 12 – Step 2, Magazine Articles
Figure 63. K-Map Screen 13 – Step 2, Magazine Articles Part II

Step 2: Choose Resources:
“What type of information resources should you use?”

Step 3: Identify Search Terms

Step 4: Apply Search Strategy

Step 5: Evaluate Findings

Type

Periodicals

Type

Magazine Articles

Characteristics

Example

Basic information

Comment

Staff writers

May not be experts in field

Example

Represent opinion / point of view

On the Cover

172 THE SECRET TO A BLISSED-OUT BABY Comforting advice to soothe the little ones

156 TEACH OPTIMISM! The real world is tough, but helping kids doesn’t have to be.

52 TANTRUM TAMERS Tips for taming down bad behavior

149 RAISE A KID WHO LOVES TO LEARN Our smart advice for a successful school year

206 SHOULD YOUR CHILD SEE A CHIROPRACTOR? Experts weigh in about whether this practice is good for kids

Not recommended for college level research
Figure 64. K-Map Screen 14 – Step 2, Journal Articles
Figure 65. K-Map Screen 15 – Step 2, Journal Articles Part II
Figure 66. K-Map Screen 16 – Steps 1 & 2, Type of Information & Resources
Figure 67. K-Map Screen 17 – Steps 1 & 2, Audience & Resources

Step 1: Define Your Topic: “What type of information do you need?”

Step 2: Choose Resources: “What type of information resources should you use?”

Step 3: Identify Search Terms

Step 4: Apply Search Strategy

Step 5: Evaluate Findings

Type

Overview / Introduction

In-Depth

OR

Characteristics

Reference Books

Monographs

General / Factual Information

Devoted to broad or specific topics

In-depth / comprehensive

Learn about unfamiliar topic

Characteristics

General Audience

Scholarly / Professional Audience

Leads To

Leads To

Leads To

Leads To

Leads To

Magazine Articles

Journal Articles

Characteristics

Basic Information

Staff writers

Represent opinion / point of view

Written by specialists in a field

Peer-Reviewed

Based on research
Figure 68. K-Map Screen 18 – Step 3, Identify Search Terms

Figure 69. K-Map Screen 19 – Step 3, Choose Keywords
Figure 70. K-Map Screen 20 – Step 3, Identify Related Terms

Figure 71. K-Map Screen 21 – Step 3, Database Search Fields
Figure 72. K-Map Screen 22 – Step 3, Subject Headings

Figure 73. K-Map Screen 23 – Step 4, Search Strategy Operators
Figure 74. K-Map Screen 24 – Step 4, AND Search

Step 1: Define Your Topic

Step 2: Choose Resources

Step 3: Identify Search Terms

Step 4: Apply Search Strategy:
"Creating a database search statement"

Type

AND

Definition

RESULTS IN

Combines one or more terms

Example

Should inclusion practices be used at the preschool level?

Choose Keywords

Example

inclusion = 30,905 citations
preschool = 15,758 citations

Step 5: Evaluate Findings

Type

OR

Definition

RESULTS IN

Search synonyms & related concepts

Expanding Citations

Type

Truncate

Definition

RESULTS IN

To shorten a term

Expanding Citations

Figure 75. K-Map Screen 25 – Step 4, AND Search Part II

Step 1: Define Your Topic

Step 2: Choose Resources

Step 3: Identify Search Terms

Step 4: Apply Search Strategy:
"Creating a database search statement"

Type

AND

Definition

RESULTS IN

Combines one or more terms

Example

Should inclusion practices be used at the preschool level?

Choose Keywords

Example

Apply AND Search

inclusion = 30,905 citations
preschool = 15,758 citations

preschool = 46 citations

inclusion AND preschool = 46 citations

Step 5: Evaluate Findings
Figure 76. K-Map Screen 26 – Step 4, AND Search Part III

Step 1: Define Your Topic
Step 2: Choose Resources
Step 3: Identify Search Terms
Step 4: Apply Search Strategy: “Creating a database search statement”
Step 5: Evaluate Findings

Type: AND
Definition: Combines one or more terms
Results In: Limiting citations
Example:
Should inclusion practices be used at the preschool level?

Next

Choose Keywords

Next

Apply AND Search

Next

Additional keywords = fewer results

Example:
inclusion AND preschool = 48 citations
inclusion AND preschool AND evaluation = 5 citations

Type: OR
Definition: Search synonyms & related concepts
Results In: Expanding Citations

Type: Truncate
Definition: To shorten a term
Results In: Expanding Citations
Figure 77. K-Map Screen 27 – Step 4, OR Search
Figure 78. K-Map Screen 28 – Step 4, OR Search Part II
Figure 79. K-Map Screen 29 – Step 4, OR Search Part III
Figure 80. K-Map Screen 30 – Step 4, Truncation

Figure 81. K-Map Screen 31 – Step 4, Truncation Part II
Figure 82. K-Map Screen 32 – Step 4, Truncation Part III

Step 4: Apply Search Strategy: “Creating a database search statement”

Type

AND
Definition
Combines one or more terms

OR
Definition
Search synonyms & related concepts

Truncate
Definition
To shorten a term

Search variations of root word

Example

The term inclusion is sometimes used as the phrase “inclusive schools”

Apply truncation to keyword inclusion

Example

inclus* = inclusion inclusive

Example

inclusion AND preschool = 48 citations

inclus* AND preschool = 82 citations

Figure 83. K-Map Screen 33 – Step 5, Evaluate Findings

Step 5: Evaluate Findings
“Does the information retrieved match your information need?”

Yes
Search is complete

No
Retrace steps

Type

Information sources adequate?

Type

Database results do not match topic?

Type

Retrieved too many or too few results?
Figure 84. K-Map Screen 34 – Step 5, Evaluate Information Sources
Figure 85. K-Map Screen 35 – Step 5, Evaluation of Results & Topic
Figure 86. K-Map Screen 36 – Step 5, Evaluation of Amount of Results
Figure 87. K-Map Screen 37 – Worked Example Step 1, Type of Information

Step 1: Define Your Topic: “What type of information do you need?”

Type

Overview / Introduction OR In-Depth

Leads To

Basic info about Steroids

Opinions about eligibility

Research Scenario: prepare a 5-minute persuasive speech for your intro speech class.
Topic: Should Major League Baseball ban steroid users?
Figure 8. K-Map Screen 38 – Worked Example Step 1, Audience

Step 1: Define Your Topic:
"What type of information do you need?"

Type

Overview / Introduction OR In-Depth

 Leads To

 Basic info about Steroids

Opinions about eligibility

Research Scenario: prepare a 5-minute persuasive speech for your intro speech class.
Topic: Should Major League Baseball ban steroid users?

Step 2: Choose Resources

Step 3: Identify Search Terms

Step 4: Apply Search Strategy

Step 5: Evaluate Findings

General Audience OR Scholarly / Professional Audience

 Leads To

 Not Applicable

 Information a general audience can understand

Not Applicable
Figure 89. K-Map Screen 39 – Worked Example Step 2, Books
Figure 90. K-Map Screen 40 – Worked Example Step 2, Periodicals

Step 2: Choose Resources: "What type of information resources should you use?"

Research Scenario: prepare a 5-minute persuasive speech for your intro speech class.
Topic: Should Major League Baseball ban steroid users?

