PROXIMITY SEARCH TECHNIQUES TO REDUCE COGNITIVE LOAD:

A CASE STUDY

by

Donald G. Campbell

Liberty University

A Dissertation Presented in Partial Fulfillment

Of the Requirements for the Degree

Doctor of Education

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ABSTRACT

The purpose of this qualitative case study was to explore the usefulness of higher-level search techniques to reduce students' cognitive load. The central question of the study is, "What causes students of higher education to avoid using syntax operator commands to provide better search results?" The participants in the study were new students at a community college in northern Arizona. As defined by Sweller (1988), cognitive load theory indicates that the reduction of cognitive load increases learning and reduces stress, guided this study. The sample size was five participants. Data were collected through semi structured individual interviews in a closed office location. Data were then triangulated to synthesize the findings from participants. Field notes, journal records, interview transcripts, observations, focus groups, audio, and video recordings were utilized. The results of the research confirmed beginning students have limited searching skills, and the education system does not usually provide such instruction. The implications for this research are schools need to include a curriculum that provides searching skills, at which point the student is entering school. Future research needs to include more instruction on students indexing their own content. and that will reduce extraneous cognitive load.

Keywords: cognitive load theory, extraneous cognitive load, germane cognitive load, intrinsic cognitive load, working memory, indexing, syntax command.

Dedication

I dedicate this dissertation to my parents, Leonard and Evelyn Campbell, who passed away many years ago before I started this educational journey. I often think of the opportunity I have had that I could never share with you and wish that I could have.

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I thank you, God, for blessing me along this journey. During the most challenging moments, my prayers were answered.

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List of Abbreviations

Application programming interface (API)

Cognitive load theory (CLT)

EBSCO Discovery Service (EDS)

Graphical user interface (GUI)

Institutional Review Board (IRB)

Massive open online course (MOOC)

Touch User Interface (TUI)

CHAPTER ONE: INTRODUCTION

Overview

Human cognitive architecture is complex, and scientists are still beginning to understand the capabilities of the human brain (Sweller, 1998). Cognitive architecture is the link between long-term memory and short-term memory, and how they relate to learning (Sweller et al., 1998). The human cognitive structure consists of working memory, long-term memory, schemas, and automation. Cognitive load is utilized for the assessment of human cognitive performance in various academic disciplines such as psychology, political science, mathematics, and science (Gwizdka, 2010).

The higher education environment requires significant research, and such research is most often done using school libraries or data from the Internet. Sweller (2013) suggests such research creates high cognitive load among such students. This was observed by the author of this paper. Sweller (1988) indicated humans possess a limited cognitive load capacity, meaning there is a limit on the amount of information that can be processed at a time. When there is too much incoming information, it can result in stress and greater cognitive load interference. There is a need to utilize technology to reduce student stress and cognitive load interference. This author’s informal interviews indicate that students do not know how to use advanced search techniques to reduce cognitive load.

Students’ problem occurs when there is too much content to examine in the available time, and many students do not know how to use advanced search techniques to reduce cognitive load. Sisman et al. (2016) discuss how beginning students are confronted by a large amount of text content. This problem is compounded by the schools not making the students aware of advanced search techniques such as proximity searching, and not providing training in the utilization of syntax commands (Anshari et al., 2015).

To this date, a paucity of research has been found on the use of proximity searching operator techniques. Searching operators employed by software companies such as Google provide significant advantages over single word or other simple searches. Such search operators are abundant, but no evidence has been found that they are taught or explained in the education environment. Therefore, there is a gap in this field of study. The goal of this research effort is to increase the learning skills of students, which to this researcher's knowledge, has not been discussed in any meaningful way by past or current researchers.

Such research could reveal student interest and influence patterns of searching at the start of their higher education journey and thus benefit them throughout the term of such an experience. This would start with simple searches followed by syntax operators and then train them to use a graphical interface method that would do complicated syntax operators. If successful, it provides an opportunity for creative instructional design. This chapter will provide a background to showed and support this consideration. This will be followed by historical and theoretical contexts of the research.

Background

Searching skills are some of the primary requirements for incoming students, and enhancement of these skills is often neglected by schools, instructors and students. These skills can be influenced by the adaptation of simple syntax command operators. The historical, social, and theoretical context for learning to use such searching skills will be discussed in the following sections. Learning complex syntax commands needed to do advanced searches increases cognitive load. There are faculty that are unaware of both advanced search possibilities and of cognitive load and thus do not educate their students about the negative impact of cognitive load and/or how to avoid it. These skills can be influenced by the adaptation of simple syntax command operators. The historical, social, and theoretical context for learning to use such searching skills will be discussed in the following sections.

Historical Context

Searching is premised on having an available index. Without an index, searching is difficult. One of the first used cross-indexing systems was the Eusebian canons implemented circa 280-340 CE during the transition from the roll to the codex (Nordenfalk, 1984). A biblical canon is a series of texts that the religious community considers authoritative. These canons divided the four Gospels used from late Antiquity through the Middle Ages. There are about 1165 sections within the 1189 chapters of the Bible: 355 for Matthew, 235 for Mark, 343 for Luke, and 232 for John (Nordenfalk, 1984). The term "canon" can apply to non-religious and religious works. In this case it is being used in a religious context. It is a set of texts used by a distinct religious community as authoritative scripture. It is derived from the Greek κανών, meaning "rule" or "measuring stick." The Canon consists of the 39 books of the Old Testament forming the Bible of Judaism, while the Christian Bible includes those books and the 27 books of the New Testament. This provides a way for the reader moved between related segments in the texts, serving as an organizational structure and cross-indexing system (Norman, 2017). Canon was a system for dividing the four gospels in the centuries before they were put into chapters and verses. They are the sections of the respective gospels. The tables were used at the beginning of each gospel to enabled the reader to find what they are looking for and were usually placed at the beginning of each gospel. This way of finding things was usually put into a table with references to sections in the canons. In the table (like a table of contents), there were 1165 sections, or entries, 355 for Matthew, 235 for Mark, 343 for Luke and 232 for John (Nordenfolk, 1984). These tables allow a reader to transit between related sections in the texts and are an early organizational structure and cross-indexing system (Norman, 2017).

By the end of the thirteenth century there were about 20,000 foreign students in Paris (Walsh, 1913). The first alphabetical indexing tools for books were developed in Paris by university teachers and religious orders as reference tools for preachers. The creation of printing brought forth a challenge in the organization of manuscript collections and this was a slow process of growth. The growth of data became more available, as well as at a comparatively lower cost.

A national code for descriptive cataloguing was implemented circa 1789-1791 (Luhn, 1958). Hans Peter Luhn of IBM designed automated systems for encoding library information in 1957 (Norman, 2017). This was followed by the production of literature abstracts in 1958. Eugene Garfield’s citation analysis, which was first published in 1964 in five printed volumes, indexing 613 journals and 1,400,000 citations. On October 29, 1969, the first message was sent over the Arpanet from Kleinrock’s UCLA computer to the second node at Stanford Research Institute’s computer. On April 30, 1993 CERN released World Wide Web software into the public domain. This was an important factor in universal adoption of the World Wide Web.

By October 2010, the Google project, had scanned more than 15,000,000 books in more than 400 languages (Norman, 2017). This represented better than 10% of Google’s 2010 estimate of the number of different books in the world, excluding serials and pamphlets. The velocity at which Google scanned over 15,000,000 books demonstrates the remarkable difference in speed between the automated process of scanning and indexing relative to the centuries required for discussion, editing, thinking, and writing prior to publishing in print or digital form. Hundreds of thousands of books are available on a variety of ebook readers, cell phones, and computers. Books and digital information had merged into one global library of data (Norman, 2017). In December 2010, ebooks were about 10% of trade-book sales, double the rate of the previous year. As of June of 2011, The New York Times reported that Apple announced that 130,000,000 iBooks were downloaded from Apple’s iBookstore during its first year of operation, and, within 16 months, it averaged 17,000,000 books per month (Dediu, 2013; Zickuhr & Rainie, 2014).

A study regarding Google as it relates to university libraries and the use of federated searching technology sheds light on real-world issues regarding improving tools for students (Georgas, 2014). Federated searching is an advanced form of technology searching and information retrieval that allows the user to search using multiple resources (Fagan, 2011) simultaneously. It was, at one time, considered the library’s answer to Google. A significant study on student’s choices using both Google and a federated search tool revealed that students believed that they were skilled researchers, but their search queries and behaviors did not support this belief. Participants were questioned regarding choices using each search tool as well as any perceived relation to the sources they found using each search tool. Researchers asked participants to self-assess their online searching talents. Participants believed that they possessed excellent searching skills. These participants preferred the federated search tool to Google. Although federated searching showed some limitations, participants saw the value behind it and desired to utilize it in the future. Librarians should be encouraged to provide a federated search option and to focus on instructing students in using federated search and Google more effectively (Georgas, 2013).

There are significant cost issues with the use and implementation of federated search systems (Fagan, 2011). Operational concerns with the federated search engine systems were amplified by performance issues as well. It became obvious that a federated search tool needed to be intently reviewed. Part of this review process meant that student's feelings towards a federated search tool needed to be considered and that researchers needed to understand how it was used. If the Brooklyn College Library staff continued to offer federated searching, it would be advisable for them to teach effectively, particularly undergraduates. In an age in which Google still dominates, and ten years since federated search technology's inception, it would be good to know how they compare. Georgas (2013) commented, "Do undergraduate students prefer federated searching or Google? Are students able to identify relevant research resources using both a federated search tool and Google? Do students possess adequate information literacy skills to use each of these search tools effectively" (p. 167).

Research findings indicated that ease of use was an important factor to the participants (Georgas, 2014). Regarding which search tool was simpler, 26 students (81.2%) indicated Google, and six students (18.8%) preferred the federated search tool. Of the 26 students who indicated Google was easier to use, one thought it was faster (Georgas, 2013). Regarding efficiency, the federated search tool was preferred, with 18 participants (56.3%) indicating it was more efficient, and 14 participants (43.7%) indicating Google was more efficient. One participant believed a federated search tool was better at separating each source specifically.

Most students found Google more intuitive and easier to use (Georgas, 2013). Although Google was liked by students, there was no mention of Google's syntax command operators. Google's syntax command operators were viewed to be extremely fast while the federated search tool was viewed to be slow. Georgas (2013) provides good insight as to a contrast between a federated system and the Google process but does not consider alternatives within the Google environment.

Georgas (2013) summarized and highlighted a significant problem facing librarians and their beliefs about what students should know and what students believed they should know:

> Despite these known and student-reported assets and deficiencies of each search tool, the results of the questionnaire were surprising. It was certainly expected that most students would cite Google as easier to use (81.2%). Findings indicated that students found the federated search tool to be more efficient (56.3%), preferred it to Google for future research assignments (59.4%), and stated that the federated search tool was the tool they would recommend to a friend (56.3%). (Georgas, 2013, p. 167)

Findings revealed that students liked the federated search tool for its citation feature, and in casual observation of the students, Georgas (2013) found they frequently used this feature. The feature is marked on the right-hand side of the interface, and many students reported desiring a similar function in Google.

Social Context

From the inception of computers to the present, computer functions could index content that enable the user to more easily found the content (Connaway et al., 2011). Search engines use a very sophisticated indexing system keeps track of 1,000,000,000 pages on the Web (Arlitsch & O’Brien, 2012). These advances in technology had created opportunity for higher education to facilitate learning methods on how to access a formidable new inventory of textual content. Never in history has such an opportunity been provided for students. Early efforts to index content was all done by programmers using syntax commands. Today, Google masks some of these syntax commands with a GUI for the user. Research with advanced GUI technologies using the Apple iPads indicated individuals will choose a GUI interface if available, and he or she has a choice between syntax commands or GUI (Blanton, 2017).

According to Konnola et al. (2016), the instructor is well acquainted with the curriculum, but the student has not explored any of the subject curriculum at the start of each new course (Konnola et al., 2016). The student is a person raised in the age of digital technology and familiar with computers and the Internet from an early age. However, students had lived in a GUI environment versus a syntax command environment. Therefore, the use of syntax commands is absent from their knowledge base unless they had programming experience. As Blanton (2017) illustrated, digital tools make more sense to young digital natives than to members of older generations. Since searching is key to researching, it is paramount for these beginning students to learn basic syntax commands for searching to be more efficient researchers.

Theoretical Context

Supporting evidence for cognitive load theory (CLT), Sweller (1988) found that students avoided the utilization of high-level search tools using syntax command operators while performing search functions in course work or research. Sweller (1988) amplified the work of Miller (1956) regarding cognitive load. Millers' information-seeking research demonstrated that short term memory is limited in the number of elements being contained simultaneously. Sweller (1994) created a theory that uses schemas, or a collection of elements, to be the cognitive structure that makes up an individual's knowledge base (Sweller, 1988). The present study seeks to identify whether students are informed about these features at the course's inception, and whether they will accept the complexities of using syntax command operators to yield improved search results.

Situation to Self

I am a nontraditional student whose education journey began when I reentered the education system after 50 years working as an entrepreneurial individual.

Motivation

My motivation is to better understand the reluctance of beginning students to adopt higher-level syntax command operators to get better search results. Many postulates that learning this skill is an investment that provides rewards over a lifetime. It is analogous to the rewards of compound interest on money. It requires important discipline early in the beginning students' education but benefits them immediately in learning. It is similar to my desire helped beginning Christians with relevant searches of the Bible and commentaries using syntax command operators from the software utilized. I had a licensed version of the software so that I could produce the search system with operators at no user cost. Although, I had limited success with this approach, it was a preview of how it could be used in education. I helped these students use tools for high-level searching to improve their ability to extract germane content.

Philosophical Assumptions

It is noted that students had an inordinate amount of text material to read and absorb (Russell, 2016). Some students, myself included, complain that their ability to absorb a vast amount of material is impeded by the material required to complete a course. This indicated that finding answers to questions and finding ideas through a search of the materials would be easier than traditional methods. Over time they would peruse most, if not all of the material in their search activities, though often not in the order usually presented.

Assumption 1--Students have an inordinate amount of text material to comprehend.

Assumption 2--Reading all the material from start to finish is difficult and contributes to student anxiety (cognitive load). Searching for answers to questions and key words for discussion questions would be more effective and efficient and would reduce anxiety created by the need to increase one's cognitive load.

Assumption 3--Students are not taught to digitize text, index it, and use advanced search techniques to quickly and easily found answers to questions and discussion subjects (reducing cognitive load).

Assumption 4--A useful advanced search technique is a proximity search, which can be done with a syntax command or a GUI.

Assumption 5--The use of GUI will reduce cognitive load more than the use of syntax command, as it has more variables to facilitate the search.

Axiological

Higher education institutions' failure to make the students aware of higher-level search tools is an ethical failure. To simply transfer the student's burden to learn a higher-level skill is an ethical shortcoming that could negatively influence the student's education. The Bereans set the standard of what should be done. According to Paul of Tarsus, Silas preached at Berea, and the inhabitants "... received the word with all readiness of mind, and searched the scriptures daily, whether those things were so." Now the Bereans were of more noble character than the Thessalonians, for they received the message with great eagerness and examined the Scriptures every day to see if what Paul said was true (Acts 17:11, The New International Version).

Such failure could be compared to having only one version of the Bible. One version of the Bible, such as the King James, provided significant insight but could not compare to the multitude of Bible versions today. More content is informative, but due to the limitations of time, it became more difficult to search for germane textual material. The human generated index entered the textual world in 280-340 CE. All Bibles had indexes, and some had concordances. From the King James Bible to the advent of the computer, indexing was done by humans and thus was subjective in nature.

This was an attempt by the publishers to make text content easier to find (Francis & Greenway, 2015). Computers changed this environment by indexing everything except common words. The index was no longer subjective but was also more complete, being 10 times the typical size of a human created index. Enabling students to become more proficient at searching and retrieving germane information in the Bible or any other source is a teaching consideration that future educators should examine.

Pragmatism

The interpretive framework is based on pragmatism. The study is premised on the use of the syntax command operators. Software programming and the execution of software commands are subjective, so the programmer can selectively choose what he or she enters into the field. It is reasonable and acceptable for any user to use their own search criteria. Starting students will be free to choose which software they use and what syntax command operators they use. Bias will not be a factor as each beginning student will make their own choice. Collecting data using interviews will allow a wide range of possibilities. All results are true to the instruction given as they are exact instructions for the computer to perform upon execution. The goal is to get the beginning student to examine the “what” and “how” of the research event (Yin, 2014). In addition to interviews, the project will include the use of archival records, direct observations, documentation, interviews, participant-observation, physical artifacts, and focus groups.

Problem Statement

Sweller (1988) indicated humans possess a limited cognitive load capacity, meaning there is a limit on the amount of information that can be processed at a time. When there is too much incoming information, it can result in stress and greater cognitive load interference. There is a need to utilize technology to reduce student stress and cognitive load interference. Informal interviews indicate that students do not know how to use advanced search techniques to reduce cognitive load. Students' problem occurs when there is too much content to examine in available time, and many students do not know how to use advanced search techniques to reduce cognitive load. Sisman et al. (2016) discuss how a large amount of text content confronts starting students. This problem is compounded by the schools not making the students aware of high-level search techniques such as proximity searching, and not providing training in the utilization of syntax commands (Anshari et al., 2015).

This study will teach students to do advanced searches using syntax commands. Students will then be asked to evaluate their cognitive load during data finding. Content from a single source, such as a book, usually has at least a minimal index. Such a book's computer indexes are 10 times greater than the same book's index, excluding common words (Tellez et al., 2016). Computers are well suited for indexing, but they present a maze of approaches and produce further complexity in how they provide results through the use of syntax command operations while searching (Savolainen, 2016). There are no standard high-level searching techniques. Large arrays of syntax commands are available which can add extraneous cognitive load onto the student (Devi et al., 2016). This study will then teach students to use a GUI to do advanced searches. Students will be asked to evaluate their cognitive load in finding needed data to know if it is reduced from the syntax of advanced load techniques. The researcher has found no studies focusing on avoiding using higher-level search techniques by starting students.

Purpose Statement

The purpose of this qualitative case study is to explore the usefulness of high-level search techniques to reduce students' cognitive load. The central phenomenon of the study is what causes students to avoid learning syntax operator commands (Yin, 2014). At this stage in the research, higher level search techniques will be defined as using computer technology implementing a syntax operator command technique or a GUI technique to more quickly discover pertinent answers to questions on previously gathered content (Vuurens & Vries, 2014). This research will take place at a community college in northern Arizona using students in their first college level classes. The theories guiding this study are CLT as defined by Sweller (1994) and information seeking theory by Wilson (1999) as it indicated that the reduction of cognitive load increases learning and reduces stress.

Significance of the Study

Higher education does not provide a course in searching techniques (Georgas, 2014). These techniques are readily available, but they require a skill set that many starting students are not aware of. Students are also not generally aware of indexing software that allows the students to index their own curriculum content. I am a non-traditional student by being 86 years old. I had a background in using private sector software for this purpose and was employed on the first day upon returning to school after a 50-year absence. A typical course load of three courses could have three prime textbooks of 1,000 plus pages. If so, a 1,000-page textbook had 500,000 words and three textbooks had 1,500,000. An indexing system would index these total words in about 15 seconds and allow the user to find all occurrences in less than a second (Vuurens & Vries, 2014). The potential benefits for using easy to use software or web-based apps are unknown to most students. Also, unknown is the benefit or impact of searching with a skill set of tools, such as syntax operators. If cognitive load is increased, it hinders learning (Sweller, 1988). While the ability to measure these events is not assured, in the future, such measurements could be possible.

It is acknowledged that comprehending how computers execute programs and learning the instruction's syntax is difficult (Stachel, 2011). These techniques, independent of difficulty, should be explored by beginning students. Students that can master these techniques will benefit throughout their lives from this educational experience.

The research study intends to explore a simpler GUI approach and compare this to a syntax command approach (Sweller, 1994). A GUI executes the syntax command for the user. It also uses schemas that everyone knows, is comfortable with, and understands. The syntax is embedded with the GUI, and many are not aware that it is happening. Therefore, the syntax behind a GUI works automatically. The GUI uses pre-existing schemas and does not add to intrinsic cognitive load. Programmers, on the other hand, already have schemas developed for advanced search techniques, so the syntax command is not new and does not cause additional intrinsic cognitive load.

The significance of this study shows that advanced search techniques helped students in their learning. By learning rules-based searching techniques, students will be able to learn more and faster, finding needed material quicker and easier (Hsin et al., 2016). These techniques will be beneficial to them for a lifetime of learning. This study showed that a Graphic User Interface (GUI) to replace syntax commands for searching will mitigate the adverse effects of cognitive load by using a process that students already understand as compared to the syntax commands where students had to learn new techniques for searching (Sweller, 1994).

The stakeholders in this effort are new entry level students, all other students, and faculty (Keengwe et al., 2011). Other stakeholders could include younger students such as those in high school or middle school (Ruzic et al., 2016). Stakeholders could also include parents of students that could witness a student benefitting from the use of higher-level syntax commands. Schools and faculty could benefit by placing fewer demands on students (Han & Yates, 2016). None of these parties had been trained to use syntax command operators. If students or faculty institute a discipline of indexing content in their learning environment that would include everything in their domain, it would be more easily found. Indexes can be specific such as a single document or can be partial for a combination of documents including books, an entire collection, or a complete course.

Johnson & Simonsen (2015) surveyed a group of graduate students and found that 50% used Google Scholar for their last research effort. These engineering students in a master's program expressed an interest in "increasing their knowledge of skills and strategies to find worthwhile electronic information" (Johnson & Simonsen, 2015, p. 36). Pitol and Groote (2014) discuss the dominance of Google Scholar (GS) as students rely heavily on GS, and for many it is their first choice. In a study conducted by Pitol and Groote (2014), they discovered listings for 982 articles in multiple fields involving three universities. These were studied for version types, repository versions, how often they were cited, and available in full text (Pitol & Groote, 2014). They found that open access articles were cited more than articles without free full text. Journal web sites were indexed most often, although a small number were available as free full text. There was no correlation between the number of versions and the frequency in which an article was cited. Pitol and Groote (2014) thought versions of an article could be useful as over 70% of articles had at least one free full-text version available through an indexed GS version (Pitol & Groote, 2014). Although this research article addressed the volume of GS articles, it did not explore the use of Google syntax command operators, and it is possible this had yielded better search results. Tables 1 and 2 in the Appendices provide examples of Google's search operators. Tables 3 to 10 provide Microsoft operators.

Francis and Greenway (2015) indicated that end-of-book indexes are usually done by professional indexers or by the authors themselves. They cover the use of Microsoft Word and manual systems. Francis and Greenway (2015), spoke in terms of a couple of hours for creating a manual index, but such indexes do not themselves search except visually and without providing a list of germane results. The “machine-aided indexing rather than for fully automated indexing and found it increases indexing speed up to 6.7 times that of completely manual indexing” (Hedden, 2016, p. 247). Virtually all indexes today are unstructured data, and this is the manner in which Google and others index textual content (Data Center Knowledge, 2017). The key function of searching is to find something pertinent, and this is most easily accomplished using a system like Google.