<table>
<thead>
<tr>
<th>Type</th>
<th>Books</th>
<th>Periodicals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference</td>
<td></td>
<td>Journal Articles</td>
</tr>
<tr>
<td>Monographs</td>
<td></td>
<td>Magazine Articles</td>
</tr>
<tr>
<td>Leads To</td>
<td>Find basic information</td>
<td>Leads To</td>
</tr>
<tr>
<td>Example</td>
<td>effects of using steroids</td>
<td>Example</td>
</tr>
<tr>
<td></td>
<td>% of athletes who use steroids</td>
<td></td>
</tr>
</tbody>
</table>
Figure 91. K-Map Screen 41 – Worked Example Step 3, Identify Keywords
Figure 92. K-Map Screen 42 – Worked Example Step 3, Identify Related Terms
Figure 93. K-Map Screen 43 – Worked Example Step 4, AND Search

Step 1: Define Your Topic
Step 2: Choose Resources
Step 3: Identify Search Terms
Step 4: Apply Search Strategy: “Creating a database search statement”
Step 5: Evaluate Findings

AND
Definition
Results In
Combines one or more terms
Limiting citations
Example
Should Major League Baseball ban steroid users?
Next
Choose Keywords
Example
baseball = 110,207 citations
steroids = 40,014 citations
Next
Apply AND Search
Example
baseball AND steroids = 1,912 citations
Next
Additional keywords = fewer results
Example
baseball AND steroids AND ban = 44 citations

OR
Definition
Results In
Search synonyms & related concepts
Expanding Citations

Truncate
Definition
Results In
To shorten a term
Expanding Citations
Figure 94. K-Map Screen 44 – Worked Example Step 4, OR Search

Step 1: Define Your Topic

Step 2: Choose Resources

Step 3: Identify Search Terms

Step 4: Apply Search Strategy: “Creating a database search statement”

Step 5: Evaluate Findings

Type

AND
Definition
Results In
Combines one or more terms
Limiting citations

OR
Definition
Results In
Search synonyms & related concepts
Expanding Citations

Truncate
Definition
Results In
To shorten a term
Expanding Citations

Example
Should Major League Baseball ban steroid users?

Next
Identify related concepts
Example
ban also suspend

Next
Apply OR search
Example
ban OR suspend = 62,080 citations

Next
Combine with AND search
Example
baseball AND steroids AND (ban OR suspend) = 68 citations
Figure 95. K-Map Screen 45 – Worked Example Step 4, Truncated Search
Figure 96. K-Map Screen 46 – Worked Example Step 5, Evaluate Findings
Figure 97. Text Screen 7 (Without Images) – Step 2, Reference Books Part II

Step 2: Choosing Your Resources - Reference Books

Reference books

-- Often contain general or factual information. This information is useful for answering basic questions about a topic.

-- Reference books are most often consulted when someone is learning about an unfamiliar topic.

There are two main types of reference books:

-- General reference books including dictionaries and encyclopedias.

Examples of these include: *Webster's Dictionary* -- *World Book Encyclopedia*

OR

-- Specialized reference books such as encyclopedias, handbooks, etc.

Examples of these include: *Encyclopedia of Special Education* -- *CRC Handbook of Chemistry and Physics*

Figure 98. Text Screen 9 (Without Images) – Step 2, Reference Books Part IV

Reference Books are often useful for finding the following types of information:

*Examples as found in the *Encyclopedia of Special Education* (c2007)

-- A definition of a concept

*Example: Inclusion - refers to the placement of students who display one or more disabilities in age-appropriate classrooms.*

-- Basic factual information

*Example: Inclusion - is based on the belief that children with disabilities benefit from being educated with students who do not display disabilities.*

-- Data or statistic

*Example: Inclusion - the 1990 Individuals with Disabilities Education Act (IDEA) established standards for eligibility, types of services, and procedural safeguards.*
Step 2: Choosing Your Resources - Monographs

1: Define Topic
3: Identify Search Terms
4: Apply Search Strategy
5: Evaluate Findings

A monograph:

-- Is typically a book devoted to a single topic or a specific area within a topic.
You may find a general book that covers a variety of mental illnesses.
Example: Mental Health and Mental Illnesses (c2004)

OR

A book about a specific mental illness such as schizophrenia.
Example: Schizophrenia: Cognitive Theory, Research, and Therapy (c2005)

-- Is often much more in-depth and comprehensive than a reference book.
A monographic book about disease typically covers a single class or type of disease and contains more detailed information than a reference book would.

Figure 100. Text Screen 13 (Without Images) – Step 2, Magazine Articles Part II

Step 2: Choosing Your Resources - Magazines

1: Define Topic
3: Identify Search Terms
4: Apply Search Strategy
5: Evaluate Findings

Magazine articles can be obtained for nearly any topic.

Some of the common characteristics of magazine articles include:

-- Articles provide basic information intended for individuals with no expertise in the area.
Example: Parents Magazine contains articles about child behaviors and characteristics intended for parents.

-- Articles are usually written by a staff writer, who may not be an expert in the field.

-- Articles may represent a particular point of view or opinion.
Example: Parents Magazine offers practical tips for controlling child behaviors.

-- Magazine articles are typically not used for college level research.
Figure 101. Text Screen 15 (Without Images) – Step 2, Journal Articles Part II

**Step 2: Choosing Your Resources - Journals**

<table>
<thead>
<tr>
<th>1: Define Topic</th>
<th>2: Choose Resources</th>
<th>3: Identify Search Terms</th>
<th>4: Apply Search Strategy</th>
<th>5: Evaluate Findings</th>
</tr>
</thead>
</table>

Journal articles are the most appropriate resource when you need reliable, in-depth information intended for a scholarly/professional audience.

-- They are written by specialists in a field and are based on research they have conducted.

Example: Aging, Neuropsychology, and cognition, Vol 13, Iss 2, 2006

Competence in Everyday Activities as a Predictor of Cognitive Risk & Mortality
Jason C. Allaire – North Carolina State University
Sherry L. Willis – The Pennsylvania State University

-- Journal articles are peer-reviewed.

This means the articles are selected by an editorial board to ensure the information is valid & reliable.

-- Journal articles are based on a considerable amount of research by the authors.

Because they are based on research—the articles typically have extensive bibliographies at the end of the article.

Figure 102. Text Screen 22 (Without Images) – Step 3, Subject Headings

**Step 3: Identifying Search Terms**

<table>
<thead>
<tr>
<th>1: Define Topic</th>
<th>2: Choose Resources</th>
<th>3: Identify Search Terms</th>
<th>4: Apply Search Strategy</th>
<th>5: Evaluate Findings</th>
</tr>
</thead>
</table>

In order to search a database you need to use the most appropriate keywords or search terms.

Databases often search for keywords within the following fields:

-- **Title**
Can music preference indicate mental health status in young people

-- **Subject Heading(s)**
Music & youth; Music--Psychological aspects; Rap (Music); Heavy Metal (Music); Delinquent behavior

-- **Abstract**
In the aftermath of the double suicide of two teenage girls in 2007, the media linked the themes of 'emo' music and the girls' mental state. But it is not just emo music that has been the subject of scrutiny. Rap, country and heavy metal have also been blamed for antisocial behaviors including violence, theft, promiscuity and drug use.

After you've conducted a search and found a relevant citation, the best way to identify additional search terms is to use the subject headings.

Subject headings are uniform descriptions of a topic or concept.
Figure 103. K-Map Screen 7 (Without Images) – Step 2, Reference Books Part II

Step 2: Choose Resources: "What type of information resources should you use?"