Google is the largest search engine in the world, with a market share of 90% since 1997 (Data Center Knowledge, 2017). Google claimed that it had 247,000,000 unique users within the United States in 2015. Do these students know to use the syntax commands called operators to get better results and thus had a better learning experience? Google like other search engines possesses an array of powerful operators that employ syntax commands to provide a more controlled result list. However, these syntax command operators create issues for the user in terms of complexity, but they are solvable by using a GUI in order to execute the syntax commands. The index is the key to making a search possible; however, the results list must take advantage of word associations that are not impacted by the totality of the content or resultant index’s size. DtSearch comments, which index sizes of a terabyte, can be easily handled by a normal PC, and it is only necessary for indexes to be re-indexed when new data is updated.

Students often had vague information requirements (Simitsis et al., 2007). Simitsis et al. (2007) indicated that students “want to achieve their goals with a minimum of cognitive load and a maximum of enjoyment . . . humans seek the path of least cognitive resistance and prefer recognition tasks to recall tasks" (p. 1). There is a need to close the void between the typical user's free-form discernment of the educational world and the prevailing systems' partially structured representation of the educational environment. This became increasingly important with student and school expectations. The significance of the study is to analyze and divide the elements of the current search environment into discernable parts and reassemble them into a better method of application. This will result in a more useful toolset for a learner and in the process, increase learning skills while reducing cognitive load. The following three heading sections address all students' issues and solutions supporting the same students in their search efforts.

Single User Software Search Process

Single users had a wide choice of possible search software (Hedden, 2016). For an individual learner, a search starts with indexed content. Software developers offer both free or paid indexing software tools for the user. Creating an index for papers, articles or a dissertation is like an index for other purposes, except a computer will perform this function faster. Considering the vast amount of text content that is normal for students to gather during their educational journeys, a student is likely concerned about the time and task involvement required to index this content. Indexing is remarkably fast and effortless for any contemporary personal computer. Apple had two software searching systems and PC offer even more options.

When a computer indexes content, it responds to search operators (Hedden, 2016). Those involve one character or a string of characters in a search engine query for the purpose of narrowing the search focus. This is a powerful asset to any student performing research. Many students use a narrow range of basic Boolean operators, such as AND, OR, and NOT. However, Cathey (2011) found that few students are well-acquainted with extended Boolean functionality, which can also be referred to as proximity searching.

The two main types of proximity searching are fixed proximity and variable proximity (Hedden, 2016). A student can use a proximity search to find two words or a greater occurring within a defined number of words (or fewer) of each other in the index (Cathey, 2011). Proximity searching is used with a keyword or Boolean search. The greater the amount of distance the words are mentioned from each other, the less likely they are semantically related. For example, at a distance of over ten words, each word could be provided in distinct separate bullet points or in separate sentences on a document and thus be unrelated. The use of configurable proximity searching techniques can enhance a student's learning by reducing overall cognitive load.

Using Library Search Systems

Higher education and its library systems had sought a discovery tool or a discovery layer (Fagan, 2011). The search and discovery process for information on most university campuses has shifted from the library to Google. Library students are not required to know how to use library tools, an online catalog, or the large subject databases (Tonkery, 2011). Google has developed a significant group of its users by enabling the search process to be easy and effective. Library services and database companies are racing to recover the ground lost to Google.

An indexing service compiles relative sources and creates their own instance of a database and this is updated often (Miller, Personal Communication, February 7, 2018). Like Google, it indexes the content it compiles. This is how Summon - the Search Anything box works. Summon is a ProQuest product, but Summon does not contain all the resources because some databases do not allow their content to be indexed into the discovery tools. EBSCO does not let

ProQuest put EBSCO databases in Summon because ProQuest will not let EBSCO put ProQuest sources in EBSCO Discovery Service (EDS). Summon is not missing them all, but it also does not include all of them. Some are indexed because the journal is indexed online and then it links to the content in the databases.

Comparing Discovery Tools

There are five major Discovery tools available to libraries (Guajardo et al., 2017). These all use different approaches but had some things in common. Some were Discovery Services, but some used ILS linked and only functioned if the library had that ILS process. EDS uses a Google searching approach from either a single search box or a very powerful advanced search (Chickering & Yang, 2014). Independent of the tool being used, learners had difficulty evaluating sources, frequently using imperfect resources from the initial results screen. This often overwhelmed the learner by the mere number of search results. Learners relied on using the search engine's relevancy scores to determine probable quality. As "relevancy ranking algorithms are proprietary, and therefore unknown to the user, this reliance is problematic" (Djenno et al., 2014, p. 6).

EBSCO Discovery Services (EDS)

Basic Search starts with a single screen that gives the use the choice of doing a title, keyword, and author search (Georgas, 2014; Hanneke & O'Brien, 2016). EDS provides an autocomplete aspect helping a user identify related items, and thus reduces typing effort. Search options are presented using Search Modes that facilitates Boolean phrase and SmartText Searching. A person can type a phrase into the system, and the system processes searching in the citation abstracts or a title if the abstract is not present. Results could be restricted to publication date, full-text, image quick view types, journal name, language, local collection, location, and scholarly peer-reviewed journals. This includes “Only show content I can access” (Council of Chief Librarians, Electronic Access and Resources Committee, 2016, p. 9). The Advanced Search screen is similar to other discovery systems in a guided-style field interface. Boolean operators are present allowing combined search terms. The left column screen is where a user can edit a search by using expanders and limiters. Each facet selected can be viewed based on the number of results provided. Looking at the Results, “it starts off with a Research Starter (an optional feature), an article from an encyclopedia, mostly from Salem Press Encyclopedia, which gave users a general overview of the topic. Clicking on the title displays a corresponding detailed record” (Council of Chief Librarians, Electronic Access and Resources Committee, 2016, p. 9). A user can perform his or her personal folder searches and results across multiple sessions. A Search History feature meant that both recent searches and previous searches performed are one combined into saved personal folders.

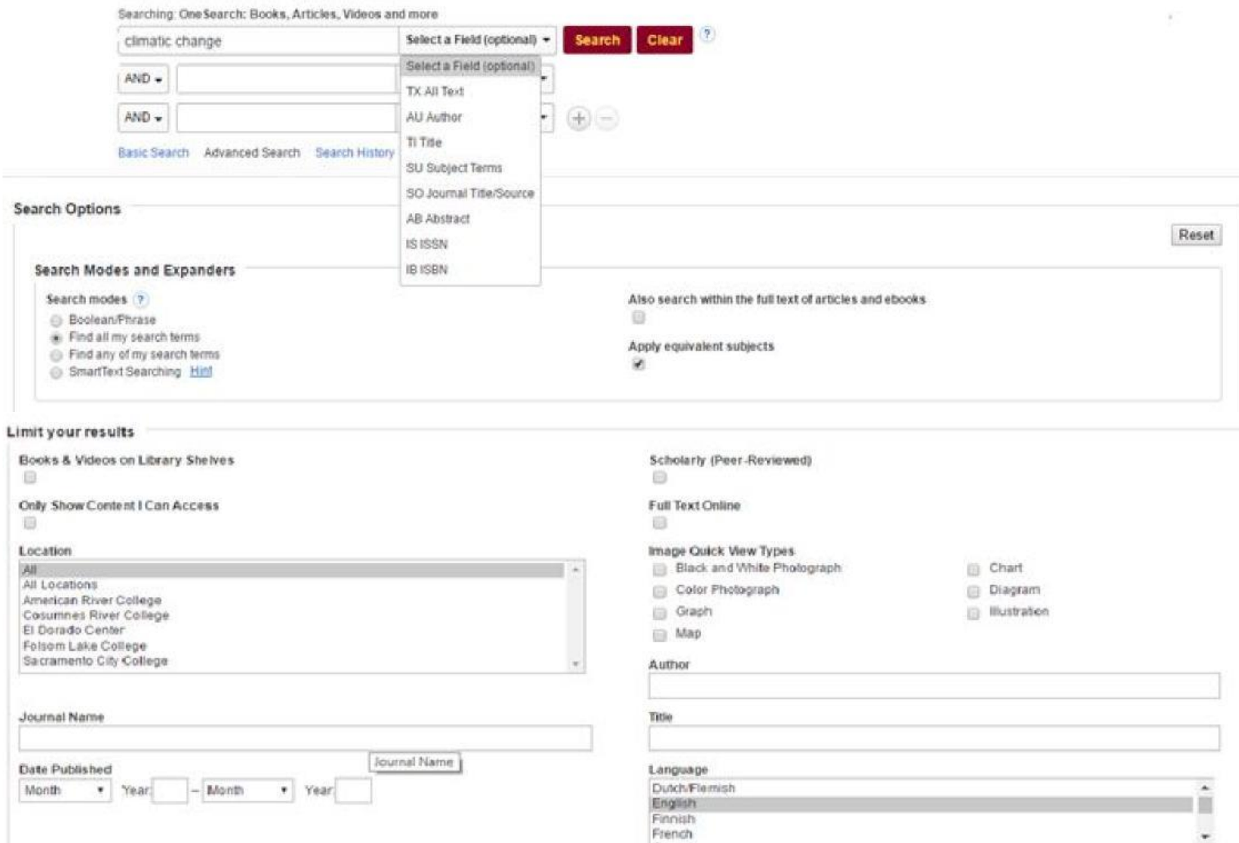
Figure 1

EBSCO Discovery Services (EDS): Basic Search Screenshot

Note. From “Discovery Comparison,” by Council of Chief Librarians, Electronic Access and Resources Committee, 2016 (https://cclibrarians.org/sites/default/files/reviews/Documents/DiscoveryComparisonCCLEAR16.pdf). Copyright 2016 by the Council of Chief Librarians Electronic Access & Resources Committee. Reprinted with permission (see Appendix V).

Figure 2

EBSCO Discovery Services (EDS): Advanced Search Screenshot



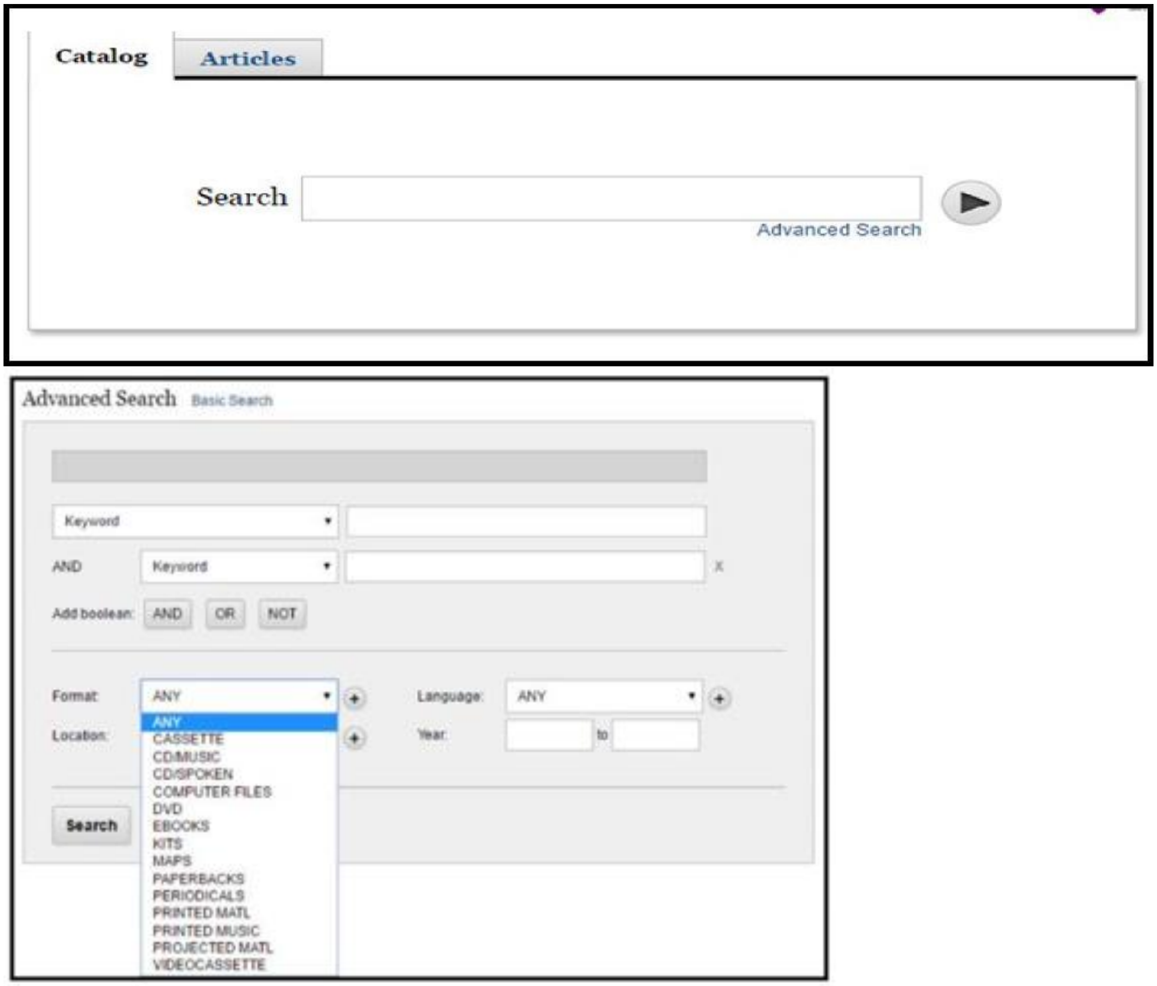
Note. From "Discovery Comparison," by Council of Chief Librarians, Electronic Access and Resources Committee, 2016 (https://cclibrarians.org/sites/default/files/reviews/Documents/DiscoveryComparisonCCLEAR16.pdf). Copyright 2016 by the Council of Chief Librarians Electronic Access & Resources Committee. Reprinted with permission (see Appendix V).

Encore Synergy

Encore Synergy claims that it provides "extensive customization" although minimal information is provided regarding options other than possible integration with EDS (Council of Chief Librarians, Electronic Access and Resources Committee, 2016). This is accomplished by using EDS from the back end and Encore as the user interface. Administrators can control the order of full text links that appear as the results for specific terms. Encore Synergy only provides the Sierra (Innovative Interface). This is an additional service to the ILS and the cost is comparable with other products. However, this could be prohibitive for some colleges.

Figure 3

Encore Synergy: Basic and Advanced Search Screenshots



Note. From "Discovery Comparison," by Council of Chief Librarians, Electronic Access and Resources Committee, 2016 (https://cclibrarians.org/sites/default/files/reviews/Documents/DiscoveryComparisonCCLEAR16.pdf). Copyright 2016 by the Council of Chief Librarians Electronic Access & Resources Committee. Reprinted with permission (see Appendix V).

Primo

An Ex Libris product, Primo, uses a subscription index of content from various online providers (Council of Chief Librarians, Electronic Access and Resources Committee, 2016). An important aspect of Primo is the ubiquitous single-search box feature on its interface. Commercial search engines commonly use this style. Kliewer et al. (2016) suggest that Primo lends authority to focus on source appraisal as web-scale discovery. This is a progressively mutual aspect of using undergraduate research (Seeber, 2015).

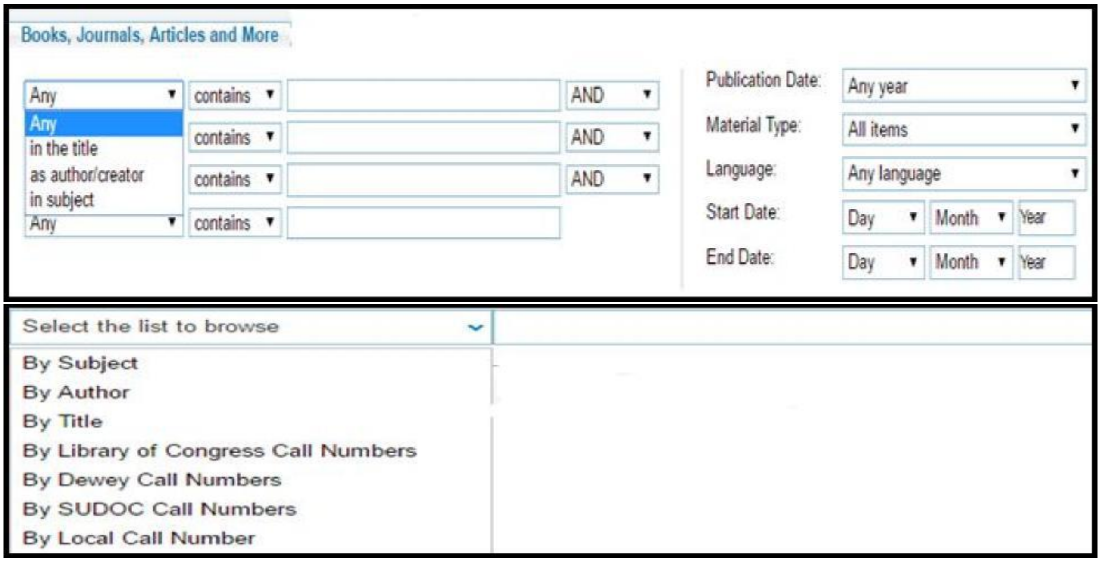
Figure 4

Primo: Basic Search Screenshot

Note. From "Discovery Comparison," by Council of Chief Librarians, Electronic Access and Resources Committee, 2016 (https://cclibrarians.org/sites/default/files/reviews/Documents/DiscoveryComparisonCCLEAR16.pdf). Copyright 2016 by the Council of Chief Librarians Electronic Access & Resources Committee. Reprinted with permission (see Appendix V).

Figure 5

Primo: Advanced Search Screenshots



Note. From "Discovery Comparison," by Council of Chief Librarians, Electronic Access and Resources Committee, 2016 (https://cclibrarians.org/sites/default/files/reviews/Documents/DiscoveryComparisonCCLEAR16.pdf). Copyright 2016 by the Council of Chief Librarians Electronic Access & Resources Committee. Reprinted with permission (see Appendix V).

Summon

The Summon search box at the top of the home page drives its users to use the process, but usability testing proved that inexperienced users had difficulty determining where to start (Council of Chief Librarians, Electronic Access and Resources Committee, 2016). On a new home page feature, the Summon search box is larger and centered on the page. Other search options are shown, “but some options, such as ‘find articles’ or ‘find books and media,’ are actually Summon searches with facets applied” (Daniels et al., 2013, p. 83).

Summon’s Basic Search provides a feature that predicts the word that a user is typing in (Council of Chief Librarians, Electronic Access and Resources Committee, 2016). The Advanced Search has fields to choose from (see Figure 7). Boolean options are provided by a drop-down menu to connect the terms. Search is limited to content type, full text, language, library catalog items, publication date range, and scholarly materials. Certain formats can be excluded that allows for the expansion of results greater than the library’s collection. A result list screen provides a three-column layout. The right column provides entries from a reference data to provide the user with a summary of the topic. Links to Related Topics are shown below the reference entry. Facets to modify one’s search term by content type, language, library location, publication date, and subject terms are in the left column. A unique aspect is limiting results by discipline versus other discovery services. An additional benefit is that the facets are customizable by enabling/disabling options. The result is provided in the center column. Hovering on the title, “displays the abstract and citation information on the right column replacing the reference entry. Read Online, Cite and Email tabs are available features on top of the abstract to retrieve the article” (Council of Chief Librarians, Electronic Access and Resources Committee, 2016, p. 18).

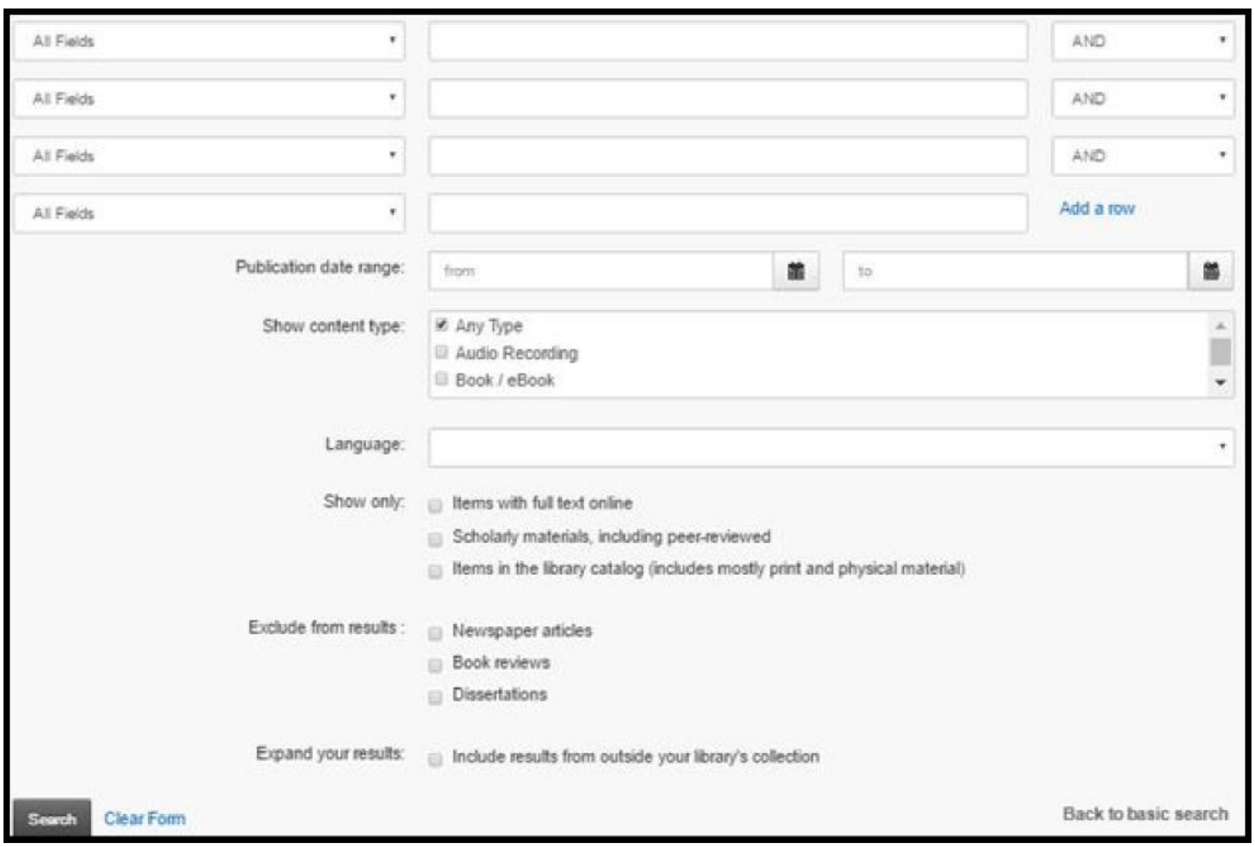
Figure 6

Summon (ProQuest): Basic Search Screenshot

Note. From "Discovery Comparison," by Council of Chief Librarians, Electronic Access and Resources Committee, 2016 (https://cclibrarians.org/sites/default/files/reviews/Documents/DiscoveryComparisonCCLEAR16.pdf). Copyright 2016 by the Council of Chief Librarians Electronic Access & Resources Committee. Reprinted with permission (see Appendix V).

Figure 7

Summon (ProQuest): Advanced Search Screenshot



Note. From "Discovery Comparison," by Council of Chief Librarians, Electronic Access and Resources Committee, 2016 (https://cclibrarians.org/sites/default/files/reviews/Documents/DiscoveryComparisonCCLEAR16.pdf). Copyright 2016 by the Council of Chief Librarians Electronic Access & Resources Committee. Reprinted with permission (see Appendix V).