- Type

Reference
  - Characteristics
    - General/Factual Information
      - Answer basic questions
      - Learn about unfamiliar topic
  - Type

General
  - Example
    - Dictionaries
      - Example: "American Heritage College Dictionary"
    - Encyclopedias
      - Example: "World Book Encyclopedia"
  - Type

Specialized
  - Example
    - Subject encyclopedias, handbooks, etc.
      - Example: "Encyclopedia of Special Education" "Handbook of Chemistry & Physics"
  - Type

Books

Step 3: Identify Search Terms

Step 4: Apply Search Strategy

Step 5: Evaluate Findings

Step 1: Define Your Topic

Next
Figure 104. K-Map Screen 9 (Without Images) – Step 2, Reference Books Part IV
Figure 105. K-Map Screen 11 (Without Images) – Step 2, Monographs Part II

Step 2: Choose Resources:
“What type of information resources should you use?”

Type

Books

Reference
General / Factual Information
Answer basic questions
Learn about unfamiliar topic

Monographs
Devoted to broad or specific topics
Comprehensive coverage

Characteristics

Step 3: Identify Search Terms

Step 4: Apply Search Strategy

Step 5: Evaluate Findings

"Mental Health and Mental Illness" c2004

Example
"Broad -- Mental Illnesses"

Example
"Specific -- Schizophrenia"

Comment: Monographs typically contain more detailed information than reference books.

"Schizophrenia: Cognitive Theory, Research, & Therapy" c2005
Figure 106. K-Map Screen 13 (Without Images) – Step 2, Magazine Articles Part II
Figure 107. K-Map Screen 15 (Without Images) – Step 2, Journal Articles Part II
Figure 108. K-Map Screen 22 (Without Images) – Step 3, Subject Headings
APPENDIX H

DAVIS READING TEST

Davis Reading Test
By Frederick B. Davis and Charlotte Croon Davis
(Copyright © 1956, 1957 by The Psychological Corporation)

Directions: The Passages in this test are taken from textbooks, stories, humorous writings, scientific reports, and other types of reading material. Each passage is followed by one or more multiple-choice items. Your are to read each passage carefully as you come to it and then decide, on the basis of the passage, how to answer each item. Select the choice that you think best answers the question or completes the statement. You may go back to the passage as many times as you wish.

It pays to answer items even when you are not sure that your answers are correct, but it is better to omit an item than to guess wildly among the choices. Work as rapidly as you can without making careless mistakes.

You will have 20 minutes to complete this test.

Please raise your hand and let the administrator know you are ready to begin
It is likely that the second way man told time was by fire. Very early in history the Chinese knotted grass ropes, dampened them, and calculated the time by marking each knot as it burned off by slow fire. Alfred the Great devised a system using candle clocks. He divided every day into three equal periods, to be devoted to religion, public affairs, and rest. At the rate of one inch burning every twenty minutes, one candle lasted four hours. The next development was probably water clocks; these were basins from which water trickled drop by drop into receiving glasses having marks to indicate the hours. The Greeks used them to time their orators. Water clocks were an improvement over sundials for they told how long rather than merely when.

1. About how tall were the candles used by Alfred the Great?
   - 8 inches
   - 12 inches
   - 16 inches
   - 18 inches
   - 20 inches

2. If Alfred kept a candle clock burning during all the time he devoted to religion and public affairs, how many would he use in a week?
   - 21
   - 24
   - 28
   - 36
   - 42

3. If the Greeks wished to improve the accuracy of their water clocks by increasing the distance between the hour marks, they could do so by:
   - Reducing the trickle of water.
   - Making the sides of the basin steeper.
   - Increasing the capacity of the basin.
   - Increasing the diameter of the receiving glass.
   - Decreasing the diameter of the receiving glass.

4. What disadvantage do the various timing devices described in the passage all have?
   - They vary with the seasons.
   - They vary markedly with the weather.
   - They require considerable attention.
   - They are not transportable.
   - They cannot be used at night.

5. In the article from which the passage was taken, the paragraph immediately preceding this one probably described:
   - The discovery of fire.
   - Sundials.
   - Early methods of making rope.
   - The early history of the Chinese.
   - Prehistoric inventions, such as the wheel.

The summer visitors spent hours on end in the graveyard, looking at the inscriptions. "Did you see this one?" they would call, reading it out loud. "Isn't it quaint and frightful?"

Stranger, pause as you pass by,
As you are now, so once was I,
As I am now, so shall you be,
Prepare for death and follow me.

We "natives" saw nothing quaint or frightful about a man's wanting to pass on the lessons he had learned. Moreover, we honored our dead and never raised our voices above them.

6. The visitors found the inscriptions
   - Entertaining.
   - Frightening.
   - Undignified.
   - Stilled
   - Dull

7. How did the "natives" feel toward the visitors?
   - Amused
   - Curious
   - Humble
   - Resentful
   - Grateful

8. The inscription quoted advises the reader to
   - Make merry while he can, for tomorrow he may die.
   - Live so that he will be ready for death.
   - Lead the same sort of life as the man whose grave it marked.
   - Prepare for everlasting life.
   - Remember that he will be dead a long, long time.

9. The writer uses quotation marks around "natives" because
   - It is an unusual word.
   - He felt superior to them.
   - They were so referred to by the visitors.
   - They were not really natives.
   - That was what they called themselves.

10. "Them" (last word in the passage) means the
    - Inscriptions.
    - Voices of the visitors.
    - Voices of the "natives."
    - Voices of the dead.
    - Graves of the dead.

- 2 -
11 Morel appears to be a
- Juggler.
- Quack.
- Painter of humorous pictures.
- Hypnotist.
- Spiritualist medium.

12 What answer does the writer expect to the question, “What, for example...?” (lines 4-8)
- A great many things.
- Everything.
- Nothing.
- Two billiard balls.
- A billiard ball and a cue.

13 The writer expresses
- Envy.
- Deep religious feeling.
- Contempt.
- Admiration.
- Uncertainty.

14 He attributes human qualities to
- A fly.
- A cue.
- A billiard table.
- Admiration.
- Uncertainty.

15 His style is
- Informal.
- Extremely serious.
- Matter-of-fact.
- Careless.
- Awkward.

16 In the last two sentences (lines 16-18), he
- Is sarcastic.
- Exaggerates.
- Contradicts himself.
- Uses figurative language.
- Loses emphasis by repetition.

17 How many pieces of equipment does Morel use in the most difficult feat described?
- Six
- Two
- Three
- Four
- Five

18 The second “it” in line 16 refers directly to
- Feast (line 14).
- Miracle (line 14).
- The first “it” in line 16.
- Unseen world (line 18).
- Everything (line 18).

20 The passage suggests that the travelers
- Still had a considerable distance to go.
- Had reached their destination.
- Were lost.
- Were going over a familiar road.
- Had been overtaken by a storm.
(1) Most sponges are able to produce new individuals by regeneration, from pieces cut out of the old sponge. A biologist tried to find out just how much cutting up a sponge will stand and still be able to produce a normal individual. To break up the sponge as completely as possible without killing it, he tried to pull it apart with needles. This was not thorough enough, so he put about a gram of clean, fresh sponge tissue in a small cloth bag under water and squeezed it. The structure of the sponge was completely mashed and the spheroid portions were pushed out through the cloth's tiny pores. This sleeve was so fine that to pass it the tissue had to break up into single cells. As they came through the bottom of the bag and fell through the water down to the surface of a glass plate, they looked like a small reddish cloud. Surely this was the ultimate in disintegration.

(19) But these cells were not dead. They began to glide about and send out questing filaments. And now comes the most remarkable part. They did not cherish their new independence. When two approached and their filaments touched, they promptly fused. The two fused cells soon added a third, and then another and another, until the host of separate cells formed small round masses. Adjacent masses now fused, and finally the whole body of cells formed a single group.

(29) Soon in the mass the characteristic cellular differentiation appeared—an outer layer, a middle layer, skeletal cells, etc. Whether, as a result of their drastic separation, all the cells revert to a primitive form from which any type of cell may later arise or whether they keep their original characters and assume their proper places in the new sponge is not certain. But the new whole is built by the spontaneous assembling of individual units, each of which develops into a cell characteristic of the particular place it happens to occupy. Like soldiers in a well-drilled company, when the bugle blows they assemble in orderly formation. In some way the structure of the whole sponge, with its specific pattern and cellular variety, is inherent in each individual cell.

21 The biologist (line 3) was investigating

○ Into how small bits a sponge can be separated.
○ From how small bits of sponge tissue a new sponge will form.
○ Whether sponges formed by regeneration are like the parent sponge.
○ How quickly a new sponge will form from old tissue.
○ Whether single sponge cells can live.

22 According to the passage, an important conclusion from this experiment is that individual sponge cells

○ Differ from one another.
○ Do not differ from one another.
○ Cannot be destroyed.
○ Have inherent in them the structure of the whole organism.
○ Can take on the characteristics of other types of cells.

23 It is not known whether, when sponge cells are separated, they

○ Can still move about.
○ Maintain a spherical shape.
○ Lose their color.
○ Remain independent one-celled organisms.
○ Retain their original character.

24 The passage indicates that, if a sponge is pulled apart with needles,

○ It will disintegrate into a reddish cloud.
○ The bits of sponge will die.
○ New sponges will form by regeneration.
○ The cells will live as separate units.
○ The cells will lose their special characters.

25 In this experiment, which of the steps listed below occurred first?

○ Passage of a small reddish cloud through the water.
○ Fusing of masses of cells.
○ Appearance of cellular differences.
○ Sending out of filaments.
○ Separation into single cells.

26 Of the steps listed in the item above, which one occurred last?

○ Passage of a small reddish cloud through the water.
○ Fusing of masses of cells.
○ Appearance of cellular differences.
○ Sending out of filaments.
○ Separation into single cells.

27 The writer likens an individual sponge cell to a

○ Tiny pore.
○ Small cloud.
○ Filament.
○ Soldier.
○ Well-drilled company.

28 Which one of the following words suggests that he is for the moment, giving sponge-cells human attributes?

○ Produce (line 5).
○ Cherish (line 22).
○ Touched (line 23).
○ Body (line 28).
○ Characters (lines 34-35).
(1) Greek and Roman societies were built on the concept of the subordination of the individual to the state; it set the safety of the commonwealth above the safety of individuals. Trained from infancy to these unselfish ideals, the citizens devoted their lives to public services and were ready to lay them down for the common good; or if they shrank from this it never occurred to them that they acted otherwise than basely in preferring their personal existence to the interests of their country.

(12) All of this was changed by the spread of Oriental religions that inculcated the communion of the soul with God and its eternal salvation as the only objects worth living for. The inevitable results of this selfish and immoral doctrine was to withdraw the devotee more and more from public service. A disintegration of the body politic set in; the ties of the state and the family were loosened and society tended to relapse into barbarism.

29 Which one of the following goals did Greek and Roman societies regard as most important?
- Individual freedom
- Eternal salvation
- Personal welfare
- Welfare of the state
- Devotion to the gods

30 The writer criticizes
- Greek and Roman Societies.
- Public service.
- Family ties.
- Oriental religions.
- Pagan ideals.

31 He regards the idea that eternal salvation for the soul is man's only objective as
- Praiseworthy.
- Unimportant.
- Unselfish.
- Inevitable.
- Immoral.

32 "It" in line 4 refers to
- Concept (line 2).
- Subordination (line 2).
- Community (line 3).
- Obligation (line 3).
- State (line 4).

33 "Them" in line 8 refers to
- Individuals (line 5).
- Ideals (line 6).
- Citizens (line 6).
- Lives (line 7).
- Public services (line 7).

34 The "devotee" (line 17) was devoted to
- The safety of the commonwealth.
- Worldly pleasures.
- Religion.
- His family.
- Unselfish ideals.
One of the best-known Southern poets of the post-Civil War period was Sidney Lanier. Although excited by the intellectual ferment of the time, he never did any hard thinking about the philosophic problems raised by science and the machine. His plastic mind entertained all the faith-doubt conflicts of the nineteenth century; and, in contrast to Emily Dickinson, he had a lot to say about them. Whether he had anything important to say is another matter. Like Carlyle, whom he followed devoutly, he romanticized the conclusions of thinkers whom he could neither supplement nor contradict. He waited a lot about "trade" but what does he offer as a cure except his misty personifications, his jargon of Love and Art? Even his finest poem, "The Symphony," ends:

Any yet shall Love himself be heard,
Though long deferred, though long deferred:
O'er the modern waste a dove hath whirred
Music is Love in search of a word.

Very pretty, but not worthy of a student of Wordsworth. Lanier's reactions toward the thinking of his time were always emotional. Only his special fields of music and the craftsmanship of verse was he a constructive thinker.

35 The central thought of this passage is that Lanier
- Was a great poet.
- Lived in a world of his own.
- Was not a great thinker.
- Had something important to say.
- Understood the relationship between poetry and music.

36 A reader disagreeing with the general tone of the passage might best point out that
- Lanier had never met Emily Dickinson.
- Lanier wrote other fine poems besides "The Symphony."
- Lanier had no wish to contradict Carlyle.
- Faith, doubt, love, and art are actually important subjects.
- Thinking constructively in two important fields is a considerable achievement.

37 Which one of the following words would not be applied to Lanier by the writer of the passage?
- Emotional
- Independent
- Vague
- Romantic
- Impressionable

38 The writer regards the lines he quotes from "The Symphony: as
- Among Lanier's finest.
- Not very good.
- Inspiring.
- Penetrating.
- Symbolic.

39 The passage indicates that Lanier wrote extensively about
- Religious problems.
- Southern poetry.
- Education.
- Carlyle.
- His own life.

40 A phrase used sarcastically is
- "hard thinking."
- "plastic mind."
- "waited a lot."
- "misty personifications."
- "very pretty."

Please click the "Submit" button when you are finished with the Davis Reading Test
APPENDIX I

RELATED KNOWLEDGE TEST

Please complete the following multiple-choice items. Choose the best answer for each question. Only one correct answer is listed per question.

1. Which of the following statements most accurately describes the use of documentation or citation styles, e.g., APA, MLA?
   a. All disciplines use the same documentation style for formal written papers.
   b. There are many documentation styles, and they vary by discipline.
   c. There are many documentation styles, and they vary by education levels, such as high school, college undergraduate, graduate, and doctoral.
   d. There are many documentation styles, and which style you use depends on the format of the source being cited, such as books and articles.

2. You must write a paper on the environmental practices of Sony Corporation. Which of the following is most likely to provide balanced information?

3. If you wanted to find books about the American poet Maya Angelou, which search would you do?
   a. Author: angelou.
   b. Publication: angelou.
   c. Subject: angelou.
   d. Title: angelou.

4. If you find a very good article on your topic, what is the most efficient source for finding related articles?
   a. Bibliography from the article.
   b. Library catalog search.
   c. Other volumes of the journal.
   d. Web search.
5. If you need an article or book that is not available online or in your library, what course of action would most likely help you obtain the source expediently?
   a. Complete a purchase request form at the library.
   b. Consult with staff at the circulation desk.
   c. Request a copy from the publisher.
   d. Submit an interlibrary loan request.