WorldCat Local and Discovery

WorldCat Local provides one box Basic Search interface (Council of Chief Librarians, Electronic Access and Resources Committee, 2016). An Advanced Search has search fields that users can select from. Note that “WorldCat added the term “phrase” in major fields (ex. author phrase, source phrase, language phrase) making them field options. Users can limit search by content, formats, publication year and location, including Libraries Worldwide” (Council of Chief Librarians, Electronic Access and Resources Committee, 2016, p. 17). Users can deselect from the default databases. Database groups can be configured.

The Result List has two columns (Hedden, 2016). The left one is for the purpose of editing results like other Discovery Services. Facets can be subdivided into unique fields which makes a list for the user. Users can limit results by author, content, databases, date, format, language, location, and publication year. By “clicking a title on the result list leads to source information, including libraries’ catalogs nearby. Items in the search results will include icons for users to quickly add records to a list, email a record or a list of records, copy a record link, or export a citation” (Council of Chief Librarians, Electronic Access and Resources Committee, 2016, p. 17).

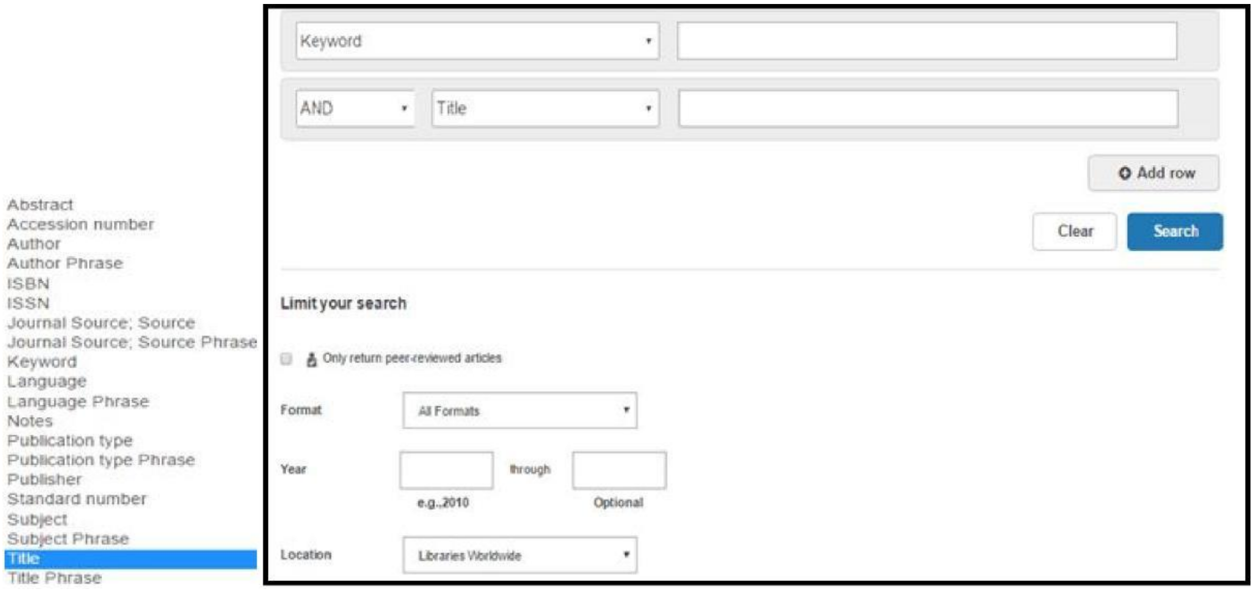
Figure 8

WorldCat: Basic Search Screenshot

Note. From “Discovery Comparison,” by Council of Chief Librarians, Electronic Access and Resources Committee, 2016 (https://cclibrarians.org/sites/default/files/reviews/Documents/DiscoveryComparisonCCLEAR16.pdf). Copyright 2016 by the Council of Chief Librarians Electronic Access & Resources Committee. Reprinted with permission (see Appendix V).

Figure 9

WorldCat: Advanced Search Screenshot



Note. From "Discovery Comparison," by Council of Chief Librarians, Electronic Access and Resources Committee, 2016 (https://cclibrarians.org/sites/default/files/reviews/Documents/DiscoveryComparisonCCLEAR16.pdf). Copyright 2016 by the Council of Chief Librarians Electronic Access & Resources Committee. Reprinted with permission (see Appendix V).

Google, Google Scholar and the Student

Google's attributes are discussed at length in the library world and education (Asher et al., 2013). Library, faculty and student learners expect a simplified, quick, comprehensive, online research event that reflects their use of Google as their primary source. Asher et al. (2013) commented:

> Library staff and faculty stress the requirement to have "a single point of entry" or a "Google-like interface" for library databases if there is to be any hope of students and researchers consistently accessing library resources and maintaining the relevance of libraries in academia (Asher et al., 2013, p. 464).

Having a single Google-style search box is expressed throughout the research literature (Fagan, 2011; Georgas, 2014). It is mostly the students that wanted this design because it is similar to Google. The provision of unified searching abilities across multiple databases are proclaimed to be the library's solution to Google. By pre-gathering content from numerous databases into a single index, the system improves on federated searching tools' speediness by eliminating duplicate copies of repeating data, relevancy, and the quantity of data content that can be accessed and evaluated (Asher et al., 2013).

Like Summon, Google Scholar does not index entire journals or replicate entire databases (Miller, Personal Communication, February 7, 2018). Google Scholar indexes individual articles, particularly ones that had a dedicated web page for distinct articles. There are journals that had a considerable lack of coverage. It is often difficult to evaluate the quality of sources and how to cite them. Google Scholar "often struggles with essays (chapters from books) or gray literature, not knowing whether to treat them as books or journal articles" (Miller, 2015, p. 10). It is difficult to distinguish which articles are peer-reviewed. Miller (2015) indicated that a Google Scholar search does not allow the use to: search by peer review, sort/search by disciplinary field, or limit search results in as many ways as you can with subscription databases.

An important aspect of discovery tools is the capability to meet learners' expectations at the single point of entry for research activities supported by a robust and flexible search system (Asher et al., 2013). Having a consistent search interface and gathering content behind a singular brand, discovery tools such as EDS, Summon, and Google Scholar helped to "diminish the '*cognitive load*' on students by eliminating the often difficult and confusing step of choosing an appropriate disciplinary database using the syntax command for that particular database, as well as the need to repeat searches in multiple databases" (Asher et al., 2013, p. 476). This consistent search interface should simplify user learning by permitting instructional librarians to emphasize teaching their pupils a single research tool and providing more attention on conceptual research skills.

Research Questions

The central question of the study is, “What causes students of higher education to avoid using syntax operator commands to provide better search results?”

The following sub-questions (SQ) will provoke analysis of the research questions.

Blanton (2017) discusses the reluctance of younger students to use syntax commands in any learning venue. This opens the door to explore and analyze the nature of their reluctance with a qualitative case study. Although these syntax commands are proficient, they must be exact to be effective. The following sub-questions (SQ) will provoke analysis of the research questions.

SQ1: What motivates students to avoid or fail to use powerful syntax commands for searching on the Internet or other content sources? (e.g., proximity searching)

Sweller (1994) indicated that highly complex instructions cause cognitive load. This theory might provide a reasoning in that any person might resist complex instructions, which is required by a syntax command. Is there a connection between an increased burden of cognitive load when confronted by a complex syntax command?

SQ2: How do complex syntax command operators induce cognitive load or self-efficacy on students who are learning to do searches?

Blanton (2017) indicated that the students that participated in his quantitative study preferred using devices such as Apple IPads to any other device including a mouse (GUI). The Apple iPads use touch technology (TUI). Is it possible that technologies such as GUI and TUI would be more welcomed by beginning students and thus be more adaptive resulting in higher-level search skills?

SQ3: Does substituting a Graphical User Interface (GUI) for syntax commands impact a student's use of complex search techniques?

EBSCO (2016) features a lengthy article on how to facilitate a proximity search, as well as its benefits. A key question in this research project is the feelings of the participants after being taught how to do proximity searches. Had they felt it enhanced the search experience?

SQ4: How did proximity searches benefit students by decreasing the distance between key words?

Blanton (2017) discussed student preferences with devices.

SQ5**:** What do students feel more comfortable with, syntax command or GUI?

Definitions

The researcher will utilize the following terminology to operationalize terms used in the research investigation:

1. *Cognitive Load* - The theory of cognitive load as it relates to the interaction of intrinsic, germane, and extraneous loads produces "an evidence-based set of universal principles and guidelines that result in more efficient learning environments" (Clark et al., 2006).
2. *Extraneous Cognitive Load* - Extraneous cognitive load remains under the instructional designer's purview and causes cognitive load that is not related to course objectives (Clark et al., 2006).
3. *Germane Cognitive Load* – Sweller et al. (1998) defined germane cognitive load as a function that creates and automates schemata.
4. *Intrinsic Cognitive Load* - Intrinsic cognitive load is concerned with the natural complexity of information that must be understood and material that must be learned, unencumbered by instructional issues such as how the information should be presented or

in what activities learners should engage to maximize learning (Sweller, 1994, 2010; Sweller & Chandler, 1994).

5. *Instructional Design* - Instructional design processes divide content into hierarchies, which provides the framework for menu systems that learners can access content for delivery (Sims, 2012).
6. *Information Processing Theory* – This theory defines the learning process similar to how a computer processes information (Craik & Lockhart, 2008).
7. *Syntax Command* - Syntax refers to a programming language's spelling and grammar (Blanton, 2017). Computers are inflexible machines that understand what you type only if you type it in the exact form that the computer expects. The expected form is called the syntax. Our research premise is that humans will choose a GUI interface if available. In our research, each individual has a choice between a syntax command or a GUI.
8. *Proximity* - Proximity searching is a way to search for two or more words that occur within a certain number of words from each other (EBSCO, 2016). The proximity operators are composed of a letter, such as "n" or "w," and a number, to specify the number of words. The number cannot exceed 255.
9. *Discovery System* - Discovery systems allow users to find library content from a singular search box (Guajardo et al., 2017). This permits library research as intuitive as Google, but with the comprehensiveness of valuable library collections (Cmor & Li, 2012).
10. *Abstracting and Indexing Services* - Indexing and abstracting services allows for the concise summarizing of documents that are succinct, and they assign descriptors for referencing documents (Hedden, 2016; Cummings, 2013). The product is frequently a

bibliographic index. This can be a subject bibliography or a bibliographic database (Chen, 2010).

11. *Academic Library* - An academic library is a library that is part of a higher education institution facilitating two reciprocal functions supporting the school's curriculum, and the research of faculty and students (Daniels et al., 2013).
12. *Academic Self-efficacy* - Influences how people act based on their feelings and thought processes (Bandura, 1991). Low self-efficacy is related with low results in the work, low self-esteem and negative thoughts regarding personal development and accomplishments. High self-efficacy provides a higher sense of competence. This encourages cognitive processes in areas of academic achievement (Vasile et al., 2011).
13. *Cloud Computing* - A collection of networked essentials providing services that do not needed to be exclusively managed by users (Hedden, 2016). The complete managed suite of hardware and software can be thought of as a formless cloud (Breeding, 2016).
14. *Proximity Search* - Proximity search allows simple "focusing" queries premised on general associations between objects (Goldman et al., 1998). This is helpful for interactive query sessions. Proximity is defined based on the shortest path(s) between objects.
15. *Attraction Effect* - The attraction effect is an inferior product's ability to increase the appeal of an alternative if the inferior product is added to a choice set (Lee et al., 2016).
16. *Compromise Effect* – Pocheptsova et al. (2009) explained the compromise effect occurs when a middle option is preferred (such as, option b in the set abc) over an extreme option (such as, option b in the set bcd; Pocheptsova et al., 2009).

17. *Context Effect* - Context effect indicates that when assessing a primary option, people consider features of reasonable alternatives versus only the elements of the principal alternative, and this confounds the decision-making process (Lee et al., 2016).
18. *Element Interactivity Effect* - Sweller (2016a) stated, “If elements of information interact, they must be processed simultaneously in working memory to be understood, imposing a heavy cognitive load” (p. 9).
19. *Expertise Reversal Effect* - If new information is given to learners, it is processed in a limited working memory (Sweller, 2016b). Learning reduces working memory limitations by creating schemas, which are stored in long-term memory and enables information to be processed more efficiently (Kalyuga et al., 2003).
20. *Imagination Effect* - The approach of imagining an activity, performance, procedure or steps, happens if a person processes a technique through working memory (Leahy & Sweller, 2005). Imagining an answer to a recently solved problem provides an example.
21. *Guidance Fading Effect* - The guidance fading effect is confirmed by improved learning that is the result of gradually faded worked examples versus the consistent application of worked examples, problems, or worked example-problem pairs (Sweller et al., 2011).
22. *Isolated Elements Effect* - The isolated elements effect demonstrates at first presenting a set of isolated elements of information versus the whole complexes of interactive elements in instructional materials (Chen et al., 2017). It has the potential to reduce excessive intrinsic load.
23. *Goal-free Effect* – The goal-free process tries to observe and measure all effects, impacts, or actual outcomes whether they be intended or unintended, without being prompted to

the program’s intentions (Chen et al., 2017; Sweller et al., 1998). Goal-free problems are intended to minimize extraneous load created by using a means-ends analysis.

24. *Worked Example Effect* - The worked example effect occurs when learners who showed the solution to a problem perform better than those asked to solve the problem independently (Cooper & Sweller, 1987; Renkl, 2014; Renkl & Atkinson, 2003). Conventional problem solving tends to diminish with learning as it is it concentrated on developing a problem goal versus moving knowledge to long-term memory (Sweller, 2016a). The study of worked examples is no longer effective with increasing expertise, which is referred to as the expertise reversal effect (Renkl, 2005; Kalyuga, 2007).
25. *Split-Attention Effect* - The split-attention effect suggests that graphics needed explanations that are essential to the graphic, so the student does not have to search for an explanation (Chen et al., 2017). If the “same information is physically integrated, thus obviating the need to mentally integrate it, extraneous cognitive load is reduced and learning is enhanced due to the reduction in the number of interacting elements” (Chen et al., 2017, p. 298).
26. *Transient Information Effect* - The negative influence of transient information is referred to as the transient information effect (Sweller, 2016a). This happens if restricted learning happens due to transient information disappearing before the student can appropriately use it or link it with new information.
27. *Redundancy Effect* - Information not necessary for learning is considered as redundant information (Sweller et al., 2011). An example would be identical information in various forms like listening to or reading the same text. It could include unnecessary enhancing

information or cartoons associated with text. This type of information uses working memory, and thus increases the extraneous working memory load (Chen et al., 2017).

28. *Completion and Variability Effects* - The completion problem effect happens if participants are required to complete a problem when provided a partial solution or partial completion to the problem, and these students learn at a quicker pace than participants that are required to solve a problem without assistance or direction (Paas, 1992). The variability effect happens if participants showed a high variety of work examples learn more rapidly than participants showed more similar work examples (Sweller, 2016a).
29. *Collective Working Memory Effect* - Participants with independent knowledge bases work together on a task and through cooperation, they can combine their working memories, which are limited as individuals (Sweller, 2016a). If the expense of cooperating is less than the real increase in working memory due to pooling their working memories together, performance is expected to increase compared to individual learning.

Summary

The problem statement provided a vision of a new student compromised by text overload. Their higher learning institution does not prepare these same students for the tasks ahead to control this seemingly unlimited text or determine how to locate something by searching for it. Searching is ubiquitous as it estimated that 249,000,000 people use Google every day (Internet Live Stats, 2018). You would had thought everybody is an expert at searching. A small cadre of software programmers do know how to do sophisticated syntax command instructions to cause computers to do specialized searches. These syntax commands are referred to as operators. Few students know software can index any amount of content at the rate of 30,000,000 words a minute and make any word or number available in less than a second. Computers are designed for this type of function, but educational institutions do not prepare new students in the process of handling this content (Diesendruck et al., 2014). Conventional databases with records and fields are not used; rather, unstructured databases are used that do not require any structure. Expense can be zero as some are free, but even professional-level software for indexing and retrieval is often less than $200 dollars. Many syntax commands are available, adding to extraneous cognitive load for the student (Devi et al., 2016, p. 1347).

New students with limited training can precisely find “a needle in a haystack” (Stanford, 2011). Indexing can happen at 30,000,000 words a minute. The NIV Bible, with five matching commentaries comprised of 15,705,182 words, is indexed in 28 seconds. Schools do not teach these new students indexing or retrieval skills, but they should. The purpose of this study is to comprehend how skilled new students are at a community college in northern Arizona at searching their own content once indexed. They will be trained to use these syntax command operators. Once they had this skill learned, they would also be trained to substitute a GUI for the syntax command operator to know if this induces them to use these refined search attributes. The theories guiding this study are CLT and information process theory (Sweller, 1984; Wilson, 1999). The reduction of cognitive load enhances learning and reduces stress. The researcher believes life changing search skills will endure with the new students and benefit their learning in school and thereafter. The next chapter provides an overview, a theoretical framework, and a listing of related literature.

CHAPTER TWO: LITERATURE REVIEW

Overview

The purpose of this literature review is to present a clear, logical, and synthesized approach to a review of the body of knowledge available within the literature and to justify the worthiness of this research. Additionally, through the totality of content, this chapter justifies the usefulness, significance, and importance that the results of this study apply to the body of knowledge in regard to using syntax command operators in searching content either previously acquired or to be acquired from the Internet or other sources (Jayaweera et al., 2014). The body of knowledge will also consider using a GUI as an alternative to the syntax command operator. This review reveals higher education has provided no significant effort to provide elementary basic syntax command instruction to students at their entry-level introduction, and thus their skills at searching are minimal. Syntax command operators are specific to the function and, if mistyped, will have a total failure. Failure opens the possibility of extraneous cognitive load inhibiting the learning process for students. There are elements of comprehending some of the factors in this body of knowledge without drawing a conclusion on how to address this issue. Failure to provide skilled training for searching techniques limits the student learning significantly in terms of results, but it also imposes an extraneous cognitive load that impairs learning. The complexity of possible operators contributes to this issue. The following parts will provide a theoretical framework, related literature, and a summary of this chapter.

Theoretical Framework

The following information provides insight by scholars in cognitive load taken from peer-reviewed articles and journals. The material represents practices and theory in recent literature, allowing the reader to evaluate these scholars' thinking and other considerations. Tyler-Smith

(2006) suggested cognitive load, added to the stress and other factors, potentially reduces the learner’s capability to pursue the minimum class goals in either the classroom or an online class. Sweller (2008) indicated that instructional designs are grounded in CLT.

The concept of cognitive load is broadly subjective. A methodological discipline will introduce methods, rules, and postulates. It will create a set of procedures for analysis of the principles of inquiry in this field. Cognitive load expanded this researcher’s ability to consider why human minds could not assume more than a certain amount of information. Miller first thought the idea of the limited human ability to grasp new information in 1956. His now-famous “Magical Number Seven, Plus or Minus Two: Some Limits on Our Capacity for Processing Information” (Miller, 1956, p. 81) opened consideration of why people struggled to learn telephone numbers greater than nine numbers. From that time forward, researchers like Sweller (1988), Paas (1992), Ayres (2006), Kalyuga (2007), Jong (2009) and many others had provided thousands of scholarly articles for new researchers.

One of the major findings (in fact, the very first finding) of CLT is that requiring learners to search for information imposes a very heavy, extraneous cognitive load. The search process overloads working memory with processes that are extraneous to learning. (Sweller, 2013) Sweller’s (2013) comment introduced cognitive load parameters to the researcher. The research to be done is a study of introducing two methods of proximity searching to students to know if they felt either one or both reduce their cognitive load when searching for information. If they say it does reduce the cognitive load, then Sweller’s statements and theory are supported.

Germane cognitive load. Sweller et al. (1998) defined germane cognitive load as a function that creates and automates schemata; the authors believed that “while intrinsic load is generally thought to be immutable, instructional designers can manipulate extraneous and germane load. It is suggested that they limit extraneous load and promote germane load" (Sweller et al., 1998, p. 251). Extraneous cognitive load, as hypothesized by Clark et al. (2006), remains under the purview of the instructional designer and causes. Intrinsic cognitive load. Albers and Mazur (2003) advanced the thesis that intrinsic cognitive load encompasses information and concepts related to lesson tasks and objectives and consists of the difficulty and interoperability of the instruction; because this load is based on course content, it is unaffected by the instructional designer.

Related Literature

The following paragraphs provide my philosophical assumptions, primary theorists and reflection, and recent literature issues.

General Definitions and Assumptions About Cognitive Load

Miller (1956) maintained that working memory is severely limited while long-term memory is essentially limitless. As new information enters working memory, it is processed and is assimilated into long-term memory. Cognitive overload occurs when the number of components required to be processed in working memory exceeds working memory capacity. In cognitive overload events, a reduction of learning and performance occurs due to the portion of the instructional task that cannot be assimilated into a schema (Sweller, 1994).

Jong (2009) commented on cognitive load in an article stating that "extraneous cognitive load is cognitive load that is evoked by the instructional material and that does not directly contribute to learning (schema construction)" (p. 108). As van Merriënboe and Sweller (2005) wrote: "Extraneous cognitive load, in contrast, is load that is not necessary for learning (i.e., schema construction and automation) and instructional interventions can alter that" (p. 150).

CLT was developed by John Sweller (1988) because of his research on problem solving. Sweller believed learning can be improved by the means of the delivery of information. This assumes a restricted amount of working memory and an unlimited long-term memory. Schemas, which store content by the way it will be needed, are gathered later with additional disclosure to associated difficulties, are automated as rules, then archived in the long-term memory for recall. Structuring content for a person can imbed schemas and regulations to store in long-term memory. This, in turn, improves knowledge acquisition and performance ("Cognitive Load Theory," 2014).

Wilson (1981) had a significant impact on the development of information science. It covered basic issues, such as the nature of information and models of information seeking and information behavior. This included those based on "whole life" concepts, suitable research methods for this disciple, and the concept of information science as an academic discipline (Bawden, 2006). Wilson (1981) commented on the complexity of information:

> The problem seems to lay, not so much with the lack of a single definition as with a failure to use a definition appropriate to the level and purpose of the investigation. The word "information" is used, in the context of user-studies research, to denote a physical entity or phenomenon (as in the case of questions relating to the number of books read in a period, the number of journals subscribed to, etc.), the channel of communication through which messages are transferred (as when we speak of the incidence of oral versus written information), or the factual data, empirically determined and presented in a document or transmitted orally. (p. 3)

An instructional task requires a learner to exert mental effort to obtain a solution (Hodson, 2016). This effort places a burden or load on the limited working memory resources.

During an instructional task, a learner exerts mental activity to obtain the skill needed. The expended effort places a load on limited working memory resources (Hodson, 2016). Cognitive load is the part of working memory resources that is used while processing an instructional task. The first goal of CLT is to comprehend how to exploit the design of instruction. CLT tries to consider and improve situations where students are excessively burdened by task demands (Sweller, 1988).

Cognitive overload is based on the foundation of information seeking theory that states working memory is very limited, whereas long-term memory is virtually limitless (Mayer, 2012; Miller, 1956). As sensory information enters the working memory, it is brought into long-term memory by developing schema. Cognitive overload happens if the number of elements needed to be processed in working memory exceeds the learner's working memory capacity (Mayer, 2012). When cognitive overload occurs, a reduction in performance and learning happens because of the part of the task that cannot be brought into a schema (Sweller, 1994).