6. Which of the following statements is generally true about a Web search engine (for example, Google, Yahoo, Bing)?
   a. Searches most peer-reviewed materials on a topic.
   b. Searches most recent databases.
   c. Searches unpublished materials.
   d. Searches using subject headings.
APPENDIX J

FREE RECALL PROSE ANALYSIS SCORING KEY

LEVELS:

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<td>-EXERCISE</td>
<td>-CONSIDER</td>
<td>-depth</td>
<td>-specific</td>
<td>-need</td>
<td>-patient</td>
<td>-INFORMATION</td>
<td>-description: specific</td>
<td>-patient</td>
<td>-MANAGE (CONTROL)</td>
</tr>
</tbody>
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LEVELS:

1  2  3  4  5  6  7  8  9  10  11

-patient
-AUDIENCE
-description: specific

-comparison: alternative
-causation: covariance, antecedent (54, 158)
-collection
-REPORTS FACTS
-OPINION
-INTENDED FOR GENERAL
-description: specific
-NEED

-patient
-INFORMATION
-description: specific
-CHILD BEHAVIORS

-patient
-FOR PARENTS
-collection
-BED ON TIME
-EAT VEGETABLES
-causation: covariance, antecedent (70, 180)
-collection
-SCHOLARLY INFORMATION
-INTENDED FOR ACADEMIC/PROFESSIONAL
-description: specific
-NEED

-patient
-INFORMATION
-description: specific
-BEST PRACTICES

-patient
-CHILD DEVELOPMENT
-collection
-TIME OUT
-BEHAVIOR MANAGEMENT
-TELEVISION VIEWING
-OBESITY

-CHOOSE (DECIDE)

-patient
-SOURCES
-description: attribution
-APPROPRIATE
-INFORMATION
-description: specific
-collection
-BOOKS
-description: specific
-causation: covariance, consequent (15, 98)
-collection
-REFERENCE
-description: specific
-collection
LEVELS:

1 2 3 4 5 6 7 8 9 10 11
103 -GENERAL
104 -description: specific
105 -collection
106 -ENCYCLOPEDIAS
107 -DICTIONARIES
108 -description: specific
109 -collection
110 -WEBSTERS
111 -WORLD BOOK
112 -SPECIALIZED
113 -description: specific
114 -collection
115 -(SUBJECT) ENCYCLOPEDIAS
116 -HANDBOOKS
117 -description: specific
118 -collection
119 -ENCYCLOPEDIA OF SPECIAL EDUCATION
120 -CRC HANDBOOK OF CHEMISTRY AND PHYSICS
121 -description: attribution
122 -collection
123 -GENERAL
124 -FACTUAL
125 -ANSWER BASIC QUESTIONS
126 -description: specific
127 -collection
128 -EFFECTS OF STEROIDS
129 -% ATHLETES USING
130 -LEARN ABOUT UNFAMILIAR TOPIC
131 -description: attribution
132 -collection
133 -FINDING DEFINITION
134 -FINDING BASIC (FACTUAL) INFORMATION
135 -FINDING DATA / STATISTIC
136 -description: specific
137 -collection
138 -ENCYCLOPEDIA OF SPECIAL EDUCATION
139 -INCLUSION DEFINITION
140 -INCLUSION BENEFITS
141 -1990 IDEA
142 -causation: covariance, consequent (33, 142)
143 -MONOGRAPHS
144 -description: attribution
145 -collection
146 -SINGLE TOPIC / SPECIFIC AREA
147 -description: specific
148 -comparison: alternative
149 -MENTAL HEALTH
150 -SCHIZOPHRENIA
151 -IN-DEPTH / COMPREHENSIVE
152 -description: attribution
153 -collection
154 -SPECIFIC DISEASE
155 -MORE DETAILED THAN REFERENCE
156 -PERIODICALS
LEVELS:

1  2  3  4  5  6  7  8  9  10  11

- description: specific
- causation: covariance, consequent (54, 158)
- collection

-MAGAZINES
- description: attribution
- collection
  - INTENDED FOR GENERAL AUDIENCE
    - description: specific
    - PARENTS MAGAZINE
      - description: attribution
      - NOT RECOMMENDED FOR COLLEGE LEVEL RESEARCH
  - PROVIDE BASIC INFORMATION
    - description: specific
    - PARENTING TOPICS FOR PARENTS
      - description: attribution
      - NOT EXPERT IN FIELD
      - REPRESENT OPINION / POINT OF VIEW
        - description: specific
        - collection
      - TIPS FOR PARENTS
      - ETHICS OF ELIGIBILITY
      - IMPACT ON SOCIETY / KIDS

- causation: covariance, consequent (70, 180)

-SCHOLARLY JOURNALS
  - description: attribution
  - collection
    - INTENDED FOR PROFESSIONAL/SCHOLARLY AUDIENCE
      - description: specific
      - AGING NEUROPSYCHOLOGY & COGNITION
        - description: specific
        - collection
      - WRITTEN BY SPECIALIST IN A FIELD
        - description: specific
        - collection
      - AUTHORS COLLEGE PROFESSORS
      - RESEARCH CONDUCTED
        - description: specific
        - collection
      - PEER-REVIEWED
        - description: specific
        - collection
      - EDITORIAL BOARD SELECTS
      - RELIABLE INFORMATION
        - description: specific
        - collection
      - BASED ON RESEARCH
        - description: specific
        - collection
      - EXTENSIVE BIBLIOGRAPHIES

- IDENTIFY
  - patient
  - KEYWORDS
    - description: setting
    - ELECTRONIC DATABASE
      - description: attribution
      - collection
      - FIND INFORMATION FROM
        - description: specific
        - collection
      - TITLE
| LEVELS:                                                                                      |
| 1 2 3 4 5 6 7 8 9 10 11                                                                    |
| 211                                                                                         |
| -description: specific                                                                      |
| 212                                                                                         |
| -MUSIC PREFERENCE INDICATE MENTAL HEALTH YOUNG                                               |
| 213                                                                                         |
| -SUBJECT HEADINGS                                                                          |
| 214                                                                                         |
| -description: specific                                                                      |
| 215                                                                                         |
| -collection                                                                               |
| 216                                                                                         |
| -MUSIC & YOUTH                                                                             |
| 217                                                                                         |
| -MUSIC - PSYCHOLOGICAL ASPECTS                                                             |
| 218                                                                                         |
| -DELINQUENT BEHAVIOR                                                                       |
| 219                                                                                         |
| -RAP                                                                                       |
| 220                                                                                         |
| -HEAVY METAL                                                                               |
| 221                                                                                         |
| -ABSTRACT                                                                                 |
| 222                                                                                         |
| -description: specific                                                                      |
| 223                                                                                         |
| -DOUBLE SUICIDE TEENAGE GIRLS EMU                                                          |
| 224                                                                                         |
| -DOES NOT RECOGNIZE SENTENCES OR PHRASES                                                    |
| 225                                                                                         |
| -description: specific                                                                      |
| 226                                                                                         |
| -EFFECT OF MUSIC ON BEHAVIOR = 0                                                            |
| 227                                                                                         |
| -LOCATE INFORMATION                                                                       |
| 228                                                                                         |
| -description: specific                                                                      |
| 229                                                                                         |
| -collection                                                                               |
| 230                                                                                         |
| -BOOK FORMAT                                                                              |
| 231                                                                                         |
| -ARTICLE FORMAT                                                                            |
| 232                                                                                         |
| -description: equivalent                                                                    |
| 233                                                                                         |
| -MAIN IDEAS (CONCEPTS)                                                                     |
| 234                                                                                         |
| -patient                                                                                  |
| 235                                                                                         |
| -TOPIC (RESEARCH QUESTION)                                                                |
| 236                                                                                         |
| -description: specific                                                                      |
| 237                                                                                         |
| -problem                                                                                  |
| 238                                                                                         |
| -FIND MATERIALS FOR TOPIC                                                                 |
| 239                                                                                         |
| -description: specific                                                                      |
| 240                                                                                         |
| -WHAT EFFECT DOES MUSIC HAVE ON TEENAGERS BEHAVIOR                                         |
| 241                                                                                         |
| -SHOULD MAJOR LEAGUE BASEBALL BAN STEROID USERS                                            |
| 242                                                                                         |
| -solution                                                                                 |
| 243                                                                                         |
| -IDENTIFY                                                                                 |
| 244                                                                                         |
| -patient                                                                                  |
| 245                                                                                         |
| -collection                                                                               |
| 246                                                                                         |
| -MAIN IDEAS                                                                                |
| 247                                                                                         |
| -description: specific                                                                      |
| 248                                                                                         |
| -collection                                                                               |
| 249                                                                                         |
| -MUSIC                                                                                    |
| 250                                                                                         |
| -TEENAGERS                                                                                |
| 251                                                                                         |
| -BEHAVIOR                                                                                 |
| 252                                                                                         |
| -BASEBALL                                                                                 |
| 253                                                                                         |
| -BAN                                                                                       |
| 254                                                                                         |
| -STEROID                                                                                  |
| 255                                                                                         |
| -RELATED TERMS                                                                             |
| 256                                                                                         |
| -description: specific                                                                      |
| 257                                                                                         |
| -collection                                                                               |
| 258                                                                                         |
| -RAP                                                                                       |
| 259                                                                                         |
| -HEAVY METAL                                                                              |
| 260                                                                                         |
| -YOUTH                                                                                     |
| 261                                                                                         |
| -JUVENILES                                                                                |
| 262                                                                                         |
| -ADOLESCENTS                                                                              |
| 263                                                                                         |
| -VIOLENCE                                                                                 |
| 264                                                                                         |
| -SUICIDE                                                                                  |
LEves:
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265  -SPORTS
266  -SUSPEND
267  -PERFORMANCE ENHANCING DRUGS
268  -description: specific
269  -problem
270  -IDENTIFY
271  -patient
272  -ADDITIONAL ARTICLES
273  -solution
274  -USE
275  -patient
276  -SUBJECT HEADINGS
277  -description: equivalent
278  -UNIFORM DESCRIPTION
279  -patient
280  -CONCEPT
281  -causation: covariance, antecedent (281, 289)
282  -APPLY
283  -description: equivalent
284  -DEVELOP
285  -patient
286  -SEARCH STRATEGY OPERATIONS
287  -description: equivalent
288  -AND/OR/TRUNCATION (ALL 3)
289  -causation: covariance, consequent (281, 289)
290  -CREATE
291  -patient
292  -DATABASE SEARCH STATEMENT
293  -description: specific
294  -collection
295  -AND
296  -description: specific
297  -causation: covariance, antecedent (297, 305)
298  -COMBINES
299  -patient
300  -TERMS
301  -description: specific
302  -comparison, alternative
303  -TWO
304  -MORE
305  -causation: covariance, consequent (297, 305)
306  -REDUCES (LIMITS)
307  -patient
308  -AMOUNT OF CITATIONS
309  -description: evidence
310  -FIND
311  -patient
312  -CITATIONS
313  -description: specific
314  - SHOULD INCLUSION BE USED AT THE PRESCHOOL LEVEL
315  -description: manner
316  -CHOOSE
317  -patient
318  -KEYWORDS
| LEVELS: |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 319 | -description: specific |
| 320 | -collection |
| 321 | -INCLUSION=30,905 |
| 322 | -PRESCHOOL=15,758 |
| 323 | -BASEBALL=110,207 |
| 324 | -STERIODS=40,014 |
| 325 | -description: manner |
| 326 | -APPLY |
| 327 | -patient |
| 328 | -AND SEARCH |
| 329 | -ADDITIONAL KEYWORDS |
| 330 | -description: specific |
| 331 | -comparison: analogy |
| 332 | -INCLUSION AND PRESCHOOL=48 |
| 333 | -INCLUSION AND PRESCHOOL AND ASSESS=5 |
| 334 | -BASEBALL AND STEROIDS=1,912 |
| 335 | -BASEBALL AND STEROIDS AND BAN=44 |
| 336 | -OR |
| 337 | -description: specific |
| 338 | -causation: covariance, antecedent (338, 344) |
| 339 | -SEARCH |
| 340 | -patient |
| 341 | -comparison: analogy |
| 342 | -SYNONYMS |
| 343 | -RELATED CONCEPTS |
| 344 | -causation: covariance, consequent (338, 344) |
| 345 | -EXPANDS (RESULTS) |
| 346 | -description: evidence |
| 347 | -FIND |
| 348 | -patient |
| 349 | -CITATIONS |
| 350 | -description: specific |
| 351 | -SHOULD INCLUSION BE USED AT THE PRESCHOOL LEVEL |
| 352 | -description: manner |
| 353 | -IDENTIFY |
| 354 | -description: specific |
| 355 | -comparison: analogy |
| 356 | -PRESCHOOL |
| 357 | -KINDERGARTEN |
| 358 | -BAN |
| 359 | -SUSPEND |
| 360 | -description: manner |
| 361 | -APPLY |
| 362 | -patient |
| 363 | -OR SEARCH |
| 364 | -COMBINE WITH AND |
| 365 | -description: specific |
| 366 | -comparison: analogy |
| 367 | -PRESCHOOL OR KINDERGARTEN=20,461 |
| 368 | -INCLUSION & (PRESCHOOL OR KINDERGARTEN)=75 |
| 369 | -BAN OR SUSPEND=52,080 |
| 370 | -BASEBALL & STEROIDS & (BAN OR SUSPEND)=68 |
| 371 | -description: specific |
| 372 | -USE |
LEVELS:

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<td>-ALTERNATE WORD ENDINGS</td>
<td>-PLURALS</td>
<td>-causation: covariance, consequent (381, 387)</td>
<td>-EXPANDS</td>
<td>-patient</td>
<td>-RESULTS (CITATIONS)</td>
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<td>-SYMBOL=*</td>
<td>-description: specific</td>
<td>-CHILD*=CHILD, CHILDREN, CHILDHOOD</td>
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<td>-DOES INFORMATION RETRIEVED MATCH INFORMATION NEED</td>
<td>-description: specific</td>
<td>-collection</td>
<td>-problem</td>
<td>-ARE INADEQUATE</td>
<td>-patient</td>
<td>-INFORMATION SOURCES</td>
<td>-solution</td>
<td>-comparison, alternative</td>
<td>-MATCH</td>
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LEVELS:

1  2  3  4  5  6  7  8  9  10  11
427  -patient
428  -collection
429  -TYPE OF INFORMATION NEED
430  -APPROPRIATE INFORMATION SOURCE
431  -description: specific
432  -CHECK
433  -patient
434  -CHARACTERISTICS
435  -range
436  -INFORMATION SOURCES
437  -problem
438  -DOES NOT MATCH TOPIC
439  -patient
440  -DATABASE RESULTS
441  -solution
442  -comparison, alternative
443  -REEVALUATE
444  -patient
445  -KEYWORDS
446  -description: manner
447  -collection
448  -SELECT
449  -patient
450  -MAIN IDEAS
451  -IDENTIFY
452  -patient
453  -RELATED TERMS
454  -EXAMINE
455  -patient
456  -SUBJECT HEADINGS
457  -problem
458  -comparison, alternative
459  -RETRIEVED
460  -patient
461  -RESULTS
462  -description: manner
463  -comparison: alternative
464  -TOO FEW
465  -TOO MANY
466  -solution
467  -comparison, alternative
468  -CHECK
469  -patient
470  -SEARCH OPERATORS
471  -description: specific
472  -APPLY
473  -patient
474  -collection
475  -SEARCH STRATEGY
476  -SEARCH OPERATORS
477  -range
478  -DATABASE
APPENDIX K

LIBRARY RESEARCH TRANSFER TEST

Please complete the following 12-item multiple-choice library exercise. Choose the best answer for each question. Only one correct answer is listed per question.