It is important to comprehend the elements in cognitive load as they played a key role in student learning patterns (Mayer, 2012). An instructional task requires a learner to exert mental effort to obtain a solution. This effort places a burden or load on the limited working memory resources. Cognitive load is the portion of working memory resources that is used while performing an instructional task (Hodson, 2016). The main goal of CLT is to understand how to optimize the instructional design. CLT strives to correct situations where students are overburdened by task demands (Sweller, 1988).

CLT provides a basis to explore with research, and their confluence of impacting learning by students (Sweller, 2016a). Students are deprived of using accessible searching tools that require using syntax command operators that use elements of software programming skills.

These operators require the user to execute the syntax perfectly to get the result. If one step of the syntax command is in error, then the command cannot be performed (Theng et al., 2016). Programmers utilize syntax commands daily, but non-programmers often do not know what a syntax command is or what it does. When a person executes a GUI, the GUI often runs a syntax command. Apple computers do not use syntax commands, but PCs usually respond to these commands.

The problem faced by students starting their education journey is not taking advantage of higher-level syntax command operators that are available (Russell, 2015). This inhibits learning. The researcher has not found any evidence that higher education includes this technique in their instructional designs. The problem could be within these parameters (a) cognitive load, (b) information transfer, or (c) self- efficacy. The solution is used in instructional design to teach students the elements of higher-level syntax command operators, and this emulates how programmers get the results they wanted by using such commands. An even better solution is developing GUI methods to do these steps. In the final step of this study, the researcher will introduce the GUI concept to demonstrate that programming skills are not necessary.

Theory and CLT weave a tapestry of complexity of human limitations that inhibit student learning patterns. There are possible solutions to this that deserve consideration. Blanton (2017) provides a possible solution in his dissertation. Blanton focuses on pads such as the Apple iPad and their use of touch user interface (TUI). There are a lot of pieces in this puzzle, but no one researcher has suggested a solution, and this provides a gap in the research literature.

Cognitive Load and Working Memory

CLT is used to design instruction in instructional design (Sweller, 2016b). Human/student cognition is a key component to instructional design. CLT assumes students had not explicitly evolved to acquire learning skills taught in educational institutions. These topics require that students gain domain-specific versus generic-cognitive knowledge. Generic-cognitive knowledge does not require precise instruction as students had gradually acquired it. However, domain-specific concepts and skills do require explicit instruction. These elements interact with the capacity and time interval limits of working memory to determine the essential quality, a cognitive architecture relevant to instructional design (Sweller, 2016a). Working memory “limits do not apply to biologically primary, generic-cognitive knowledge acquired without explicit instruction but do apply to biologically secondary, domain-specific knowledge that requires explicit instruction” (Sweller, 2016b, p. 360). As a result, CLT developed and evolved to create techniques, minimize unnecessary working memory load if “working with explicitly taught, biologically secondary, domain-specific knowledge” (Sweller, 2016b, p. 360).

Based on CLT as discussed by Sweller et al. (2011a), this paper develops the purpose of working memory, its ties to long-term memory and variations in the characteristics of working memory with differences in the types of information being processed (Sweller, 2016b). The point is to show those characteristics of human/student cognitive structure that can be useful to build instructional procedures. The aspects of working memory are key to CLT and to instructional design.

Instructional design has three related characteristics of human/student cognition that are frequently ignored: (a) the discrimination between knowledge a person has precisely developed to acquire and knowledge that the person requires for mostly cultural reasons, (b) the different roles regarding domain-specific knowledge and generic-cognitive, and (c) the situation in which instruction is explicit (Sweller, 2016b). Each factor is important but related by their reciprocal action or influence with working memory and long-term memory.

Humans had evolved to have biologically primary knowledge over countless generations (Youssef-Shalala et al., 2014). Consider learning to speak and listen, or to recognize faces, or “generic-cognitive processes such as solving problems by using solution knowledge of related problems” (Sweller, 2016b, p. 360). Primary knowledge is usually modular. Biologically primary knowledge usually developed unconsciously and without input from others. There is no requirement to be instructed how to listen to another person’s speech or how to determine how to find a way from Point A to a visible Point B. These complex skills we acquire without difficulty (Sweller, 2016b).

Working memory limitations that researchers had been familiar with for decades do not apply to biologically primary material where limits may be far wider than those usually discussed in the literature (Shipstead et al., 2014). Most people do not have difficulty remembering the enormous number of points of difference needed to distinguish one face from another face nor do we have difficulty learning and retaining the large range of sounds that constitute our native language (Sweller, 2016b). We had evolved to acquire the knowledge needed for facial recognition and the sounds of our native language.

Biologically secondary knowledge involves of a variety of different knowledge required for cultural reasons (Sweller, 2016b). It is mostly not differentiated except for secondary knowledge needs primary knowledge for the cognitive process of acquired skill (Paas & Sweller, 2012). Most topics instructed in schools are an example of secondary knowledge (Sweller, 2016b).

Working memory is an important cognitive difference between primary and secondary knowledge (Sweller, 2016b). The “well-known capacity and duration working memory limitations apply only to biologically secondary knowledge” (Sweller, 2016b, p. 361). If using biologically secondary information, working memory is significantly limited in both duration and capacity. As a result, constraints had instructional consequences (Sweller et al., 2011a).

Schools were mostly designed to instruct domain-specific, biologically secondary knowledge (Sweller, 2015). They were not designed to teach generic-cognitive skills because these are acquired automatically without being taught individually (Sweller, 2016b). Students might be required to be instructed as to a generic-cognitive skill applied to a specific domain-specific area, but they do not require the individual to learn the skill itself (Youssef-Shalala et al., 2014).

Sweller (2016b) asked, “Why is explicit instruction important in educational contexts?” The solution is in the working memory aspects if dealing with new or unusual, biologically secondary, domain-specific information. If the category where “the limitations of working memory occur, it is important that instruction reduces all sources of an extraneous cognitive load. Explicit instruction is likely to reduce the working memory load imposed compared to instructional procedures that rely on minimal guidance” (Sweller, 2016a, p. 362). There is excellent evidence to this hypothesis.

Sweller (2016b) provides the following to provide emphasis. The worked example effect is one of the empirical effects generated by CLT. It occurs when learners shown the solution to a problem subsequently outperform learners who must solve the problem themselves (Cooper & Sweller, 1987; Renkl, 2014; Renkl & Atkinson, 2003). Sweller (2016b) commented, “Based on the worked example effect, the empirical evidence overwhelmingly favors explicit instruction, providing support for the cognitive architecture that underpins the theory. That cognitive architecture will be discussed next” (Sweller, 2016b, p. 362).

In conclusion to this article, Sweller (2016b) suggested “that the knowledge acquired in academic contexts consists of a biological secondary, domain-specific rather than generic-cognitive information. It may be the only information that can be taught" (Sweller, 2016a, p. 366). The emphasis is the writer of this paper.

In contrast to the scarcity (perhaps a gap) of literature showing effective instruction of generic-cognitive knowledge, a significant body of literature provides techniques for instructing domain-specific knowledge (Sweller, 2016b). This literature focuses on the critical significance of the aspects of human cognition while creating instructional concepts. The limits of working memory "when acquiring novel, biologically secondary information and the elimination of those constraints when dealing with familiar information stored in long-term memory are central to this work. "Without this critical knowledge of human cognition, instructional design is blind" (Sweller, 2016b, p. 366).

Cognitive Load Effects

CLT was developed in the 1980s and was even more substantially developed and expanded in the 1990s by researchers (Sweller, 1992). It became a major theory by providing a framework for research into cognitive processes and allowing new ideas for instructional design. By "simultaneously considering the structure of information and the cognitive architecture that allows learners to process that information, cognitive load theorists had been able to generate a unique variety of new and sometimes counterintuitive instructional designs and procedures" (Paas et al., 2003, p. 1)

Goal-Free Effect

Sweller (2016a) indicated that trying to solve a problem can result in a significant amount of 'working memory' being used in the search process, and this reduces the amount of working memory available for 'learning' from the related task. Thus, the problem gets solved, but the related solver often does not make any generalizations from the resulting solution and will be unlikely to do it again in the future. CLT proposed that limiting extraneous cognitive load while learning could benefit transfer learning. Maulidya et al. (2017) commented on goal-free problem strategies evolved in CLT, and showed they are effective for transfer learning put forward for consideration. This technique allows students to learn a significant number of problem-solving moves from mathematics problems. Instructions in a goal-free problem caused participants to develop as many possible solutions as they could, versus a singular solution. Research showed goal-free problems improve learning (Maulidya et al., 2017).

Worked Example Effect

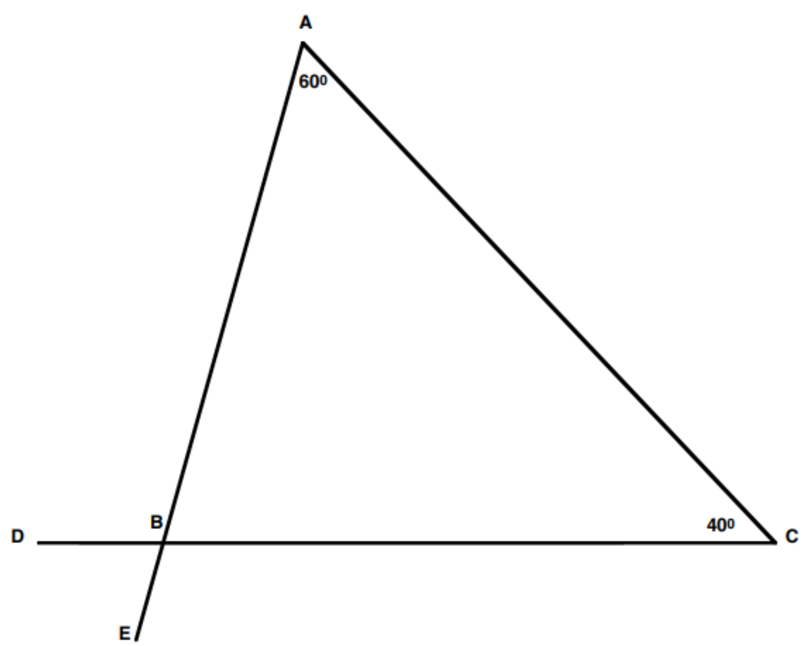
A worked example is “a step-by-step demonstration of how to perform a task or how to solve a problem” (Clark et al., 2006, p. 190). Worked-examples are designed to support initial acquisition of cognitive skills through introducing a formulated problem, the solution steps, and the final solution (Renkl, 2005). Worked examples provide problem-solving guidance allowing student learners how to solve a problem are superior to ones that provides no guidance. Studying worked examples using well-structured knowledge from alternative users via the reorganizing and borrowing concept is encouraged. Problem solving “in the absence of domain-specific, problem solving knowledge, requires learners to randomly generate solutions and test them for effectiveness via the randomness as genesis principle” (Chen et al., 2017, p. 297). Utilizing a worked example requires students to deal with less interactive elements than randomly creating and validating expectant moves, thus, it would result in increasing the extraneous cognitive load (Chen et al., 2017).

Split-Attention Effect

Sweller (2016a) provides insight that the split-attention effect is innate in some poorly developed instructional designs. It is most obvious if the same modality, such as visual, is used for alternative types of information usually in the same display (Sweller, 2016b). In further discourse Sweller (1992) provides a graphic of this after commenting that students considering an attempt to study a conventionally structured worked example such as that of Figure 10. The diagram in isolation provides no instruction (Sweller, 1992). The associated statements such as "Angle DBE = Angle ABC are unintelligible without a diagram" (p. 1503).

Figure 10

An Example of a Conventional, Split-Attention Diagram and Text



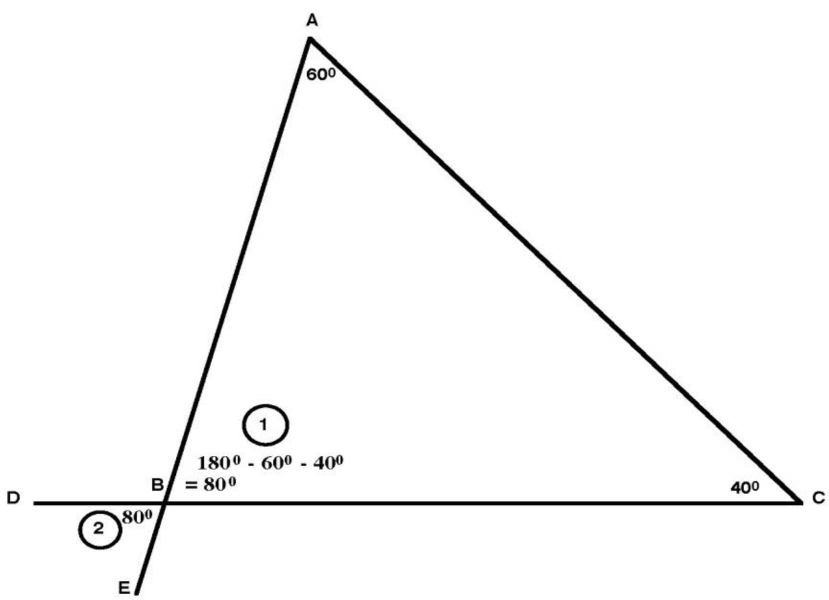
In the above figure, find a value for Angle DBE.
Solution:
Angle ABC = 180^0 – Angle BAC – Angle BCA (Internal angles of a triangle add to 180^0
= $180^0 - 60^0 - 40^0$
= 80^0
Angle DBE = Angle ABC (Vertically opposite angles are equal)
= 80^0

Note. From "Visualisation and Instructional Design," by J. Sweller, 1992 (https://www.iwm-tuebingen.de/workshops/visualization/sweller.pdf). Copyright 1992 by J. Sweller. Reprinted with permission (see Appendix W).

Working memory load can be limited by assimilating diagrams and statements (Kirschner, 2002). Alternatively locating statements next or below to a diagram as usually happens, related comments can be combined in the diagram allowing a search for referents is reduced (see Figure 11). If normally organized worked examples are associated with actual combined examples, outcomes usually establish a benefit for the unified forms subsequent in the split-attention effect. Multiple versions of the effect are used in some instructional materials (Sweller, 1992).

Figure 11

An Example of an Integrated Diagram and Text



Note. From "Visualisation and Instructional Design," by J. Sweller, 1992 (https://www.iwm-tuebingen.de/workshops/visualization/sweller.pdf). Copyright 1992 by J. Sweller. Reprinted with permission (see Appendix W).

This is a representation of the modality effect (Sweller, 1992). Physical incorporation of multiple bases of data can be very efficient. There is an alternative that is similarly effective and, in some situations, it may be desirable. The split-attention effect relies on the visual modality with graphic search being limited to the use of physical integration. Visual search means the visual channel is only used and overburdened under split-attention conditions (Sweller, 1992). There is significant evidence that operative working memory can be improved by using dual versus a single modality.

The Modality Effect

The instructional modality effect occurs when learners, faced with two sources of information that refer to each other and are unintelligible in isolation, learn more when presented with one source in visual mode and the other in auditory mode as opposed to both in visual mode (Sweller, 1992). From a theoretical perspective, capacity should increase to the extent that visual and auditory processors can function autonomously without sharing other cognitive structures that limit capacity. Some of the empirical evidence of an increase in working memory capacity, when using both modalities, also provides evidence for a partial autonomy of the auditory and visual channels.

The possibility of increasing working memory capacity by using dual rather than a single modality should have instructional consequences (Sweller, 2016b). For example, under split-attention conditions, rather than presenting a diagram and written text that should be physically integrated, it may be possible to present a diagram and spoken text. Since the diagram uses a visual modality while speech uses the auditory modality, total available working memory capacity should be increased resulting in enhanced learning.

Transient Information Effect

The negative influence of transient information is referred to as the transient information effect (Sweller, 2016a). This occurs if limited learning happens due to transient information disappearing before the student learner can suitably use it or link it with new information

(Sweller et al., 2011a). The transient aspect of spoken material is likely why humans invented writing. A modality effect is compromised and reversed when using long, complex spoken text (Leahy & Sweller, 2011). Benefits of using both auditory and visual processors is reduced by presenting lengthy, complex text in audio form. Text should be presented in written form as students can refer to the parts to make certain they comprehend text (Sweller et al., 2011a). Syntax commands are not auditory.

Redundancy Effect

The redundancy effect happens if additional information, interferes with learning (Sweller, 2016a). The redundancy principle or effect implies redundant content interferes versus facilitates learning. Redundancy occurs if the same information is provided at the same time in various formats or is excessively elaborated. Additional redundant information often has strong, negative consequences. The effect can be considered in CLT terms. If one form of "instruction is intelligible and adequate, providing the same information in a different form will impose an extraneous cognitive load. Working memory resources will be used to process the additional material and possibly relate it to the initial information" (Sweller, 1992, p. 1505).

The redundancy effect can happen if multiple sources of content can be understood apart foregoing a requirement for mental integration (Sweller et al., 2011). Text re-describing a diagram can be comprehended without the text that demonstrates an example. Combining the written text with the diagram is not likely to be beneficial to the user. There is little logic to believe learning will be enhanced if text integration within a diagram text that is not pertinent to student comprehension. These situations can be "detrimental to learning by imposing an extraneous cognitive load. Accordingly, redundant information should be omitted to preclude an increase in extraneous cognitive load caused when learners inevitably focus attention on unnecessary information and physically integrate it with essential information" (Sweller, et al., 2011, p. 141).

Element Interactivity Effect

Most cognitive load effects occur under only obvious situations that provide high intrinsic cognitive load leading to the element interactivity effect (Sweller, 2016a). Most cognitive load effects happen due to reductions in extraneous cognitive load (Sweller, et al., 2011). The element interactivity effect indicates no cognitive load effect can be developed if element interactivity is low. CLT applies to complex material that is difficult to comprehend (Sweller, 2016a).

Expertise Reversal Effects

The expertise reversal effect refers to the reversal of the effectiveness of instructional techniques on learners with differing levels of prior knowledge (Chen et al., 2017). Chen et al., (2017) believed all instructional effects, as well as all cognitive load effects, had boundary limits beyond to which they no longer apply. The expertise reversal effect creates a limit on many cognitive load effects that results from the interaction of learner and task features (Kalyuga et al., 2003).

Sweller (2016a) provides an example of the expertise reversal effect. More specifically, this effect happens when "Instructional Procedure A is superior to B for novices with the superiority decreasing and eventually disappearing or even reversing with increases in knowledge levels" (Sweller, 2016a, p. 9). Studying worked examples might be superior than solving issues for student novices. However, with improved skills, solving problems could be an improvement. CLT supports the use of minimal guidance according to Kalyuga and Singh (2015) and the expertise reversal effect (Kalyuga 2007; Kalyuga et al. 2003; Sweller et al. 2011). This effect refers to constant or stable patterns of interactions with various levels of student learner prior expertise and the consequential effectiveness of various instructional techniques. Novice learners, which are in the first levels of skill gathering, encompass forms of explicit guidance that provides learning domain-specific schemas (Kalyuga & Singh, 2015).

Completion and Variability Effects

The completion problem effect happens, if learners are prompted to finish solving an incomplete problem more quickly than other students required to solve a problem without being shown any moves (Paas, 1992). The variability effect happens if student learners had significant variable worked examples and learn more than learners shown more difficult but similar worked examples (Paas & van Merrienboer, 1994). The variability effect illustrates an example of increasing intrinsic cognitive load to improve learning (Paas & van Merrienboer, 1994; Sweller et al., 2011). When the “variability of worked examples is increased, then students must not only learn how to solve a class of problems, they will also be needed to learn how to distinguish between problems and learn how to classify them into solution categories” (Sweller, 2016b, p. 365)

Guidance Fading Effect

The fading effect “is predicated on the assumption that by gradually decreasing problem-solving guidance and increasing problem-solving demands with increases in expertise, learners will retain sufficient working memory capacity to deal with the increasing demands” (Sweller et al., 2011, p. 172). If novices require many worked examples, and more skilled learners are given problems, an instructor might hypothesize learners needed to use the initial presentation of worked examples. This would be followed by completion problems and then full problems. Work on the guidance fading effect “has repeatedly demonstrated the advantages of this sequence” (Sweller, 2010, p. 132). The expertise reversal effect maintains that if working with experts, the opposite is true (Stachel, 2011). Experts learn more effectively by building mental models to solve complex problems. Using the guidance fading effect meant that as expertise increases assistance should fade (Tyler-Smith, 2006).

Isolated Elements Effect

The isolated elements effect states that when these elements are taught in isolation initially, learners will form schemas that can be stored in long-term memory (Sass, 2016). Schemas, are made of multiple components and then combined as a single element, resulting in more information processed by working memory. This improvement in working memory capacity permits the learner to study interactions among elements and/or phases (Kalyuga et al., 2011; Paas et al., 2003; Pollock et al., 2002). The isolated elements effect showed that while the initial presentation of a set of isolated elements of information versus the entire complexes of interactive elements in instructional materials could minimize excessive intrinsic load. A significant disadvantage to this is that the information in the form of isolated elements causes students to be less likely to consider the relativity between the isolated elements at first. These separated elements should assist students’ structure partial schemas, and subsequently enables the formation of the complete schema (Chen et al., 2017).

Imagination Effect

The imagination effect happens when students are asked to imagine concepts, and these same students learn better than students are asked to study the same materials (Paas, 2017). Cooper et al. (2001) and Sweller (2016a) carried out the initial work on this effect. The imagination effect is dependent on various levels of expertise and can reverse, if students, at inappropriate levels are asked to imagine material. This is evident only with students that had benefitted from some level of experience. At lesser levels of experience, studying class work is more efficient than imagining for those students that found it difficult to imagine. To imagine class work, a person must process the class work in working-memory. This may be “impossible until schemas have begun to form. Until that point, studying may be superior to imagining” (Leahy & Sweller, 2005, p. 268).

Collective Working Memory Effect

The premise to group learning is more efficient than individual learning because the provision of the content complexity required for learning is high (Sweller, 2016a). Group participants sharing the load processing of complex content with their working-memories allows for more efficient processing and better comprehension of the content to be learned. This assumption was experimentally confirmed, suggesting that “for high-complexity tasks, group members would learn in a more efficient way than individual learners, while for low-complexity tasks, individual learning would be more efficient” (Sweller, 2016a, p. 11).

Research into learning by collaboration has evolved over a long period of time (Sweller, 2016a). Students are motivated by being grouped together. Or alternatively, a social constructivist point of view indicates that knowledge is best constructed by discourse among students (Sweller et al., 2011a). Collaboration with students, from a CLT viewpoint, provides a basic understanding of how and when group collaboration work can be effective and developed. The Collective Working Memory Effect “is a new cognitive load theory effect that occurs when individuals obtain higher learning outcomes through collaborative work than when learning alone” (Sweller et al., 2011a, p. 230).

The collective working memory “effect supports that members use of each other’s working memory capacity, by sharing the cognitive load imposed by a task, to process information elements deeply and construct higher quality schemas in their Long-Term Memories than learners working individually” (Kirschner et al., 2010, p. 9). This is due to a trade-off between transaction cost (coordination and communication within the group), and the reduction in cognitive load based on group sharing. Researchers are cautious to generalize research findings from the laboratory to classroom settings. “It can be assumed that the complex pattern of interactions between cognitive, motivational, and social factors that characterize a real-life context would add ‘noise’ to the data and cause the effects to be less pronounced” (Kirschner et al., 2010a, p. 24).