1. Select the set of terms that best represent the main concepts in the following: What are the health risks associated with the use of drug therapy for hyperactive students?
   a. Drug therapy, health risks
   b. Drug therapy, hyperactivity, health risks
   c. Drugs, hyperactivity, therapy
   d. Drugs, students, health risks

2. You are writing a paper on prescription drug research. Your search for “drugs and research” in a research database has produced over a thousand results. What is the best strategy to deal with these results?
   a. Add additional terms to the search.
   b. Look at all of the results so as not to miss a good article.
   c. Remove one of the search terms.
   d. Select a new database.

3. If you conducted a search about a communication topic that resulted in only a couple of hits in the database, which of the following from the result screen would be the best to use to find additional relevant sources?
   a. Abstract
   b. Article title
   c. Journal name
   d. Subject heading

4. You are writing a paper on economic development in China. You search a research database by typing in, “economic development in China” and retrieve no results. Which of the following actions would help you retrieve a good number of relevant results?
   a. Omit one of the search terms.
   b. Try searching for “econ* and dev* and Chin*”.
   c. Try searching for “economic development China”.
   d. Try searching for “economic development and China”.

5. If you wanted to search for a topic that has several synonyms (for example, young people, adolescents, teenagers, teens), which search operation would you use?
   a. And
   b. Not
   c. Or
   d. Truncation

6. If you end a search term with a special symbol like this: Teenage*
   You would retrieve articles that contain which of the following words?
   a. Adolescents, teenagers, youth
   b. Preteen, teens, teenage
c. Teens, teenager, teenagers
d. Teenaged, teenager, teenagers

7. For a research assignment, you need to find what is known about planaria/planarian regeneration. Which search term(s) would you use to get the most relevant results?
   a. Planaria AND regeneration
   b. Regeneration AND (planaria or planarian)
   c. Planarian AND regeneration
   d. Regeneration AND planaria AND planarian

8. If you wanted to search for a topic that has several components, such as nutrition for pregnant women, which search operation would you use?
   a. And
   b. Not
   c. Or
   d. Truncation

9. When using a research database, which search is the most effective one for identifying articles on how weight affects self esteem?
   a. How weight affects self esteem
   b. Self esteem
   c. Weight and self esteem
   d. Weight or self esteem

10. You are writing a 10-page research paper. Your search on your paper topic has produced 34 articles. What is the best course of action?
    a. Change your topic completely.
    b. Do not revise the search, because the number of articles is good.
    c. Revise the search to retrieve fewer results.
    d. Revise the search to retrieve more results.

11. Which of the following best describes a “periodical publication containing original research reports”?
    a. Magazine (e.g., Psychology Today)
    b. Newsletter (e.g., International Communication Association Newsletter)
    c. Newspaper (e.g., The New York Times)
    d. Scholarly journal (e.g., Quarterly Journal of Speech)

12. Which of the following characteristics of an article is generally the most reliable indicator of scholarly research?
    a. It is available in a university library.
    b. It is indexed in a research database.
    c. It is published on the Web.
    d. It was reviewed by other experts prior to acceptance for publication.
APPENDIX L

PILOT DATA FOR LIBRARY RESEARCH TRANSFER TEST

An initial pool of approximately 20 items was chosen for evaluation. Due to constraints on the time allotted for testing, 15 items were selected. One question corresponded to Step 1, defining your topic; two questions corresponded to Step 2, choosing resources; three questions corresponded with Step 3 identifying search terms; five questions corresponded with Step 4, applying search strategy; and four questions corresponded to Step 5, evaluating findings. More questions were chosen for the latter steps because a) these steps build upon concepts from earlier steps and b) the questions in the databank for search strategy and evaluating findings represented transfer of knowledge better than questions for earlier steps, which emphasized recall of factual knowledge. No correct responses to any question were dependent upon a correct response to another question.

This test was evaluated with groups of students at one of the institutions that will be used for sampling. These students were enrolled in introductory composition classes. The classes had a scheduled library instruction presentation where attendance was a requirement of the course. The instructional presentation lasted approximately 40 minutes and was delivered by a professional librarian using a PowerPoint presentation / demonstration format. The library research content was based on the same content used in this study. The 15-item scale was given to the students in the final 10 minutes of the session.

Eighty student test scores, across four composition classes, were analyzed in the evaluation of this measure. Initial Cronbach’s $\alpha$, indicating the internal consistency of the test, was .564. Upon inspection of the item statistics, three questions were found to have a negative discrimination. Once each of these questions was removed one-by-one, the new 12-item scale
had a Cronbach’s $\alpha$ of .670. The mean of the 12-item scale was 6.96 with a standard deviation of 2.58 (See Appendix C for 12-Item Scale)

A disappointing aspect of the item analysis was that the only question in the scale dealing with Step 1, defining your topic, had the highest negative correlation. One question that asked students to evaluate a topic (Step 5) was removed as well as a question that was intended to assess student’s knowledge of keywords (Step 3). The 12 items that remained in the scale represented a wide range of difficulty ranging from a low difficulty of .85 to a high difficulty of .24. Discrimination of the 12 items ranged from a low of .216 to a high of .404. Variability of item means ranged from a low of .359 to a high of .503 standard deviations.

An exploratory factor analysis was conducted to determine the factor structure of the 12-item scale. Principle component analysis was used with an Oblimin rotation, as a concern was that some items might be related to more than one component. Four factors emerged from the analysis accounting for a cumulative variance of 54.83%.

The first factor accounted for 21.89% of the variance and consisted of three questions involving synonyms or the “OR” search (Step 4: truncation & “OR” search). The second factor accounted for 12.49% of the variance and had four questions. Two questions related to the evaluation of a search (Step 5) and two related to the identification of keywords (Step 3). The two questions from Step 3 could be considered as an evaluation type since there is an aspect of evaluation in picking keywords. Question number 7 which requires an evaluation also includes an “AND” search. This question had a factor loading above .400 on factor 3 which is the “AND” search factor.

Factor 3 accounted for 10.98% of the variance and included two questions dealing with an “AND” search. Factor 4 accounted for 9.46% of the variance. It included one question about
evaluating a search and two questions about scholarly journals. One scholarly journal question about original research had an additional factor loading above .400 on Factor 1 and a question about peer review had an additional factor loading above .400 on Factor 3.

Despite the fact that several questions had factor loadings approaching or exceeding Harmon’s criterion of .400 on a second factor, the factor correlation matrix did not have any factors correlated above .20. Therefore, no factors were collapsed into a single dimension.

The results of this initial analysis are generally positive. The major weakness of this analysis is that the sample of participants was not large enough. For the initial testing of 15 items 150 participants would be required; the final 12 items would require a minimum of 120 participants. This analysis was conducted with only 80 participants; therefore, the results should be taken with caution.