Attraction Effect

The attraction effect is a phenomenon in optimal conduct that has gained the attention of many academics (Lichters et al., 2017). Lichters et al. (2017) discussed that by adding an asymmetrically dominated third alternative (a decoy option) to a central set of two alternatives improves the relative choice share of the alternate dominating new entrant (the target option) in a way that is incompatible with the concept of stable user preferences. Liu et al. (2014) showed three behavior effects in federated search, namely, the vertical attraction effect, the examination cut-off effect, and the examination spill-over effect. The attraction effect in decision-making is an example of how predilections are predisposed by the accessibility of other options. A hypothesis for this effect is biases in attention impact preferences. Historically, “ideas had been explored indirectly through computational modeling and eye tracking” (Trueblood & Dasari, 2017, p. 3374). Research demonstrates presentation order has a significant impact on the effect, as some presentation orders improve the effect, and others reverse the effect. Research by Trueblood and Dasari (2017) revealed that presentation order determines the allocation of attention on both positive and negative variances between options. Results indicate attention has a direct influence on the attraction effect (Trueblood & Dasari, 2017).

Compromise Effect

Lichters et al. (2016) discussed the compromise effect as a standpoint of reason-based choice and extremeness aversion, based on loss aversion, in which such term infers consumers consider losses more significant than gains. While this article uses consumers, it could also apply to students doing searching. Lee et al. (2016) also discussed this issue stating that “the compromise effect is based on extremeness aversion and expected loss minimization, which involve trade-offs, and enhances the justification of the middle option” (Lee et al., p. 396). Lichters et al. 2016 commented that “regarding choices between durables, the compromise effect diminishes under a serotonin-deficiency-induced cognitive impairment, but its decrease is not as pronounced as with fast-moving consumer goods.”

Context Effect

The attraction effect and compromise effect (known as context effect) describe the underlying impetuses that cause users to choose “the middle option and introduce an inferior option to make the originally dominated option more preferable” (Lee et al., 2016, p. 394). Simultaneous presentation might aggravate “decision making biases called context effects, such as the attraction effect (Huber et al., 1982; Huber and Puto, 1983), the compromise effect (Simonson, 1989), and the similarity effect (Tversky, 1972)” (Basu & Savani, 2017, p. 87). These biases occur if users simultaneously compare presented choices involving tradeoffs. Tradeoffs are often complex and thus, users frequently use certain heuristics based on relationships “between the options (e.g., dominance, intermediacy, and similarity) to simplify the choice. Studies testing for these biases had largely used simultaneously presented options" (Basu & Savani, 2017, p. 86).

Evolutionary Educational Psychology and Cognitive Load Theory

The information processing used by CLT was comparable to the information processes formed in the basis of the evolution of natural selection (Sweller, 2016a). There appeared to be a relation among: (a) information held in DNA and in long-term memory; (b) the transmission of information during reproduction; (c) the transmission of information between humans; and (d) "random mutation and random generate and test during problem solving" (Sweller, 2016a, p. 11). Working memory did not have an obvious comparable process in evolutionary biology.

Explicit Instruction

Explicit instruction is systematic, direct, engaging, and success oriented—and has been shown to promote achievement for all students (Chen et al., 2017). This highly practical and accessible resource gives special and general education teachers the tools to implement explicit instruction in any grade level or content area (Goeke, 2009). The authors are leading experts who provide clear guidelines for identifying key concepts, strategies, skills, and routines to teach; designing and delivering effective lessons; and giving students opportunities to practice and master new material. Sample lesson plans, lively examples, reproducible checklists and teacher worksheets enable for the enhancement of volume utility.

Domain-Specific Knowledge

Domain-specific learning theories of development hold that we had many independent, specialized knowledge structures, rather than one cohesive knowledge structure (Sweller, 2016b). Thus, training in one domain may not impact another independent domain. CLT is frequently used helped with instructional design. Multiple factors of human cognition are important to instructional design. Key factors in instructional design: (a) assume we had not evolved to understand the topics taught in educational institutions; (b) that topics require students to acquire domain-specific versus than generic-cognitive knowledge; (c) that although "generic-cognitive knowledge does not require explicit instruction because we had evolved to acquire it, domain-specific concepts and skills do require explicit instruction" (Sweller, 2016b, p. 360). Sweller (2016b) considers the relationships to biologically secondary, domain-specific knowledge as he stated:

> These factors interact with the capacity and duration constraints of working memory to delineate a cognitive architecture relevant to instructional design. The working memory limits do not apply to biologically primary, generic-cognitive knowledge acquired without explicit instruction but do apply to biologically secondary, domain-specific knowledge that requires explicit instruction. Accordingly, cognitive load theory has been developed to provide techniques that reduce unnecessary working memory load when dealing with explicitly taught, biologically secondary, domain-specific knowledge. (p. 360)

Visualization and Instructional Design

Sweller (1992) described a fundamental description of human cognitive architecture and it: includes a working memory of limited capacity and duration with partially separate visual and auditory channels, and an effectively infinite long-term memory holding many schemas that can vary in their degree of automation. These cognitive structures had evolved to handle information that varies in the extent to which elements can be processed successively in working memory or, because they interact, must be processed simultaneously imposing a heavy load on working memory. Cognitive load theory uses this combination of information and cognitive structures to guide instructional design. Several designs that rely heavily on visual working memory and its characteristics are discussed (p. 1501).

Information Structures

If element interactivity is low, or non-existent, and each element can be learned serially without reference to any other element, then they are independent (Sweller, 1992). Since these elements are low in element interactivity, they do not interact with each other. Therefore, there is no loss of understanding despite the fact that they are being learned individually and in isolation. Such material imposes a low cognitive load because each element can be learned without reference to other elements. There is a close interaction between the various elements required to be learned at the other extreme of the continuum. Element interactivity is high, which means that if the material needs to be understood, the multiple elements of information must be processed simultaneously and imposes a heavy cognitive load.

There is no interaction between the elements that needed to be learned by students (Chen et al., 2017). They are independent. Element interactivity is low or non-existent, and each element can be learned serially without reference to other elements. As elements do not interact with each other, there is no loss of understanding independent of each element that is being learned individually and in isolation. Sweller (1992) defined the ability to process all elements that necessarily interact simultaneously in working memory:

> Learning such material imposes a low cognitive load because each element can be learned without reference to other elements. There is close interaction between the various elements that needed to be learned at the other extreme of the continuum. Element interactivity is high, which means that if the material is understood, all the

> information with its multiple elements must be processed simultaneously, imposing a heavy cognitive load. (p. 1501)

Working Memory

The aspects of working memory are foundational to CLT as well as to instructional design (Sweller, 2006). With instructional design, there are three related aspects of human cognition that are often ignored: "(a) the distinction between knowledge we had specifically evolved to acquire and knowledge that we needed for largely cultural reasons; (b) the differential role of generic-cognitive and domain-specific knowledge; and (c) the conditions under which instruction needed to be explicit" (Sweller, 2016b, p. 360). These factors are important and are related by their interaction with working memory and long-term memory.

Long-Term Memory

Long-term memory is considered an unlimited capacity storage that holds significant knowledge in a permanent form (Mayer, 2012). During learning, students may activate and use portions of knowledge from long-term memory and brought them into working memory to be used (Mayer, 2012).

The basic information processing model (Mayer, 2012) includes three cognitive processes indicated by arrows: selecting, organizing, and integrating. Selecting refers to paying attention to portions of the incoming information that is briefly held in sensory memory. Organizing refers "to mentally arranging incoming elements into a coherent structure in working memory. Integrating refers to making connections between incoming information and relevant existing knowledge from long-term memory" (Mayer, 2012, p. 89).

The role of long-term memory in human cognition was made significantly more comprehensible by work on high level skills in chess (De Groot, 1965). The hypothesis was that chess masters had a greater range of moves than less able players (Sweller, 2016b). Chess masters showed no indication of using greater search skills than casual players, but the masters usually chose better moves. De Groot (1965) provided insight into the mystery, by demonstrating chess masters and casual players a chessboard configuration taken from a real game for 5 s, then removing the board and asking the players to reproduce the board they had just seen (Sweller, 2016b). Chess masters “could replace over 80% of the pieces accurately while weekend players were only able to replace less than 30% of the pieces accurately” (Sweller, 2016b, p. 362). This skill was influenced by schemas stored in long-term memory.

This has been replicated in a mix of educationally relevant fields and indicate the importance of long-term memory to cognitive skills (Paas & Sweller, 2012). Experts in various fields of information acquired large numbers of schemas stored in long-term memory (Sweller, 2016b). Those schemas allow solvers to identify a problem and the best moves to solve the problem. A major function of instruction is for learners to understand the importance of acquiring schemas.

Schema(s)

Schemas had their roots in early psychological conceptions of learning by assimilation to schemata through the significant cognitive constructs provided by the work of Piaget (1928) and Bartlett (1932). They became important to modern cognitive theory and developed problem solving theories in the 1980s (Mayer, 2012). Others such as de Groot (1965), Chase and Simon (1973), and Gick and Holyoak (1980, 1983) revealed the significance of schemas in problem solving. Expert problem solvers could now visually recognize problem states and make appropriate corrective moves aligned with them. Schema theory proposed that skills in another area are dependent on the attainment of explicit schemas in long-term memory (Sweller, 1992). In long-term memory, these schemas allowed for the processing of high element interactivity material in working memory by permitting working memory to process the interacting elements as a single element. Sweller (1992) provided an example:

> Anyone reading this text has visual schemas for the complex squiggles that represent a word. Those schemas, stored in long-term memory, allow us to reproduce and manipulate the squiggles that constitute writing, in working memory, without strain.
>
> We are only able to do so after several years of learning. (p. 29)

A schema allows problem solvers to realize a problem state and belonging to a specific type of problem state that usually needed certain moves (Sweller, 1992). The problem solver is aware that certain problem states can be grouped, often by the similarity of the moves that can be made from those states. Novices, by not having suitable schemas, do not realize or memorize problem configurations and, therefore, utilize general problem-solving strategies (Sweller, 1988). Experts possessing schemas to distinguish between problem states and their relative moves and they are able to classify problems associated with those schemas. The main purpose of educational instruction is to construct schemas in working memory in order moved them into long-term memory. Instructional designs are not effective if they do not result in changes in long-term memory. They are unproductive if they ignore the limitations of working memory. CLT proposes working memory load can be levied by extraneous or intrinsic cognitive load (Sweller 2016b).

Extraneous cognitive load is created by instructional design and can be modified for better results (Leahy & Sweller, 2016). Leahy and Sweller (2016) provide an example: lengthy, complex, spoken information that cannot be adequately processed in working memory may impose an extraneous cognitive load. Intrinsic cognitive load is an inherent component of the information (e.g. the formula for a gradient ratio). It is reliant on the number of elements that, because they interact, must be managed simultaneously in working memory (Ayres, 2006). Some elements do not interact with each other and can be learned independently. Learning that circular lines on a map are termed “contours” involves low element interactivity. There are only two elements that interact: the term “contours” and the physical representations of the lines (Leahy & Sweller, 2016, p. 109).

Prior knowledge is stored in long-term memory as schemas (Saas, 2016). Schemas incorporate multiple elements of information into a single element with a specific function. For schemas to be formed, information must initially be extracted and processed in the working memory. Working memory is limited to the amount of information that can be processed at one time, and as a result, learners are often faced with cognitive overload. Useful schemas improve the working memory’s practical processing ability by allowing pieces of information to be processed as a single element (Sweller, 2005).

Schemas allow for subconscious processing and reduce the burden on the working memory (Paas et al., 2003). Novice learners often lack schemas in long-term memory, therefore, working memory relies on trial and error to provide and identify germane information between elements and this creates higher cognitive load (Sweller, 2006). The objective of the learning process became the development of such schemas to enable understanding (Kalyuga, 2010).

The Isolated Elements Effect

The isolated elements effect demonstrates that at first presenting a set of isolated elements of information versus the complete complexes of interactive elements in instructional materials might reduce excessive intrinsic load (Chen et al., 2017). A potential disadvantage is the information is in “the form of isolated elements and so students are unlikely to learn the relations between the isolated elements initially” (Chen et al., 2017, p. 300). These isolated elements often assist students who create partial schemas at the early stages and subsequently help in forming the complete schema in the next phase after receiving instructions about the relations with those isolated elements (Pollock et al., 2002).

Biologically Primary and Secondary Knowledge

Sweller (2016b) in an article and a video of an ACE Conference/researchED in Melbourne, Australia, provided content describing the significance of biologically primary and secondary knowledge influencing learning. Humans evolved to gain biologically primary knowledge over centuries. Sweller (2016b) provides examples: learning to listen and speak, learning to recognize faces, or generic–cognitive processes such as solving problems by using solution knowledge of related problems.

Primary knowledge and skills tend to be modular (Sweller, 2016b). Our ability to learn our native language evolved during a different evolutionary epoch and utilized different cognitive processes in one’s ability to recognize faces. Most importantly, from the current perspective, biologically primary knowledge tends to be acquired easily, unconsciously and without explicit intuition from other people. (Sweller, 2016b, p. 360)

Sweller (2016b) discusses working memory limitations as presented by (Shipstead et al., 2014) and others (Cowan, 2001; Miller, 1956; Peterson & Peterson, 1959). Sweller (2016b) states that these limitations “do not apply to biologically primary material where limits may be far wider than those usually discussed in the literature” (p. 361).

Biologically secondary knowledge involves a variety of dissimilar knowledge needed for cultural reasons (Sweller, 2016b). Unlike primary knowledge, it is mostly indistinguishable except to the extent that as secondary knowledge requires primary knowledge for its acquisition (Paas & Sweller, 2012). Nearly every “topic taught in educational institutions provides an example of secondary knowledge as do topics taught in the workplace and during cultural activities” (Sweller, 2016b, p. 361).

Working memory provides for a significant cognitive difference between primary and secondary knowledge (Chen et al., 2017). The duration and capacity of working memory limitations applies only to biologically secondary knowledge (Sweller, 2016b). When using original biologically secondary information, working memory is significantly limited in respect to capacity and duration (Sweller et al., 2011). A distinction between biologically primary and secondary knowledge is that primary knowledge often makes up a cognitive skill that is generic while secondary knowledge is mostly domain-specific (Tricot & Sweller, 2014). However, both include conceptual and procedural information.

Educational systems are usually developed to teach domain-specific, biologically secondary knowledge (Sweller, 2015). They were not developed to teach generic-cognitive skills, as most are acquired automatically without training. Learners may require to be skilled in that an individual generic-cognitive skill applies to a domain-specific area (Youssef-Shalala et al., 2014). However, they are not needed to be taught the skill itself.

According to Sweller (2015b), individuals should never assume that the simple acquisition of biologically primary knowledge exclusive of education is because of the lack of trained guidance, and the more complex and difficult acquisition of secondary knowledge is because of formal guidance. The difference in learning between the two contexts is because of their evolutionary modifications and not due to instructional actions. Minimal guidance contexts reduce the ease of learning in education instruction.

Human Cognitive Architecture

The term “cognitive architecture” refers to the way cognitive structures are organized (Sweller, 1992). This section describes those aspects of human cognitive architecture relevant to visually based instructional design and around which there is a broad agreement. Cognitive architecture consists of a working memory, which is limited in its processing capacity, and a theoretically unlimited long-term memory (Sweller, 1988). According to CL theory, “prior knowledge is stored in long-term memory in the form of schemas. Schemas are described as cognitive constructs that incorporate several pieces of information into a single element with a specific function” (Sass, 2016, p. 10).

The Information Store Principle

To work with a complex, dynamic environment, natural information processing systems required a massive storehouse of information (Devi, 2017). Genomes provide that storehouse by natural selection, while long-term memory has a corresponding function in human cognitive architecture. The function of long-term memory, in human cognition, is explained, by work on expertise in chess (De Groot, 1965). Sweller (2016b) shares a common thread with Youssef-Shalala et al. (2014) of which Sweller was a coauthor on the research (De Groot, 1965).

The De Groot Experiment

The hypothesis was chess masters utilized a greater range of moves than less skilled players (Sweller, 2016b). De Groot (1965) demonstrated the difference in the way that chess experts and novices reconstruct certain functions of chess in their minds. De Groot used a chess position taken from a master game. Long et al. (2005) participated in an experiment in which the participants, with various chess knowledge levels, were not made aware the position was from a master game. De Groot (1965) then showed the participants with the position for a brief period which ranged from two to 15 seconds. The position was then removed from their sight. The participants' task was to recreate the position they had just been showed using a different board. The ability of a participant's memory was assessed by on the number of chess pieces that they could correctly place on the new board (Long et al., 2005). Chess masters indicated no sign of using a greater search than casual players despite masters often choosing better moves. De Groot (1965) solved the mystery "by showing chess masters and weekend players a chessboard configuration of pieces taken from a real game for 5 s, removing the board and asking the players to reproduce the board they had just seen" (Sweller, 2016b, p. 362). Chess masters duplicated more than 80% of the pieces precisely, whereas casual amateur players replaced less than 30% of the pieces correctly.

De Groot (1965) found that his grandmaster remembered nearly every piece of the presented position scoring at a 93% correct rate. His weakest participant could place about 50% of the pieces precisely on the new board. De Groot (1965) commented "that masters of chess do not encode the position as isolated pieces" (Long et al., 2005, p. 1). The chess masters' complexes also use empty squares, and the empty places played an important role in recreating the precise location. This ability to encode these large content complexes is premised on the experience and knowledge they had developed over time in the study and practice of chess.

The Borrowing and Reorganizing Principle

Contents of long-term memory are borrowed from others as we learn from others (Sweller, 2016b). Our inclination to get information from other people is biologically primary. There is no need to be trained to emulate other people or a need to be trained to listen and speak to them. We do need to be trained to read and write as these skills are biologically secondary (Sweller, 2016b). When we had adequately gained these biologically secondary skills, we do not need to be stimulated to use them. We had advanced to communicate as a biologically primary skill even if the specific communication technique is the secondary skill of writing or reading. Whereas communicating with others is biologically primary, the information transferred is often biologically secondary (Chen et al., 2017). It is information that is not explicitly evolved to achieve to but is culturally necessary. In a contemporary society, most of that information is learned in education systems.

The Randomness as Genesis Principle

If information cannot be borrowed, it can be created through problem solving by means of a random generate and test procedure (Chen et al., 2017). Randomly generated information should be tested for efficacy with effectual information accessed in long-term memory and the unproductive information abandoned. The environment organizing and linking principle suggests the organization and storage of information in long-term memory, with the capability to effectively recover and link this previous knowledge with new knowledge, are the main features that differentiates experts from novices. Information that is organized and transferable as a unique piece of information (schema), versus multiple units, is available for working memory with less jeopardy of cognitive overload (Sweller, 2016b). This concept is related to formed and automated schema as defined in CLT. When the information has been “randomly generated or borrowed and then organized, a learner is able to use this information to interact effectively with his or her environment, including the learning tasks at hand” (Sass, 2016, p. 15).

Without This Critical Knowledge of Human Cognition, Instructional Design Is Blind

Cognitive architecture suggests that the knowledge learned in academic contexts consists of biologically secondary, domain-specific rather than generic-cognitive information (Chen et al., 2017). It may be the only information that can be taught (Sweller, 2016b). Generic-cognitive knowledge is too valuable not to acquire it automatically and without instruction. According to Youssef-Shalala et al. (2014), there is no body of literature based on randomized, controlled experiments unequivocally demonstrating effective, teachable generic-cognitive skills despite many decades of work. The best we seemed able to do is demonstrate that learners may need to be told to use previously acquired, generic-cognitive knowledge in specific domains (Sweller, 2016b, p. 366).

In contrast to the scarcity of literature illustrating the effective teaching of generic-cognitive knowledge, a large body of literature demonstrates teaching domain-specific knowledge techniques. That literature highlights the serious significance of human cognition's well-known patterns when creating instructional design procedures (Sweller, 2016b). The limitations of working memory when acquiring novel, biologically secondary information, and the removal of those limitations when dealing with accustomed information stored in long-term memory are key to this work. Without this critical knowledge of human cognition, instructional design is blind.

Kalyuga and Liu (2015) commented on cognitive load effects, stating, "Cognitive load theory has generated many instructional techniques (usually called cognitive load effects) to reduce learner cognitive load - especially extraneous load" (p. 3). Paas and Sweller (2012) indicated that "performance on the secondary task served as a measure of cognitive load. The higher the load imposed by the primary explanation task, the lower the available cognitive capacity would be for remembering the words or letters of the secondary task" (p. 37).

A search task and the system affect the burden on cognitive resources in an information search. Gwizdka (2010) determined the search results in Alvis was found to impose a higher cognitive load than Google as they are more complex. Buntine and Taylor (2004) commented on Alvis indicating that “Alvis is a research project in the design, use and interoperability of topic-specific search engines with the goal of developing an open source prototype of a peer-to-peer, semantic-based search engine” (Buntine & Taylor, 2004, p. 1). Semantic information added to the results list categories in an Alvis interface decreased mental demands during query formulation (Gwizdka, 2010). Gwizdka acknowledged the static nature of these methods makes them inappropriate for assessing dynamic changes in cognitive load, which was the focus of this article (Gwizdka, 2010).

There are indications that demand might exceed a person’s ability to process them (Lee et al., 2016). The article had three goals (a) presenting a critiques’ methods to enable the measurement of cognitive load, (b) exploring the allocation of a load across search task stages, and (c) attempting to benefit the comprehension of factors influencing cognitive load levels in an information search. In this study of 48 participants, cognitive load was analyzed with a dual-task method. Average cognitive load varied by search task stages. Gwizdka (2010) commented that “semantic information shown next to the search results lists in one of the studied interfaces was found to decrease mental demands during query formulation and examination of the search results list” (p. 2167). Dynamic assessment of cognitive load is important to information science as it improves the comprehension of cognitive needs imposed on users involved in the task and the interactive information retrieval system employed.

A study addressing cognitive load on pre-service teachers’ transfer of specific teaching behaviors by Broyles et al. (2011) concluded that this study’s results are not generalizable beyond the population in this case study. Career and technical education pre-service teachers (27) were selected randomly and placed in 14 teaching teams. Teams were provided with a pre-written lesson, videotaped after being taught, and prompted to reflect upon teaching. Seven groups were assigned to an experimental group. This group’s experience created greater cognitive load while seven in the control group were given less cognitive load. Participants used a focus group in the second round of teaching. Researchers “concluded that higher cognitive load impacted the depth of reflection and transfer of specific teaching behaviors” (Broyles et al., 2011, p. 49).

Pre-service teachers acknowledged change in their behavior due to their participation in this reflective experience” (Broyles et al., 2011, p. 49). It was calculated that a greater cognitive load impacted the reflection of pre-service teachers. Higher cognitive load impacted critical thinking skills that these experiences were designed to create. Cognitive load has a role in reflective experiences due to task factors that come into play. Task factors such as environment, initial peer teaching, receiving a grade, video recording, and lack of preparation played a role on each teacher’s cognitive load.

Choi et al. (2014) discuss and debate that the learning environment, and the application of the effects on cognitive load, can be considered as an influence on instruction effectiveness. Choi et al. (2014) explained that collective working memory effect happens if a person has reduced cognitive load and develops greater learning outcomes using collaborative work. Working collaboratively or individually could be a deviation of the physical environment. A group of learners can be considered a collection of working memories, allowing them to benefit by sharing working memory load and function better on difficult cognitive tasks than working individually (Choi, et al., 2014). This could be a benefit in teaching participants higher level syntax commands and influence instructional design.

The Internet has introduced an exceptional amount of data for students as well as provide an index of information (Yin et al., 2013). However, students are still faced with a complicated search process when they first began research using web-based searching engines and techniques. Google is reported to be the most used search engine across the globe with most students indicating they utilize Google (Data Center Knowledge, 2017). Do these students know to use syntax commands, or operators, to get better results and thus gain a better learning experience? Google like other search engines has a wide array of powerful operators that employ syntax commands to provide a more controlled result list as shown in Table 1. These operators demonstrate the complexity of available operators, but the commands create issues for the user. These issues are explored in two theories: Information Seeking Theory and CLT (Sweller, 1988; Wilson, 1981), which are both included under cognitivist theory. Considering how a student had taken advantage of tools while using common searching techniques, a researcher should consider both theories. It has been established that students prefer to use GUI solutions or enhanced syntax commands (Blanton, 2017). The researcher will first discuss information seeking theory and CLT will follow subsequently.

In CLT, the acquisition of schemas is the instructional goal, and the theory is practical for any instructional task. Kalyuga and Singh (2015) comment:

> intrinsic (productive) and extraneous (unproductive) types of cognitive load were defined based on the relevance (or irrelevance) of the corresponding cognitive processes that impose the load to achieving this universal instructional goal. The instructional methods

advocated by this theory are aimed at enhancing the acquisition of domain-specific schemas (Kalyuga & Singh, 2015, p. 831).

The paper considers a specific goal in the possible specific goals of various learner participants and possibly the cause and effect of complex learning (Likourezos & Kalyuga, 2016). This limits CLT's boundaries, the inferences for different types of cognitive load, the arrangement of differing goals, the allotment of the role of learner expertise, the use of instructional tasks, and the utilization of alternative aspects of complex learning (Kalyuga & Singh, 2015). This allows for leaving strict exact instruction versus lesser managing classification and replacing it with a flexible method premised on learner events' specific goals in complex learning. It allows for the reconciliation of opposing results based on the effectiveness of worked examples in CLT and studies in the frameworks of productive failure and invention learning, demonstrating guided tasks provided prior to explicit instruction could benefit novice learners (Kalyuga & Singh, 2015).

Indexing

Pitol and Groote (2014) consider if Google Scholar (GS) for students and researchers inspires investigation for its influence on citation patterns, freedom of information, and scholarly communication. Pitol and Groote (2014) examine and analyze GS indexes' versions, correlations between the number of GS versions and citation counts, and the value of institutional repositories for increasing scholarly impact. Examination of 982 articles in multiple subjects involving three universities was considered for GS types and this included institutional repository versions, citation rates, and free full text availability. Open access articles were cited more than those available in free full text. Journal publisher web sites were indexed most, but only a small number of those articles were available as free full text. There is no evidence of a correlation between an article and how often it has been cited. About 70% of articles had one free full-text version available.

Researchers are studying these issues, but the focus is usually instructional design (Savolainen, 2016). For example, Savolainen (2016) discussed the systematic identification of useful databases such as LIS Abstracts, EBSCO, and Google Scholar. While on the surface, this looks helpful, it does not consider using syntax command operators provided by Google and currently available others. The goal of a paper by Cummings (2013) conducted a study of indexing open-access journal's commercial databases to explore journals being indexed. This study showed significant differences in the rate of indexing OA journals by different databases. It demonstrated inconsistencies in indexing which impacted the quality of results. Cummings (2013) used public databases created by database publishers. He found a small percentage of these journals were indexed by the full-text aggregators studied. The average for OA journals included in JCR was 34.49%. The averaged for all OA journals indexed being studied was 41.2%. This is indicative of large differences in the rate of indexing by differing databases. Considering the degree of access to scholarly research today, the importance of tools allowing researchers to locate relevant information is important to probable success. This allows researchers to locate and review what is relevant to them. Cummings (2013) commented that "if creating an environment where open access research literature is more findable by researchers than it is at present then tools other than traditional abstracting and indexing tools are necessary" (Cummings, 2013, p. 177).

Francis and Greenway (2015) provide a methodology to create an index using Microsoft Word. Although it has the potential benefit for a hobbyist, it has little value for serious researchers as such a process misses 90% of the content a computer search would index.

Typically, a book's computer index is about 10 times the size of a human-created index. The computer indexing of a typical textbook of 800 pages needed less than 10 seconds. Although Francis and Greenway (2015) do not discuss common computer indexing, one might argue that they should tell the reader the contrast in terms of effort and results between the varying approaches. Typical search times for a computer index are less than a second. This is faster than turning to the index section, and they are turning back to the identified page the following article defends manual indexing.

Golub et al. (2015) claimed that tools can replace manual subject indexing but indicated that scientific performance in operating information environments is elusive. Golub et al. (2015) believed a major contributing reason is that research conducted in laboratories removes the complexities of real-life systems. The article considered issues with existing evaluation methods, such as relevance assessments. This indicated a requirement for more than a single "gold standard" process if considering indexing and retrieval. Golub et al. (2015) proposed a comprehensive evaluation framework. Tools used for automatic subject assignment consider scale and sustainability to improve metadata, which builds connections between resources and improves consistency. Software sources and researchers claim that they can replace manual subject indexing; establishing hard scientific evidence in operating information environments is hard to find because it excludes real systems' realities. Golub et al. (2015) discussed relevance issues with present approaches and commented that "more serious scholarship needs to be devoted to evaluation to further our understanding of the value of automated subject assignment tools and to enable us to provide a fully informed input for their development and enhancement" (p. 11). It is anticipated that additional research is necessary for experimental designs using subject indexing and retrieval as well as content interaction in general.

The purpose of Johnson and Simonsen's (2015) research study was to determine if engineering masters' level students use library-provided indexing and abstracting, and to what extent, and manner. 50% used Google Scholar to locate the last scholarly article used. Engineering masters' students evaluated the costs of obtaining information and may "satisfice." Students showed an interest in improving their skills and strategies to locate pertinent electronic information. Johnson and Simonsen (2015) used a mixed methodology approach to study electronic information-seeking patterns of engineering master's students at New Mexico State University. They selected a Web-based survey, usage statistics, and a focus group for their design approach ad and compared five library-provided A&I services. They suggested that students became more aware of Google Scholar and how to set its preferences. Google Scholar takes advantage of higher order syntax command operators, and it appeared there was no attempt to make students aware of this Google search feature. Johnson and Simonsen (2015) suggest that an "Application Programming Interface (API) could be set up to deliver a message that if they liked this article, they may follow a link to view a short video tutorial, and this explains how to find more or similar articles using the database directly (p. 50). This study is one of the few suggesting that improved search skills are needed.

Lin et al. (2017) considered that CLT convenience might be contrary to one's interest for learning as it minimizes the effort needed in task learning. Lin et al. (2017) explored this aspect in a study covering the impact of spelling features on finding and correcting misspelled words. These were studied by contrasting English as some second language participants performances on the finding and correcting the identified word across four conditions: control, dictionary, red underline, and spell-check (drop-down list). Durability and transferability were examined as well. Results demonstrated spelling aid features and improved error-detection skills if errors were provided in a different context "(transferability) or in a delayed post-test (durability)" (Lin et al., 2017, p. 1501). Effort used to search for correct words provides improved incidental spelling learning. Suitability and effort needed to be cognitive factors impacting spelling learning in the design of computer-based spell checkers. These cognitive load burdens are like student burdens imposed by searching requirements. Sweller commented, "One of the major findings (in fact, the very first finding) of CLT is those requiring learners to search for information imposes a very heavy, extraneous cognitive load. The search process overloads working memory with processes that are extraneous to learning" (personal communication, November 25, 2013). Georgas (2013) made no mention of cognitive load as a burden for students, and Paas (2015) is a cognitive load scholar with many scholarly articles.

Search Engines

Search engine retrieval effectiveness research is commonly small scale, using limited query samples (Lewandowski, 2015). Lewandowski (2015) provided insight to a comparison of search engines as which performs best if only considering the first ten results. Google was the clear victor in this study. Uniquely among all the articles, Lewandowski (2015) had an automatic method of rewarding participants answering his survey form, and they received an Amazon prepaid card for their participation. In this research, there was no effort to use syntax commands to better filter results. Rather, Lewandowski (2015) decided to utilize a random sample of 1,000 informational and 1,000 navigational queries using a significant German search engine contrasting this with Google's and Bing's sample results. Participants were crowdsourced, and data was analyzed by commercial software called the Relevance Assessment Tool. Lewandowski (2015) could make a fully automatic analytical procedure. Data collection was also automatic to avoid human bias. However, due to the improved sample size, the validity of the study was greater. The Relevance Assessment Tool and the crowdsourcing approach allowed a larger study than previously accomplished. Using this approach allows researchers to improve validity through larger studies and provides query sampling. This is like those researching massive open online courses (MOOCs). Lewandowski (2015) commented that “we argue that Google’s superiority as perceived by the search engine users can (at least in part) be explained by its performance on navigational queries” (p. 1772).

A common theme in Georga’s (2014) three research articles was that “the undergraduates in this study believed themselves to be skilled researchers, but their search queries and behaviors did not support this belief” (p. 503). Sweller (2016) considered working memory as an issue and referred to research by Meinz and Hambrick (2010) wherein deliberate practice is required but does not provide sufficient evidence to comprehend individual differences in piano sight-reading skill. A major part of the divergence between an excellent and less skilled pianist was caused by variations in working memory. The size of the deviation needed by working memory variations was determined by the size of the variations in knowledge held in long-term memory (Sweller, 2016b). These considerations could apply to students and searching.

While students believed they are skilled, the nature of searching today is ubiquitous, and those with computers, pads, and cell phones are likely to be users of searching skills. Georgas (2014), believes that Google has a prominent place is a student’s set of tools for doing research and comes back to that discussion frequently. Georgas (2014) revealed a personal conviction on this issue that “college students must recognize that the “search” process may work differently in a library tool-be it a discovery search tool, a federated search tool, or a single database-and they must learn to adjust accordingly” (p. 504). Skill is perceived by Sweller (2016) to be comparable to learning to play the piano. Since searching is a skill, the comparison would hold. David

Goldman (2016), a music scholar, commented on the Chinese and classical music:

> In 2008, only 3.1 per cent of Americans reported playing classical music in the preceding 12 months. By contrast, there are about 35 million piano students in China. In 2012 China produced or imported more than 400,000 pianos, not counting digital pianos, which are an adequate substitute for elementary students. (p. 3)

It is an established fact that a Chinese college level student will do well in their studies within United States schools. Campitelli and Gobet (2011), as to chess, estimated at least 3,000 hours of total practice is required to achieve a master level (Campitelli & Gobet, 2011). Campitelli and Gobet (2011) provided a “given the amount of data on chess skill. We are confident in concluding that abundant deliberate practice is a necessary but not sufficient condition to achieve high levels of skill in chess and probably in other intellectual domains” (p. 284).

Searching as discussed by Georgas (2013) does not reflect the use of syntax command operators. These syntax command operators, as shown in Table 1, demonstrate the complexity of some operators’ available and share some of the same working memory issues discussed by Sweller. Although students would not be required to engage in the same deliberate practice as a competent piano player or a skilled chess player, a student had to expect to do some deliberate practice. The scope of this would include an introduction to the benefits and the burden of developing the skill set by applying these learning tools. Librarians are concerned about a student’s inability to discipline themselves to achieve better search results. Google has taken on a love and hate relationship for some librarians. They saw how powerful it is, but it encroaches on the traditional way to research done pre-Google (Georgas, 2014). Both Google and Google Scholar confront librarians. Antell et al. (2013) discussed Google Scholar:

> One major advantage of Google Scholar compared with traditional A&I products is that, in the age of open access, Google Scholar is far better at covering institutional repositories-not only in terms of identifying content, but more importantly, in facilitating access to free full text. Google Scholar offers free full text availability indicators when it retrieves items from institutional repositories. (p. 280)

A major benefit of the Google spectrum is speed (Antell et al., 2013). Speed is important as users will abandon a search that is longer than the expectation of the user. Chen (2010) discussed Google and Google Scholar as federated search engines (Chen, 2010). They reduce a library's requirement for federated search engines. Libraries' federated search engines cannot compete with Google and Google Scholar due to its convenience, ease of use, simplicity, and speed.

Devices Used by Students

A study by Fokides and Atsikpasi (2016) provides results from the initiative Emerging Technologies in Education. Fokides and Atsikpasi (2016) analyzed learning outcomes using tablets as a content delivery method for teaching organs, photosynthesis, plants' parts, reproduction types, and respiration. Tablets are an important issue as they do not have a keyboard or mouse. They rely on a TUI versus the classical GUI. The quantitative research project lasted four months, and it involved 246 sixth-grade school students divided into three groups. The first group was taught using a textbook and notes, and the next group used a contemporary method without the instruction being technologically improved. The final group used the provided app. The method in this study involved the use of questionnaires and evaluation sheets. Findings showed that participants in the third group performed better than participants in the other two groups. There is a requirement for more research in the educational uses of tablets and their applications. Fokides and Atsikpasi (2016) commented that “taking all limitations into consideration and in conclusion, the experimental data that were obtained reinforced our view that tablets had a positive impact on learning/teaching” (Fokides & Atsikpasi, 2016, p. 2599). Tablets, as they are today, fail to have high level search abilities. They also do not have any GUI factor, but they had TUI. It is possible that voice activated search abilities may offer differing possibilities.

Montrieux et al. (2017) conducted a quasi-experimental study in secondary education to evaluate the teachers while implementing tablet devices in science education. Search functions are not native to pads as they can do web-based searches such as Google. Therefore, this research was not instructional to searching. However, the consideration of searching is a key factor in doing research to provide students the opportunity became more skilled at this key learning tool.

Three classroom scripts led students and teachers during an intervention on two social planes are compared (Montrieux et al., 2017). Student achievement, experiences guiding the role of the instructor, and students’ perceptions regarding tablet learning (iPads) in three conditions were researched. Three different situations were implemented that included (a) a classroom script using learning activities balanced between the group and the classroom level, (b) learning activities occurring mainly at the group level, and (c) classroom scripts as a control condition whereby learning activities were only at the classroom level using a tablet in a conventional way such as a “book behind glass.”

Findings revealed that students performed better on domain-specific knowledge if the teacher intervened on the classroom level (Montrieux et al., 2017). They also performed more efficiently when learning activities were divided between the group and classroom level. Students who visualized more structure found more success. Results confirmed the value of instructors in technology-enhanced learning and indicated the role of the teacher is important in technology-enhanced learning. Moreover, findings suggest that one of the best apps remains to be the teacher. There were no syntax command operators or GUI functions utilized in this environment. This is pertinent as it reflects TUI may be a potential replacement to a GUI interface.

Daesang et al. (2013) provided a study designed to observe how students are thinking about learning experiences with mobile devices and how students' perceptions in the use of mobile devices influenced their personalized learning experience outside the classroom. The number of participants was small ($N = 53$), so their considerations may not be generalizable to all mobile learners. Another limitation was the use of small devices as smaller screens on smartphones often demonstrate technical limitations because small devices do not consider searching skills. Daesang et al.., (2013) commented that "although many educators and teachers already use technology in class, they should consider modifying existing class activities to make them more practical and meaningful for language learning when using mobile technologies" (p. 64). Mobile technologies can create new learning experiences. In these experiences, it appears that students are more likely to engage in learning activities outside of class, and this provides students with better learning opportunities within their communities. Technology Adopter Category Index (TACI) scores lowered significantly after engaging in these activities, which suggests that the use of mobile technologies opens new learning venues. Based on the findings, the students reported that they were more willing to use these innovative technologies in their own environments for English instruction. Daesang et al. (2013) stated that "furthermore, the t-test results indicated statistically significant changes in their views toward mobile technology" (p. 64). While changes in views do not necessarily result in immediate changes in behavior, this experience had given the participants the impetus to adopt mobile technologies more fully in the classroom.

Attrition

Attrition is a serious problem in online learning, as the dropout rate is more than twice that of traditional forms of learning (Tyler-Smith, 2006). Learning the relationship between emotional intelligence and online learning could explain the attrition rate of learners in online programs. Available research considers that adult online learners' attrition is impacted by sociological, psychological, technical and cognitive factors, which are important aspects in the concepts of cognitive load and locus of control. First-time eLearners frequently experience cognitive overload in the early stages of an online course. It is thought this is a probable reason for high dropout rates, especially for those withdrawing early in the first few weeks of the initial start of a course. Learning to search is one of first steps new students can expect and poor searching skills is associated with a negative impact on grades.

Motivation

Kim and Frick's (2011) publications on CLT support that cognitive overload can negatively impact a students' motivation to learn by inhibiting their attention to the instructional material. The additional requirement to learn syntax commands contributes to this problem and reduces motivation. Students worked at their own rate in online classes, and thus cognitive demands can be adjusted to reduce the probability of cognitive overload (Tyler-Smith, 2006). Hallam (2015) commented that "Payne (2015) suggested the following research-based strategies for student achievement to: (a) develop self-regulation skills, (b) increase and maintain motivation, and (c) decrease cognitive load" (p. 41).

Hsin et al. (2016) conducted a qualitative multiple-case study conducted interviews and compared strategies by three groups: less-experienced doctoral students, experienced doctoral students, and junior faculty members. Hsin et al. (2016) used 15 students for this study that included common searching strategies to locate information to fulfill their research purposes. Many strategies overlap and are complementary. There were a lot of common issues with my intended research paper.

Although they used a good group in terms of differences, there was no effort to teach learning skills regarding searching (Hsin et al., 2016). This was a well-structured case study that sought to improve searching skills and noted for differences among less-experienced doctoral students, experienced doctoral students, and junior faculty. Although this case study took place in China, the results between first year students and faculty are often the same. The results of this type of research often occur in this venue illustrating it is a universal issue that instructors are often as technology skilled as new students and make no efforts to remediate the problem.

Persistence

Those not influenced by external factors often pursue goals better than those that view performance is dictated by external events outside of their control (Wang & Shah, 2017). These often include technical issues with computer systems, work issues, family requirements, and competition for other activities. Tyler-Smith (2006) quotes Bernard et al. (2004), stating individuals should consider “readiness for online learning” as being critical in determining a learner’s persistence (Tyler-Smith, 2006, p. 4).

People face boundaries and difficulties leading to failures in information seeking experiences (Wang & Shah, 2017). These are frequently caused either by the information collector or the chosen methodology. The study investigated how individuals failed to fulfill their information requirements in varying situations. It considered the limitations of previous studies in the review of the set of facts, the searcher's strategy, and the attempts to comprehend searchers' barriers and failures better. A qualitative survey was used, with 63 participants being provided 208 actual life examples of information searching failures. Semi-structured interviews (10) were utilized with other participants to evaluate the survey findings further. Barriers, strategies, and tasks revealed a wide spectrum of both internal and external factors led to failures. These impacted various aspects of searchers' goals and strategies. Participants' information requirements were frequently too contextual as well as specific to be satisfied by the data content retrieved, and time constraints intensified the problem. This highlights the significance of evaluating information searching episodes where students fail to satisfy their requirements in a holistic method by analyzing their needs, strategies, and barriers.

Factors influencing participants' needs and information seeking strategies (ISSs) are convenience (Connaway et al., 2011), familiarity with information sources, task complexity, and temporal factors (Savolainen, 2006). Tasks that required decisions and tasks people performed for the first time presented significant challenges. Difficult tasks led to lack of awareness of probable useful sources as "participants frequently reported using Google as the only channel for information" (Wang & Shah, 2017, p. 455-456). This pattern was also noted by Georgas (2013; 2014) in her articles.

Efforts to Prove Measurement of Cognitive Load

Kalyuga and Liu (2015) commented on some of the difficulties in the measurement of cognitive load. "The beast of aggregating cognitive load measures in technology-based learning" by Leppink and van Merrienboer (2015) concerns the measurement of performance and cognitive load in technology-based learning environments when repeated measurements are taken two or more times on the same variables. They argue that the common practice of aggregating scores into a single average score per participant for the subsequent analysis could result in a distorted view of observed effects and miss some potentially important relations of interest. The paper suggests alternative statistical approaches to better account for essential features of the data. It thus contributes to the critical issue of the adequate measurement of cognitive load and learner performance outcomes (Kalyuga & Liu, 2015).

Efforts to Design Curriculum to Reduce Cognitive Load

Reducing interacting elements involved in extraneous cognitive load will limit working memory load to controlled portions (Chen et al., 2017). If element interactivity due to intrinsic cognitive load is significant, it seemed plausible that lowering element interactivity could be critical. Sweller (2010) commented that “if intrinsic cognitive load is low, reducing extraneous cognitive load may had little effect because the total cognitive load due to element interactivity may be less than working memory capacity” (p. 134).

De Jong (2009) discussed efforts to reduce cognitive load in curriculum designation using lowering extraneous load in these cases to remove the affordances for germane processes. Paas et al. (2004) provided an example of this: “In some learning environments, the extraneous load can be inextricably bound with germane load (pp. 3–4). Consequently, the goal to reduce extraneous load and increase germane load may pose problems for instructional designers” (de Jong, 2009, p. 108).

There are researchers exploring better ways to search, but there are no breakthrough results (Yin et al., 2013). Some were tested, however, the methods for supporting research surveys are inefficient and similar issues impacted efforts. Other researchers had indicated the inability of junior faculty to utilize higher level search techniques. It was suggested that the junior faculty develop better technical skills to search for full texts and manage their data (Hsin et al., 2016). This is an important issue if the instructors are not skilled, then how can they instruct students. Although younger people learn new technologies easily, it is not a reason for instructors to ignore new technology.

Methods to Reduce Cognitive Load

An experimental quantitative study was conducted by researching instructional guidance to students while in the learning phase before students' engagement and the transfer problem-solving skills (Likourezos & Kalyuga, 2016). Likourezos and Kalyuga (2016) reviewed aspects of CLT and stated that worked examples are an effective instructional strategy for new students, as it reduces cognitive load and provides cognitive resources to deliver task competence. The study reviewed the effectiveness of divergent instructional guidance during the learning phase before detailed instruction in solution processes for the enhancement of student involvement and their problem-solving skills (Likourezos & Kalyuga, 2016). A traditional view of CLT is that novices benefited from explicitly guided instruction. Alternative problem-solving-first frameworks showed less-guided problem-solving in the first phase before exact instruction in the next phase might produce more lasting outcomes than exact instruction applied in both these phases. There is no apparent contradiction between "cognitive load theory and productive failure approaches," as they deal with different sets of goals. Results indicated that both approaches achieved similar overall outcomes, thus representing two alternative pathways to acquiring durable and transferable knowledge from complex learning tasks" (Likourezos & Kalyuga, 2016, p. 217).