The library research transfer scale does have evidence of reliability and validity. The Cronbach’s $\alpha$ of .670 approaches .7, which is considered good internal consistency for research studies. The items show variability in item means, the scale items have a variety of difficulty levels, and most of the item discriminations are above .3. The factor analysis shows that the four factors accounted for over 50% of the variance. Factor loadings of the items were generally high (.5 to .7) and were for the most part unidimensional.
APPENDIX M

3-D EFFICIENCY MEASURE

I analyzed an exploratory measure of efficiency which combined learning and transfer efficiencies of the transfer test. A significant 3-way interaction for 3-D efficiency was conducted comparing reading levels within the four instructional conditions and instructional conditions within the three reading levels (see Table 17 for means and standard deviations; Figure 5 displays the interaction effect between instructional conditions and readings skill levels). A significant effect for reading skill level was found for the text with images, $F(2, 49) = 26.99$, $MSE = 55.68$, $p < .0005$. Participants in the high (Tukey $\alpha < .0005$) and the medium (Tukey $\alpha < .0005$) reading skill groups were more efficient than low participants. A significant effect for reading skill level was found for the k-map without images ($F(2, 49) = 7.20$, $MSE = 28.43$, $p = .002$) conditions. High reading skill participants were more efficient than low participants (Tukey $\alpha = .001$). A trend for a reading skill level effect was found for the text without images condition, $F(2, 49) = 3.08$, $MSE = 8.97$, $p = .055$. However, there were no significant differences among the reading skill levels in the follow-up comparisons. There was no significant effect for reading level in the k-map with graphics condition. Comparing instructional conditions by reading skill level, there were no instruction effects for the high or low reading skill levels. There was a trend for an effect for medium reading skill participants, $F(3, 69) = 2.73$, $MSE = 8.17$, $p = .051$. However, there were no significant differences between conditions in the follow-up comparisons.

Compared to the learning efficiency measures the results of the 3-D efficiency were more moderate with no indications of instructional condition differences within the reading skill levels. Only two instructional conditions, the text with images and the k-map without images,
had significant differences between participants based on reading skill level. Overall these results
do not support the general prediction that k-maps would lead to more efficient performance.

Table 17
*Means (Standard Deviations) of 3-D Efficiency at Transfer for Type of Instruction by Reading Skill Level*

<table>
<thead>
<tr>
<th>Reading Skill</th>
<th>Text No Images</th>
<th>Text With Images</th>
<th>K-Map No Images</th>
<th>K-Map With Images</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>0.19 (1.77)</td>
<td>0.36 (2.04)</td>
<td>-0.39 (2.22)</td>
<td>-0.16 (1.93)</td>
</tr>
<tr>
<td>High</td>
<td>0.99 (1.01)</td>
<td>1.67 (1.04)</td>
<td>0.91 (1.69)</td>
<td>0.45 (1.67)</td>
</tr>
<tr>
<td>Medium</td>
<td>-0.28 (1.80)</td>
<td>1.17 (1.18)</td>
<td>-0.42 (1.33)</td>
<td>-0.23 (2.22)</td>
</tr>
<tr>
<td>Low</td>
<td>-0.19 (2.10)</td>
<td>-1.55 (1.88)</td>
<td>-1.67 (2.72)</td>
<td>-0.52 (1.73)</td>
</tr>
</tbody>
</table>

FIGURE 109. *3-D Efficiency of Transfer for Instructional Conditions by Reading Skill Levels*
APPENDIX N

TEXT AND K-MAP PRESENTATION TRAINING SCREENS

FIGURE 110. Text With Images Training Screen 1

How to Use this Instructional Program

The design of this tutorial utilizes a combination of text and graphics.

Information will be presented in descriptive format.

Concepts will be presented and examples of the concepts will be used to illustrate ideas related to the concept.

Instructional Example:

There are several types of sports. Different types of sports include individual sports, team sports, and water sports.

-- Two examples of team sports include football and baseball.

FIGURE 111. Text With Images Training Screen 2

How to Use this Instructional Program

The information that is presented is designed to be read from top to bottom. New information will be presented below the concepts that are being described.

Please note the following example that explains information about the sport of football. Descriptive information about football is shown below the concept of football -- examples will also be used to describe the relationship between the concepts.

Instructional Example:

There are several types of sports. Different types of sports include individual sports, team sports, and water sports.

Two examples of team sports include football and baseball.

-- The goal of the sport of football is to score more points than your opponent.

-- The team that scores the most points wins the game.

-- In football there are several ways to score points.
FIGURE 112. Text With Images Training Screen 3

How to Use this Instructional Program

Here additional examples are provided that describe of scoring points in football along with the amount of points attained.

For each concept new information may be added in additional screens. When this occurs previous information may still be visible so that you can see how the new information connects to previous concepts.

It is important to observe the relationship of new information with previous information.

Instructional Example:

There are several types of sports. Different types of sports include individual sports, team sports, and water sports.

Two examples of team sports include football and baseball.

-- The goal of the sport of football is to score more points than your opponent.

    The team that scores the most points wins the game.

-- In football there are several ways to score points.

    One way to score is to kick a field goal. Kicking a field goal results in scoring 3 points.

    A second way to score points is to score a touchdown. Scoring a touchdown will result in 6 points.

FIGURE 113. K-map Training Screen 1

How to Use this Instructional Program

The design of this tutorial utilizes a graphical mapping system.

Information is presented in a node-link format.

The nodes contain concepts about the topic — the links, which are labeled, describe the relationship between the concepts.
FIGURE 114. K-map Training Screen 2

How to Use this Instructional Program

The map is designed to be read from top to bottom -- and occasionally left to right. New information will be presented below the top level of the map -- the arrowed links will indicate the direction that is to be followed.

Please note the following example utilizing a graphical map to explain information about the sport of football. Descriptive information about football is shown below the node for football -- the links describes the relationship between the nodes.
FIGURE 115. K-map Training Screen 3

How to Use this Instructional Program

Here additional nodes and links provide examples of scoring points in football along with the amount of points attained.

While new information is being added in each additional screen, previous information is still visible so that you can see the connections to the type of sport.

It is important to observe the relationship of new links and nodes with the top level of the graphical map.

There is no formal narrative to this tutorial, you must observe the characteristics of the graphical map and follow along with the direction of new nodes and links that are presented with each screen.
## APPENDIX N

### MAIN IDEA LEARNING EFFICIENCY

Table 18

*Means (and Standard Deviations) of Main Idea Learning Efficiency for Type of Instruction by Reading Skill Level*

<table>
<thead>
<tr>
<th>Reading Skill</th>
<th>Text No Images</th>
<th>Text With Images</th>
<th>K-Map No Images</th>
<th>K-Map With Images</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>0. (0.77)</td>
<td>0. (0.70)</td>
<td>0. (1.35)</td>
<td>0. (0.55)</td>
</tr>
<tr>
<td></td>
<td><em>n = 52</em></td>
<td><em>n = 52</em></td>
<td><em>n = 52</em></td>
<td><em>n = 52</em></td>
</tr>
<tr>
<td>High</td>
<td>0.94 (0.77)</td>
<td>0.93 (0.70)</td>
<td>0.39 (1.35)</td>
<td>0.08 (0.55)</td>
</tr>
<tr>
<td></td>
<td><em>n = 18</em></td>
<td><em>n = 19</em></td>
<td><em>n = 17</em></td>
<td><em>n = 13</em></td>
</tr>
<tr>
<td>Medium</td>
<td>0.21 (0.94)</td>
<td>0.19 (0.95)</td>
<td>-0.28 (0.98)</td>
<td>-0.25 (1.24)</td>
</tr>
<tr>
<td></td>
<td><em>n = 15</em></td>
<td><em>n = 14</em></td>
<td><em>n = 18</em></td>
<td><em>n = 21</em></td>
</tr>
<tr>
<td>Low</td>
<td>-0.02 (0.99)</td>
<td>-0.83 (1.22)</td>
<td>-1.03 (0.98)</td>
<td>-0.23 (1.04)</td>
</tr>
<tr>
<td></td>
<td><em>n = 19</em></td>
<td><em>n = 19</em></td>
<td><em>n = 17</em></td>
<td><em>n = 18</em></td>
</tr>
</tbody>
</table>
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