Leppink et al. (2014) discussed whether a recently developed psychometric instrument can differentiate among intrinsic, extraneous, and germane cognitive load. The findings support a "reconceptualization of germane cognitive load as referring to the actual working memory resources devoted to dealing with intrinsic cognitive load" (p. 32). There are many measuring possibilities being developed providing a promising breakthrough in a field that had little hope of such an event. Sweller, in personal communications, commented:

> There are basically 3 ways of measuring cognitive load: physiological measures; secondary task measures; and subjective ratings. Physiological measures are the holy grail but still seemed to lack sufficient sensitivity to be useful and require equipment and are intrusive. Secondary task measures are very useful but usually require equipment and so are difficult to use in regular classrooms. Subjective ratings are still the most usable method and are still being developed. (personal communication, February 19, 2017).

Sweller (personal communication, February 19, 2017) in written communication indicated a qualitative research study was best as the measurement of cognitive load is difficult and not able to be done in a quantitative manner effectively. Additionally, this was confirmed in a paper by Hodson (2016). Hodson (2016) concluded after an exhaustive study that Sweller was correct in his assertion. There were many possible methods, but results were inconclusive (Hodson, 2016). If a significant researcher agrees that the measurement is inconclusive, this creates a need for further research to understand why students avoid using available research tools that could potentially increase learning skills.

Chunking is a way of reducing intrinsic load by carefully segmenting complex content into fewer interacting elements of information, with a manageable chunk generally considered to consist of not more than about four elements (Mostyn, 2012). Chunking requires something that is not often done: a careful identification of all the interacting elements of a topic, so that they can be separated and sequenced. Mostyn (2012) commented on chunking indicated that once targets had been evaluated intrinsic load can be optimized by applying the chunking principle. For written and visual material, this allows the reader to maintain a reduced number of interacting elements in working memory for each part of the schema acquisition (p. 235).

Recently, Hadie and Yusoff (2016) performed a research project using a cognitive load scale finding Cronbach's to be 0.7 showing a high level of internal consistency. All the items attained a standardized factor loading of more than 0.5, which indicated high contributions to their respective scales. This provides a recent case of optimism towards the measurement of cognitive load.

Abdul-Rahman and Boulay (2014) utilized a quantitative analysis, which discussed the effects of the learning phase and the transfer phase, medium effect sizes, also considered a learning style may have influenced cognitive load. This is a fundamental factor in understanding contrasting learning styles. Schemata were investigated in changes to each learners' cognitive load, which took both learning strategies and learning styles into account. However, results were inconsistent. There were significant differences in cognitive load, but it seemed possible that a learning style may have influenced cognitive load. No significant variation was seen in success during the post-test. This effort was predicated on the research of educational literature combined with worked-example research in CLT. This was built on research in the areas of learning styles, the psychology of programming, especially within the education literature, and from the worked-example research in CLT. It reflected the limits of the research while providing an agenda for the future. Therefore, the research did not provide a clear answer which is consistent with other efforts.

A study investigating working memory and instructional strategy choices affecting learners' complex cognitive task performance in online environments researched if cognitive differences caused various results if instructional design is the same for all (Cevik & Altun, 2016). Cevik and Altun (2016) used n-back task scores for defining working memory analysis. This was a quantitative study using 35 undergraduate students completing complex cognitive tasks three times. Students were assigned randomly to experimental situations by counterbalancing. Results indicated there were no differences in complex tasks using the same instructional strategies. There were statistically measurable changes in working memory groups for those with high working memory performances. Results indicated that cognitive differences resulted in various outcomes if the type of instructional design remained uniform. Cevik and Altun (2016) concluded that instructional design alternatives could consider individual cognitive differences when developing adaptive e-learning environments.

Chen et al. (2017) discussed the recent growth of MOOC development and considers instructional design principles possible to structure online learning. This would set a base line for instructional design if using computer-based learning. MOOC use is challenging because the entrenched systems educators are unfamiliar with presenting new opportunities. The manner in which their concept of a developing a base line is interesting. This implies that with the advent of MOOC and its large number of redundant events occurring, there is the possibility of easier analysis because there are more data points and sets of data. Chen et al. (2017) believed these courses had little respect for human cognitive design and instructional design principles. They propose CLT is well placed to provide instructional design principles for computer-based learning including MOOCs. Chen et al. (2017) endorses instructional design concepts that could be implemented to structure a suitable foundation for computer-based learning. While guidelines so far are not applied to MOOC development, they are relevant and capable of being applied in MOOC learning environments. CLT provides an opportunity to be used in the design of MOOCs construction of effective learning systems. The lack of research is due to MOOCs' rapid adoption, but this provides a fertile possibility for future research. CLT might explain some of the failures in the MOOC development such as learners failing to complete courses. Chen et al. (2017) comment "expect such cognitive load theory-based systems to be superior to systems that do not use the recommendations of the theory" (p. 303).

Reduce Cognitive Load Using Advanced Searches

An effective way to reduce cognitive load is teaching students how to use syntax command operators that yield better results. There are many examples of this but one would be using Google's proximity search command. Proximity searching is a way to search for two or more words that occur within a certain number of words from each other. The proximity operators are composed of a letter ("N" or "W") and a number (to specify the number of words). The number cannot exceed 255. The proximity operator is placed between the words that are to be searched, as follows: Near Operator (N) and N5 finds the words if they are within five words of one another, regardless of the order in which they appear. For example, type tax N5 reform to find results that would match tax reform as well as reform of income tax. The search findings would also include other phrases where "tax" and "reform" are within 5 words of each other. A Within Operator (W) defined as W8 finds the words if they are within eight words of one another, in the order in which you entered them. For example, type tax W8 reform to find results that would match tax reform, but the results would not match reform of income tax (EBSCO Information Services, 2016). For example, a Google proximity search Sherman around (10) Savannah Campaign reflecting General Sherman's march to the sea would result in 541,000 results; whereas, the same search using Sherman AND Savannah Campaign provide 958,000 results. The proximity results are more germane to the researcher.

Philippe et al. (2016) considered a model manual submarine steering and its impact on helmsman performance and mental workload. Activity considered (a) cognitive requirements, by labeling different aspects of control, and (b) perceptual--motor requirements, by reviewing directional compatibility of control--display design. A simulator was used. The demonstration used two driving situations with different levels of cognitive requirements involving approach and stabilization phases. Two groups were used to implement a "perceptual--motor task on a specific steering control--display configuration proposed by the naval shipbuilder, one with a standard numeric display, and one with a new visual--spatial representation, both tasks controlled by the same joystick" (Philippe et al., 2016). Findings indicated that cognitive requirements in the stabilization phase using a high propulsion speed created more mental workload, and the motor requirements also produced a heightened mental workload if a direction-of-motion stereotype was violated (upward--forward relationship). Philippe et al. (2016) believed that it is important to review the control–display configuration B design, to comply with the direction-of-motion stereotypes. Fundamentals in this research had elements that are in the researcher's scope. It appears that the view of the helmsman is important, and that played to the researcher of this paper's concept that a reduction in steps might reduce cognitive load.

Instructional Design

Hadie and Yusoff (2016) conducted a multisite case study to research digital instructional strategies instructors use to improve and modify learning to conform with learning research. This case study researched the benefits for teachers and students of the integration of technology into learning. Hadie and Yusoff (2016) used interviews, focus groups, and observations in seven exceptional schools in North America. The case study also considered familiarity, use, and comfort with technology. The case documented six strategies used with the seven sites and the five roles technology develops while improving teaching and learning.

The case assessed how these concepts may benefit teachers and learners (Ruzic et al., 2016). Researchers had developed studies regarding how instructors use technology to improve or transform student learning. These studies are mostly qualitative case study designs with observations and interviews. Leveraging the taxonomy developed from this study, the field is ready for quantitative study designs using larger sample sizes and measures of instructional design inputs. Hadie and Yusoff (2016) commented that “A technology use taxonomy such as ours can be used to measure teaching strategies, which can then be correlated with outcomes we care about, including changes in teaching practices and student learning (p. 211). A properly designed effort can add to which technology strategies provide the best possible student learning. A successful digital conversion for classrooms is not determined by the technology, but by how technology enables teaching and learning.

Sweller (1994) indicated that human cognitive architecture includes a limited working, or short-term, memory. CLT was first utilized to investigate and evaluate the instructional techniques used by educational professionals for students (Sweller, 1988). Humans possess a limited cognitive capacity, which meant that there is a limit on the amount of information that can be processed at a time (Sweller, 1994). Schema acquisition and automation are the fundamental mechanisms of learning about intellectual activities. Schemas allow for the organization of information including newly presented information that can be categorized with existing information that is already present and congruent. Schemas explain all the knowledge and intellectual skills that an individual has, and they allow an individual to store information in memory chunks, which increases storage capacity. Schema acquisition and automation seeks to alleviate or mediate the restrictions placed on an individual's intellectual capacity through working memory. Human cognitive architecture includes a limited working, or short-term, memory. Sweller (1988) first utilized CLT to investigate and evaluate instructional techniques used by education professionals for students. This pertains to education because humans possess a limited cognitive capacity, which meant that there is a limit on the amount of information that can be processed at a time. Sweller (1988) sparked the imaginations of scholars with his thoughts. What caused cognitive overload? How might it be better managed. Can instructional design solve the problem? As a researcher, my interest is whether technology can reduce cognitive load, and that is what my research is focused on.

Taxonomy, Indexing, and Searching

Effective indexing captures and makes available the concepts present in a publication (Vasicek, 2014). Words provide windows into concepts. Proximity rules provide access to context. Concepts can usually be defined using several different sets of words. Therefore, it is insufficient to simply detect words when indexing a document. There is a requirement to detect concepts that bind together different sets of words. When used in this context, the word taxonomy usually refers to a collection of definitions and rules for detecting the concepts defined by the definitions. Since concepts are often embedded within a set of relationships, a taxonomy often includes a way of encoding these relationships. Therefore, each concept can be a node embedded within a graph of other nodes. There is software based on these ideas. Such software provides syntax for encoding proximity requirements like “within 3 words”, “in the same sentence”, “within 50 words”, and “in the same document” for example. Software can add in line concept tags so that a user is provided with a link to the precise location of the indexed concept in the indexed text (D. Vasicek, Personal communication, May 2, 2018).

Search engines are not categorized into a specific research area; thus, it is difficult to address the unique needs of any one learner (Yin et al., 2013). There is a requirement to design better search engines that solve users' learning needs and knowledge levels. Such a search engine would not only provide the retrieval results, but an analysis. Technologies often accelerate learning as well as increase creativity. With technologies like data-processing, it is probable to design improved search engines to improve learning needs. Data-processing needs include search engines, data mining, and recommendations.

Reflection

Cognitive load is well discussed by scholars in general (Sweller, 1988). The focus of this study has remarkably little attention. The purpose of this study is to establish cognitive load reduction to where it can be examined allowing new ideas that will allow the researcher and others to study the possibility of improving learning and grades. Instructional design is the most common theme in most articles as research scholars are looking for a solution. It is always possible that insightful lay people may provide added answers and should not be overlooked in the quest to better students' performance and others. Also, it seemed plausible that not only students, but instructors will improve performance if students are having more success. Professional level research will go a long way to close the gap in the literature.

Madrigal (2011) a technology writer for *The Atlantic* magazine, commented:

> I talked with Dan Russell, a search anthropologist at Google, about the time he spends with random people studying how they search for text content. One statistic blew my mind. 90% of people in their studies don't know how to use CTRL/Command+F to find a word in a document or web page! I probably use that trick 20 times per day and yet the clear majority of people don't use it at all. (p. 1)

This declaration did not surprise me as I did informal questioning with others and realized how limited the skills in this environment were. This led to me to another article that used the same discussion. Neither *The Atlantic* magazine nor the *Sydney Morning Herald* were academic sources, but they were quoting Russell of Google notoriety that is an academic scholar that has authored papers with other scholars. I contacted Russell at his office at Google and he confirmed the two articles with the same comments. In 2018, Russell commented,

> I believe that folks tend to not learn advanced syntax, not because of the cognitive costs, but because they don't perceive the benefit. (That is, they don't see the value of learning advanced operators.) It's definitely a related issue, though. (personal communication, January 5, 2018)

I subscribe to Sweller's remark mentioned earlier:

> One of the major findings (in fact, the very first finding) of CLT is that requiring learners to search for information imposes a very heavy, extraneous cognitive load. The search process overloads working memory with processes that are extraneous to learning. If your technology works properly it is likely to be invaluable and very widely used. (personal communication, November 25, 2013)

Russell was not aware of the tool mentioned by Sweller. Russell has indicated that he will provide the Google survey mentioned by Kwek (2011) and Madrigal (2011). This survey should provide insight into the universal limited skill sets that people used as basic as Ctrl + F versus arrays of higher-level syntax search command operators like those provided by Google. Google is not the only provider of such syntax operators, but it is the largest search system. Google's survey should provide significant insight and will be provided in the prospectus.

Russell (2016) commented on why SearchResearch skills matter in education, “there’s always been a gap between ...those who know how to use information resources and those who don’t. Students who knew the ways to leverage a library for research could consistently do better research than those who couldn’t” (p. 2). Russell (2016) is a research scientist at Google that works in search quality, with a focus on understanding what makes Google users happy. Another focus of his position is to ensure that users are skilled and competent in their use of web searches.

This is a qualitative change from conventional paper-based libraries. Previously, research was significantly reduced to what you could felt by touch. Currently, it is possible for students to gather information from anywhere in the world. Students are not limited to text documents, but can discover archival images, videos, software code fragments, transcripts of important events, books, and other printed media and audio (Russell, 2016).

Russell (2016) commented that “students who know how to use online resources efficiently and effectively will be able to *massively* [emphasis added] outperform students who don’t” (p. 2). Russell’s (2016) use of the word “massively” deserves attention. He did not say might or other limiting descriptions. It is this shared belief that caused my choice of research.

Why Students Avoid Learning Syntax Search Command Operators

A task is usually defined as objectives to be done, instructions to be completed, or a combination of both (Gill & Hicks, 2006). Lee et al. (2016) stated that “why the term of task difficulty but not task complexity is used to examine the influence on compromise and attraction effect is because complexity may not always produce more difficulty or higher cognitive loading” (p. 395). Task difficulty is described as, difficult to complete due to its complexity, and requires a higher level of skill, or cognitive effort, including more data processing than general tasks (Brinkmann & Gendolla 2008; Reinhard & Dickhauser 2009). Brehm and Self (1989) concluded that disengagement happens if task difficulty is greater than a person's ability (Brinkmann & Gendolla, 2008). If the level of difficulty varied during processing a comparative task on the context of a choice set, does this impact the resultant presence of context effect? Four experiments "demonstrated both compromise and attraction effects decreased when the choice task becomes more difficult" (Lee et al., 2016, p. 392).

Students frequently had complex decisions in educational life (Basu & Savani, 2017). There has been an explosive growth of scholarly information and specialization. This has increased the complexity of all aspects of decision making. Lee et al. (2016) considered these assumptions. Moreover, Busemeyer and Townsend (1993) stated that "for real decisions, a great number of consequences must be considered, and these anticipated consequences are retrieved from a complex associative memory process" (Lee et al., 2016, p. 393). The focus of previous research on attraction and compromise used easy-to-count choice possibilities that are not comparative to that which students are confronted. This past research seldom evidenced complex data content in a choice task. This made it difficult to rely on math skills on comparative attributes. To comprehend how task difficulty impacts people's alternatives may evolve as a critical path to completely complement and understand decision research (Lee et al., 2016).

Today, a student is faced with searches that are not presented in mathematical values but in text strings that do not often give the searcher a sense of contrasting value (Cooper & Sweller, 1987). This is even more extreme if asking the student to use syntax operator commands. Lee et al. (2016) mentioned "cognitive load" without referencing any scholarly source information as to the meaning of the term. However, despite this limitation, they do add to the discussion on student difficulties in the classroom and the difficulty of making choices.

There are other considerations for avoidance to learn these syntax command operators, which had been considered and are reviewed for the reader (Kiamarsi & Abolghassemi, 2014). A quantitative study by Juarez-Collazo et al. (2013) examined the relationships of tool-related characteristics and learner-related characteristics. They used 140 participants (students) that did not possess a statistical difference in prior knowledge. Testing revealed embedded tools aided positively in quantity of tool use, but negatively in quality of tool use. Juarez-Collazo et al. (2013) commented that “there were significant interactions of goal orientation (mastery avoidance) and condition on quality of tool use. Performance approach influenced quality of the tool positively and self-efficacy negatively influenced quantity of tool use” (p. 330). Performance impacted quality of the tool in a positive manner. Self-efficacy negatively influenced the quantity of tool use, and this in turn impacted performance. Results showed embedding tools caused a positive impact on the quantity of tool use, and a negative impact on the quality of tool use. Partial effects of explained tool functionality were found. There were significant interactions of goal orientation (mastery avoidance) and condition on quality of tool use. Performance approach influenced quality of tools positively and it negatively influenced quantity of tool use. Uniquely, only quantity of tool use impacted performance. The results for future research on tool use in computer-based learning environments were discussed. Mastery avoidance, learners that tried to avoid misunderstanding, failing, or making mistakes showed no direct effect on tool use.

Procrastination Is a Serious Problem

“Nothing (is) so fatiguing as the eternal hanging on of an uncompleted task,” said William James in an 1886 letter to fellow psychologist Carl Stumpf (as cited in James & James, 1926, p. 247).

Klassen et al. (2008) commented that procrastination research is a growing research field of interest. Klassen et al. (2008) discovered in the period from 2000 to 2007, “the depression-to-procrastination research ratio was reduced to a factor of 274, with 117 articles published since 2000, in comparison to 38 articles published in the previous 7-year span” (p. 916). Many questions exist regarding why people tend to procrastinate to a point where it became a problem. Klassen et al. (2008) discussed that motivation correlates to procrastination, and there are significant academic costs on undergraduate procrastinators. The problem is also identified by Savithri (2014) as a global problem. It is framed as an attitude to defer specific work or decisions. Savithri (2014) commented that “researchers had projected that over 70% of students display this behavior in academic settings in North America. Many of these students are highly vulnerable to negative consequences such as poor performance, decreased subjective well-being, negative affect and reduced life achievements” (p. 377). A research study by Savithri (2014) discovered a meaningful relationship with performance and procrastination, life satisfaction and procrastination, but no interactive effect was found between procrastination, performance and life satisfaction. Savitri’s (2014) research paper was a quantitative study and deserved review.

Ferrari (2001) discussed how chronic procrastinators demonstrated “that objective self-awareness under high cognitive load and time limitations produce self-regulation failure of performance speed and accuracy” (p. 403). Chronic procrastinators did not suitably regulate performance skills to the right ratio of speed to accuracy when time constraints were imposed. During experiments, chronic procrastinators exhibited inferior performance results and seemed to “choke under pressure” versus “doing well under pressure” (Ferrari, 2001, p. 114).

Ferrari (2001) drew a logical conclusion regarding a link between procrastination and cognitive load. As Sweller in personal communication commented:

> The major findings (in fact, the very first finding) of CLT is that requiring learners to search for information imposes a very heavy, extraneous cognitive load. The search process overloads working memory with processes that are extraneous to learning. If your technology works properly it is likely to be invaluable and very widely used. (personal communication, November 25, 2013)

The complexity of syntax command operators induces cognitive load and this leads to procrastination. It is well documented that high level syntax command operators such as “proximity searches” do a better function than not using them. Procrastination is the result of cognitive load as Ferrari (2001) described.

Low Self-Efficacy in Students

Paul & Glassman (2017) in a paper indicated that reaction and generation at the same moment overwhelm novice students when cognitive overload is great. Sweller et al. (1998) conceived that cognitive overload occurs if a task’s demands require more than the student’s capacity. This suggests intrinsic cognitive load or demands are interrelated with the task’s basic aspect if excluding all the other factors is high (Paul & Glassman, 2017). This would indicate in the example by Paul and Glassman (2017) that students who are new to a procedure might have skills making it difficult to start with adequate self-efficacy levels. There are significant number of quantitative studies such as one by Celik and Yesilyurt (2013) where they tested perceived computer self-efficacy, computer anxiety, and the attitudes toward doing computer supported education variables’ ratios to each other. They concluded that anxiety issues could be related to cognitive load interfering with information processing.

Another quantitative study explored the efficiency of the five most used search engines, i.e., AOL, Ask, Google, Live, and Yahoo, in retrieving internet resources at specific points of time using many complex queries (Deka & Lahkar, 2010). However, there were no human participants. This presents an issue as syntax command operators could have been used to some degree, but this was not the goal of the study.

Larkin and Pines (2005) performed a quantitative study in which the researchers desired to exhibit the efficacy of an information literacy intervention. Criteria included the identifying the needed information for the intervention. They also wanted to know each participant's skill level with computers, software, and databases. This was to retrieve the information, and critically evaluate the information and its sources. All of these issues are significant, but do not address increasing the skill levels of students regarding syntax commands that produce better results. These students were asked questions that gave the researcher more information, but they had little to do with instructional design.

A mixed-methods study analyzed sources of self-efficacy provided by Chinese undergraduate students to evaluate the role of individual variations (Lin et al., 2017). Chinese participants (146 students) processed a questionnaire providing factors contributing to feelings of higher and lower confidence. Lin et al. (2017) analyzed the sources of reported self-efficacy levels and the role of individual differences. After qualitatively coding responses, Lin, et al., (2017) found students shared varied views on the antecedents of causing them to experience more or less confidence. Lin et al. (2017) commented that "quantitative analyses revealed differences in the types and frequencies of sources of self-efficacy when considering increases or decreases in confidence, and individual characteristics such as grade point average, only child status, and fear of failure (p. 361). However, virtually all children in China are only children and I wonder if this measure is germane to the test.

The qualitative results confirmed the four sources of self-efficacy and provided insight into self-efficacy sources if contrasting this study with previous ones (Lin et al., 2017). Some scholars believed collectivistic cultures are “less affected by their previous accomplishments than those in individualistic cultures, and the current study demonstrated that mastery experiences are still the most prevalent source of self-efficacy among Chinese college students” (Lin et al., 2017, p. 382). The study indicated that cultural differences among cultures could accentuate various aspects of the identical source of self-efficacy. Future research should examine concepts distinguishing only children versus children with siblings. Regarding practice, understanding the preceding causes of students’ feelings of increased or decreased confidence may allow educators to set goals to foster student positive self-beliefs. Mastery experiences, proper scaffolding, and targeted assignments for students could improve feelings of mastery and overall efficacy. Focusing on mastery over performance may lessen competitive attitudes, anxiety, and fear of failure. This may guide instructors to support students in their academic journeys and allow for better sensitivity in their socialization which in turn could impact learning.

In a quantitative research study by Huang (2016) regarding the effects of different types of examples on student performance, the researcher examined cognitive load and self-efficacy in a statistical learning task. The study used 116 participants undergoing computer-based instruction in one of the four situations with varying examples. Results indicated expert modeling samples were best in advancing knowledge retention. However, peer modeling samples were superior in developing self-efficacy in these different types of samples.

Vasile et al. (2011) conducted a similar study assessing self-efficacy and cognitive load in students. In this case, the researcher used the Self-Efficacy Scale (SES), but their cognitive load measurement was not supported by Sweller in personal communication:

> There are basically 3 ways of measuring cognitive load: physiological measures; secondary task measures; and subjective ratings. Physiological measures are the holy grail but still seemed to lack sufficient sensitivity to be useful and require equipment and are intrusive. Secondary task measures are very useful but usually require equipment and so are difficult to use in regular classrooms. Subjective ratings are still the most usable method and are still being developed. (Sweller, personal communication, February 19, 2017).

Self-Regulation in Students

In discussing self-regulation, Ferrari (2001) indicated that “overwhelming situational demands other than limited time, such as competing cognitive activities (a cognitive load condition), may prompt some people to engage in self-regulation failure of effective performance” (p. 392). As well as time limitations and cognitive load situations, self-regulation of speed and correctness by habitual procrastinators could be disadvantaged by objective self-awareness. Ferrari (2001) also noted that “chronic procrastinators seemed to demonstrate that objective self-awareness under high cognitive load and time limitations produce self-regulation failure of performance speed and accuracy” (p. 403). If students fail to use syntax command operators, then they had failed self-regulation. Self-regulation might solve the avoidance issue, but there is no indication that this occurred.

Psychological Vulnerability in Students

Kiamarsi and Abolghasemi (2014) did a quantitative research study to determine if a relationship was present among procrastination, self-efficacy, and psychological vulnerability in students. Cognitive vulnerability is an erroneous belief, or a cognitive bias that predisposes an individual to psychological problems. This vulnerability exists before the symptoms of a psychological disorder appear (Kiamarsi & Abolghasemi, 2014). The research demonstrated self-efficacy and procrastination were associated with psychological vulnerability in student participants. Multiple regressions revealed that procrastination and self-efficacy contributed to 40% of the students' psychological vulnerability. These results had significant considerations regarding possible prevention and the advising of students.

The results revealed a significant relationship between self-efficacy and psychological vulnerability (Kiamarsi & Abolghasemi, 2014). Negative self-efficacy is associated with the development of anxiety disorders, depressive symptoms, neurosis, and trait anxiety. Students participants achieving better self-efficacy scores had positive characteristics such as constancy in affect and mood, intimately communications, logical thoughts, responsibly behaviors, sense of dependence and independence, and suitable communication (Kiamarsi & Abolghasemi, 2014). As a result, student participants positively reflected on their capabilities regarding events and possessed a low psychological vulnerability. Karademas (2006) established that self-efficacy leads to optimism. Optimism predicted health and decreased psychological vulnerability.
The psychological vulnerability of students is an issue and is impacted by self-efficacy. Low self-efficacy needs to be isolated from psychological vulnerability regarding student avoidance of syntax command operators as these operators' use improves students' performance. The research might enlighten the researcher as to the cause and effect of avoidance in this case.

Academic Libraries

Since 2008, academic libraries had been analyzing and accepting discovery systems to apply search methodology reflecting user expectations and better access to digital resources (Guajardo et al., 2017). Libraries are pursuing discovery options and those included are open-source tools, a federated search system, and multiple index-based discovery systems. Libraries are seeking better access to digital resources. Google's PageRank algorithm utilized collective digital data intelligence of the Web by utilizing hyperlinks to create relevancy (Dahl, 2009). This system benefitted significantly from the scale of Google's computing power. Google's process got smarter as more customers used it. Google established that a Web-scale effort could succeed at this concept while small- and medium-sized firms could not. As Google was developing its search business, libraries usually failed to note search and focused on organizing an increasing array of full-text resources. Libraries gained access to electronic journals, but it was difficult to discover if a library had a specific journal.

By the mid-2000s, library catalogs were adopting more mainstream e-commerce sites by incorporating external links and improved Web design (Dahl, 2009). School libraries remained weak in search functionality. By 2005, students encountered resources on the Web exclusive of the boundaries of library-managed discovery systems (Dahl, 2009). Students discovered books or articles on Google Scholar and acquired the content using a library's virtual gateway. Like Google, these Web 2.0 sites got improved as more customers used them and aspired to a Web-wide audience.

Dahl (2009) commented:

> In order for library content to be noticed on the Web, it needs to be presented by a global player, not in a diluted fashion from thousands of separately managed library catalogs.

> Unlike local library catalogs, WorldCat.org provides a place to reference a book that is useful for anyone on the Web and maintains relationships with commercial search vendors so that its records will appear in search engine results. Furthermore, it provides a catalog with common conventions for searching and viewing records not unlike Google providing a certain consistency in its interface across the Web. (p. 7)

Network level systems will make it easier to do basic research. More specialized services are expected to increase. Libraries had concentrated most on characteristically published content in common forms. In a global discovery environment, librarians will be working at the extremes. They will be curating physically and digitally what is of interest globally and processing new intellectual content concepts that are unlike the periodical categories (Dahl,2009).

Buck and Mellinger (2011) discussed some of the problems with the discovery tool Summons and used a survey to do as quoted by Guajardo et al. (2017). Serial Solutions' Summon Service "are replacing older federated search technologies as the tool for users to access library resources quickly and easily" (Buck & Mellinger, 2011, p. 159). The survey revealed that librarians had concerns about Summon. Some librarians believed Summon has the potential to influence how librarians instruct digital information literacy skills. Librarians wanted to teach tools that work, which they understand, and that helped students gain valuable information literacy skills. Users wanted tools that are easy and fast. This inherent tension between research tools that are complex but effective and easy tools that may pull up irrelevant results makes it difficult for librarians to accept and then integrate tools like Summon into their instruction (Buck & Mellinger, 2011). For librarians to want to teach this tool, it needs to meet their expectations, not just that of the students.

Most of the concerns by the survey are common to what librarians claimed about federated search tools. The survey found librarians rejected federated search tools in their instruction. These librarians continued to use the catalog and other online databases as provided before (Lampert & Dabbour, 2007; McHale, 2009; Tang et al., 2007). This survey implies Summon is better and more acceptable to librarians than its federated search predecessor (Buck & Mellinger, 2011). This cannot be conclusive as most of the libraries surveyed had Summon for less than a year. Summon is better choice than a federated search because it is quicker, simpler to use, and includes more full text. Students liked Summon, but librarians were not as happy with it and seemed to be more amenable to Summon than they were to federated search tools. Buck and Mellinger (2011) stated “as librarians we’re all very enthusiastic, but always we wish it did just a bit more or a bit differently, so although we are very pleased that we chose it, we’re probably a bit less satisfied than the students” (p. 177).

Most librarians saw Summon as a supplement and instructing it in combination with other instructional tools. The overall feeling of the responding librarians is positive. One librarian involved said, “Summon is the only resource that really seemed to grab some of our students’ attention” (Buck & Mellinger, 2011, p. 178). Summon is the first choice and leads other products. As search behavior change, librarians are needed to consider adjusting to conform to student needs.

Gap in the Literature

Human cognitive architecture is complex, and scientists are starting to understand the capabilities of the human brain (Sweller, 1998). Cognitive architecture links long-term memory and short-term memory and how they relate to learning (Sweller et al., 1998). The human cognitive structure consists of working memory, long-term memory, schemas, and automation. Cognitive load is utilized for the assessment of human cognitive performance in various academic disciplines such as psychology, political science, mathematics, and science (Gwizdka, 2010).

The higher education environment requires significant research and such research is most often done using school libraries or data from the Internet. Sweller, 2013, suggest such research creates a high cognitive load among such students. This was observed by the author of this paper. Sweller (1988) indicated humans possess a limited cognitive load capacity, meaning there is a limit on the amount of information that can be processed at a time. When there is too much incoming information, it can result in stress and greater cognitive load interference. There is a requirement to utilize technology to reduce student stress and cognitive load interference. Informal interviews indicate that students do not know how to use advanced search techniques to reduce cognitive load.

The problem for students occurs when there is too much content to examine in available time, and many students do not know how to use advanced search techniques to reduce cognitive load. Sisman et al. (2016) discuss how new students are confronted by a large amount of text content. This problem is compounded by the schools not making the students aware of high-level search techniques such as proximity searching, and not providing training in the utilization of syntax commands (Anshari et al., 2015).

To this date there is no research on the use of proximity searching operator techniques. Search engines employed by software companies such as Google provide significant advantages over single words or other simple searches. Such search operators are abundant but not taught or explained in the education environment. Therefore, there is a gap in this field of study. This research effort aims to increase the learning skills of students, which to this researcher's knowledge, has not been discussed in any meaningful way by past or current researchers.

Such research could reveal student interest and influence patterns of searching at the start of their higher education journey and thus benefit them throughout the term of such an experience. This would start with simple searches followed by syntax operators and then train them to use a graphical interface method that would do a complicated syntax operator. If successful, it provides an opportunity for creative instructional design.

Summary

Miller (1956) was the first to consider the theory that suggests learning happens best under conditions that are aligned with human cognitive architecture. However, the structure of human cognitive architecture is perceptible experimental research. Sweller (1988) recognized George Miller's (1956) information processing research demonstrate short term memory is limited in the number of elements it can contain simultaneously. Sweller (1988) provides a theory that treats schemas as cognitive structures that make up an individual's knowledge base.

CLT weaves a tapestry of the complexity of human limitations that inhibit student learning patterns. There are possible solutions to this to be considered as well. There are many pieces in this puzzle, but no one researcher has suggested a solution and therefore is an evident gap in the literature.

CHAPTER THREE: METHODS

Overview

The nature of the present research investigation is to collect information on the use of Internet and search engine technology in college students (Yin, 2014). The collective case study will assess how students seek out or found information in web-based learning environments. The study involved data collected from individual interviews with students and focus group discussions. To evaluate the utilization of search engine technology, the research questions for this exploratory qualitative study focus attention on syntax commands versus GUI and how these may enable a reduction in overall cognitive load for students.

This chapter provides a rationale for the choice of a case study design. There is a central research question and five sub-questions. Open-ended interview questions were provided to the participants to comprehend the skill they had in searching and determine if they used any higher-level search techniques. This led the researcher to varied explanations of the participants' experiences. The research took place at a community college in Arizona, with participants representing freshman and sophomore level students. Formal data collection occurred through a review of the interview questions, instructional documents, and observation of responses to instruction, and a focus group meeting. Data were analyzed in a four-step process in addition to coding and triangulation. Trustworthiness was reinforced by confirmability, credibility, dependability, and transferability. Pseudonyms were used for the participants and institutions to safeguard their identity.

Design

Using a collective case study, this qualitative research design is exploratory in nature and utilizes observation for the collection of data. Yin (2002) defines a study's design as "the logical sequence that connects the empirical data to a study's initial research questions and, ultimately, to its conclusions (p. 20). Yin's (2014) case study design was chosen for this study. Yin (2014) comments "as the first part of a twofold definition, a case study investigates a contemporary phenomenon (the "case") in its real-world context, especially when the boundaries between phenomenon and context may not be clear" (Yin, 2014, p. 2). Yin (2014) follows this with "the second part of the definition points to case study design and data collection features, such as how data triangulation helped to address the distinctive technical condition whereby a case study will have more variables of interest than data points" (Yin, 2014, p. 2).

A qualitative design allows the researcher to gather precise, in-depth information from students and their experiences and does not involve manipulating variables. Qualitative research also seeks to discover the motivation, reasons, and opinions of individuals involving a specific topic or research interest issue to resolve or develop a gap existing in the research literature. It allows the researcher to investigate the how and why of a phenomenon of interest, in which little prior research has been conducted or little is known to the researcher and the research literature. It is based on ethnomethodology, which is field research that involves conducting individual interviews with participants. The purpose or goal of the present investigation was to gather information on student attitudes related to syntax operator command proximity searching techniques using a case study design.

A case study can include single or multiple cases, although this case study will be a multiple case study as there are 12 participants and each are case. There will be no quantitative evidence provided. Yin (2014) discusses design and refers to "the logical sequence that connects the empirical data to a study's initial research questions and, ultimately, to its conclusions" (Yin, 2014, p. 28). According to Yin (2014), case study research includes, "a case study's questions, its propositions, if any, its units of analysis, the logic linking the data to the propositions, and the criteria for interpreting the findings" (p. 29).

Case study research aims to answer the questions of how and why (Yin, 2014). The secondary component of case study designs is to establish the propositions for the research investigation. However, in the case of exploratory research, propositions are not used, but the purpose of the study is stated. In the present study, the investigation's purpose or goal was to gather information on student attitudes concerning syntax operator command proximity searching techniques.

The third portion of a case study involves the unit of analysis, which includes "defining the case to be studied" (Yin, 2014, p. 31). The present research investigation is considered a multiple-case study since 12 individuals or cases focus on the study where pertinent information is gathered and combined to formulate a narrative. The unit of analysis in this study will be the use of proximity searching techniques by college students with a curriculum that requires frequent research and web-based technology.

The fourth component involved in case study research involves drawing a relationship between the data to research propositions (Yin, 2014). In this study, the researcher will utilize pattern matching to establish reoccurring themes in verbal reports from participants. The researcher will attempt to construct a categorical matrix where reports will be put and calculate and track the frequency of common or similar events or reporting by participants. This will allow the researcher to set up the data for later analysis through the development of differing categories.

The final component of a case study design and often the most challenging aspect of qualitative approaches is establishing analytic criteria for interpreting the findings (Yin, 2014).

Yin (2014) indicated that in a case study, “much depends on a researcher’s own style of rigorous empirical thinking, along with the sufficient presentation of evidence and careful consideration of alternative interpretations” (p. 132). The analytic strategy is most likely to suffer when novice researchers conduct qualitative research because there is no established protocol for analytical qualitative techniques such as quantitative designs. This research investigation will follow the analytical strategy of using theoretical propositions that lead the case study’s direction. The theoretical propositions were reflected with a series of research questions, a thorough review of the relevant research literature, as well as any newly developed hypotheses or propositions.

A collective case design was chosen for this study to allow the researcher to gather specific information related to individualized experiences related to a topic or context (Baxter & Jack, 2008). Gathering knowledge or information from multiple participants allows the researcher to gain a better understanding of the underlying issue using a variety of data collection methods. The present study focused on proximity searching techniques for students in a community college environment, and this design enabled students to share their experiences related to the use of literature searching strategies such as syntax command or GUI. A case study should not be considered in isolation, but rather examine the interaction between the case and its context. This adds to a common problem in doing case study research (Yin, 2014), the number of data points will be far exceeded by the number of variables under study.

The present study was defined as exploratory in nature since little is known about the topic of research interest (Yin, 2014). However, this exploratory design incorporated the use of theoretical propositions to lay a groundwork for the study. This study’s criteria are formulated and developed based on cognitive load skills and their relationship with the use of two different sources of search engine technology. Most students had historically relied on GUI in comparison to syntax commands when using digital technology to find answers. One proposition is that syntax command operations may require more cognitive load from students, which may explain the avoidance of their use. Another proposition is that students do not receive adequate training in the use of searching techniques, such as syntax commands, and they are unaware of their effectiveness in narrowing down relevant information.

Research in the field of syntax command versus GUI and how it integrates into search engine technology is not well-developed in the research literature. In fact, presently to this researcher’s knowledge, there is little research on information-seeking behavior in college students and how this syntax command or GUI might improve students’ learning process.

Research Questions

The central question of the study is “what causes students of higher education to avoid using syntax operator commands to provide better search results?”

The following sub-questions (SQ) will provoke additional analysis of the research questions.

SQ 1: What motivates students to avoid or fail to use powerful syntax commands for searching on the internet or other content sources? (e.g., proximity searching)

SQ2: How do complex syntax command operators induce cognitive load or self-efficacy on students who are learning to do searches?

SQ3: Does substituting a graphical user interface (GUI) for syntax commands do for student use of complex search techniques?

SQ4: How did proximity searches benefit students by decreasing the distance between key words?

SQ5: What do students feel more comfortable with, syntax command or GUI?

Setting

According to Creswell (2013), data collection should occur in a natural setting that is sensitive to the participants, people, and places under investigation. Data collection took place within a natural setting because this is where the participants experience the problem or phenomenon of interest. The setting of data collection will be based on a web-based learning environment. Therefore, the students will be enrolled in courses in an environment that is self-directed and does occur on a college campus (Yin, 2014). Web-based learning environments can produce greater challenges for the student because there is no face-to-face time with the instructor or professor and learning does not occur in a structured learning environment on campus.

The site selection for this research investigation will be a college setting of higher educational learning because this is where literature search engines are utilized. College students are routinely required to conduct literature searches to gather information for coursework in a variety of research areas or course types. Therefore, they would be a great resource for gathering information about the efficiency of searching engines and searching techniques taught through college campuses.

The research site will be a local community college in the greater Prescott, Arizona area. The researcher identified this site because college students routinely use search engines to conduct research pertaining to their studies in various topics and/or areas, and the researcher had face-to-face interviews with participants at this site. This site was also chosen because it will allow the researcher to easily access participants and conduct face-to-face interviews will each participant. All interviews will be conducted on campus in a private room chosen by the researcher. To ensure that confidentiality is maintained for all participants, each participant will be assigned a pseudonym, which will serve to protect the identity of the participant and enable the researcher to separate participant data.

Participants

This is a collective case study that focuses on identifying a phenomenon of interest (Yazan, 2015; Yin, 2014). The phenomenon being studied in this research investigation is the use of syntax operator commands in literature searching for a selection of college students. The phenomenon of interest also involves the student's familiarity and use of proximity searching when conducting literature searches for course assignments and/or requirements. Based on the phenomenon of interest in the present study, the site and participants will be purposefully selected by the researcher for study inclusion.

Case selection is based on expected enrollment in a community college course at the identified two-year school. The role of participants is to meet the selection criteria for participation, and the criteria is based upon expected enrollment. Creswell (2013) states that "the idea behind qualitative research is to purposefully select participants or sites (or documents or visual material) that best helped the researcher understand the problem and the research question" (p. 178). The idea behind purposefully selected sites and/or participants includes four components: the site, the participants, the events, and the process.

Participants will be students in their first or second year of college at a community college located in the northern, Arizona area. Students in their first and second years of college are commonly required to gather information for large papers, and this can be difficult for students that are unfamiliar with search techniques. During the first two years of college, students are typically taught how to use literature searching techniques on campus by a librarian, but this is not possible in the context of a web-based learning environment where students do not attend classes on campus.

A total of 12 college students will participate in the research study. This study will be done with 12 subjects derived through purposeful case selection from the freshman and sophomore classes at a college in northern Arizona. The researcher selected only 12 subjects in this qualitative study to ensure that each student could fully participate in each interview and share their own unique story. This will allow the researcher to identify common themes among the participants that will permit conclusions to be drawn. Those subjects will be given a questionnaire to determine their comfort level with computers, searching and advanced searching techniques.

Procedures

Twelve college students will be randomly selected to participate in the present research investigation. These students will be selected from a professor conducting freshmen and sophomore collegiate classes at a community college in Arizona. The professor will provide written consent to the researcher to provide efficient information for the IRB process. Prior to data collection, students will be required to sign a written consent form (See Appendix R) that explains the research's purpose.

Data collection took place over a three-month period in the fall semester at the community college. The researcher will utilize three forms of data collection techniques to gather the qualitative information (Creswell, 2013). The three forms of data collections techniques will include interviews, direct observations, and review of documents following transcription. Each of the 12 cases will meet with the experimenter one-on-one to be instructed in proximity search techniques and the reason for such a search. They will be instructed on syntax commands for such a search. Each subject will then be asked to find the answers to questions provided by the researcher listed in a digital book. They will then be asked questions to determine their comfort level and possible cognitive load issues while working on the project.

The same subjects will then be instructed on the use of a GUI interface to do proximity searches. The subjects will then be asked to find the answers to a different set of questions the digital book. They will then be asked questions to determine their comfort level and possible cognitive load issues while working on the project. They will also be asked to compare their comfort level and discuss any cognitive load issues they may or may not experience between the two phases.

The researcher will interview starting students at a local community college instructed by one professor to determine the skill level in searching these students. They will be coded as to skill level and then taught how to apply these syntax commands and ultimately taught how to do the same command using a GUI. The purpose is to make the students aware of skills to use in their education journey. These tools can change searching efforts significantly. They will also be taught how to use low cost or free software to index their content as it accumulates in their journey and the value of the index.

Prior to initiating any data collection procedures, approval will be obtained by Liberty University's Institutional Review Board (IRB), which follows the Pursuant to the National Research Act (P.L. 93-348§212a). The study will be conducted under the guidelines of assuming minimal risk to participant, maintaining confidentiality, obtained written or verbal informed consent from each participant, and any other significant ethical considerations are taken under consideration.

The Researcher's Role

The researcher's paradigm utilized in this study was a case study approach, which focused on the development of a common meaning for multiple individuals through an in-depth description of those multiple cases (Creswell, 2013). The focus will be on capturing the participants' individual experiences as they learn new ways of utilizing searching to narrow the results of their findings through proximity searching. The philosophical assumptions aimed to reach the goals of this case study is to study current cases, to understand a specific problem or issue, to provide an in-depth understanding of the case or cases, to compare and analyze multiple cases, to provide an efficient and accurate knowledge of the cases, and to present a theoretical model based of the analysis of the described cases. Interviewing the participants will be the primary form of data collection that will facilitate the development of a theory.

The primary role of the researcher is to construct knowledge based on the qualitative data collection techniques. The qualitative researcher serves as the interpreter of information. They serve as "gathers of interpretations that require them to report their rendition or construction of the constructed reality or knowledge that they gather through their investigation" (Yazan, 2015, p. 137). The primary assumption in which qualitative research is founded involves the perspective of constructed reality for participants within their social contexts. Therefore, the researcher's role is to construct understanding based upon the knowledge gathered from participants.

This qualitative research case study evolved from personal business experiences and a desire to impart better search results to nontraditional students. My own experiences in the business world made me aware there were software packages that provided indexing of digital content. The software I was familiar with was Odyssey Development of Australia. I was an early adopter and was impressed with its functionality. I learned that digitizing paper documents and indexing the text made searching and retrieving text simple with results returned to the user in one second. When I applied the software to biblical content or commentary on the Bible it was remarkable.

In 2008, I decided to return to school to get a certificate of completion at my local community college. I never finished the community college but did transfer to Grand Canyon University, where I did finish. The indexing and search software that I used from 2008 until today was a major part of my educational life. I indexed everything in my educational effort. As I moved from a bachelor's degree to the Ed.D. program, I was to learn about cognitive load and how it impacts students over the last nine years. Reducing cognitive load is well developed field. On November 25, 2013, John Sweller, a cognitive load authority in Australia responded to an inquiry regarding the indexing and searching technology I was using and provided the following:

> One of the major findings (in fact, the first finding) of CLT is that requiring learners to search for information imposes a very heavy, extraneous cognitive load. The search process overloads working memory with processes that are extraneous to learning. (Sweller, personal communication, November 25, 2013)

Although the process of selecting a qualitative or quantitative study was fraught with some difficulty, Sweller once again provided insight in a personal communication:

> There are basically 3 ways of measuring cognitive load: physiological measures; secondary task measures; and subjective ratings. Physiological measures are the holy grail but still seemed to lack sufficient sensitivity to be useful and require equipment and are intrusive. Secondary task measures are very useful but usually require equipment and so are difficult to use in regular classrooms. Subjective ratings are still the most usable

method and are still being developed - see: Leppink, et al., (2014). Effects of pairs of problems and examples on task performance and different types of cognitive load. Learning and Instruction, 30, 32-42. Sweller, J. (2017, February 19). Basically 3 ways of measuring cognitive load. (Sweller, personal communication, February 19, 2017)

Once the qualitative case study approach was determined, I started gathering research material. Among items retrieved was an article referring to a Dr. Daniel Russell at Google. The article titled “Only One in 10 Know What Ctrl-F Does - Here Are Shortcuts You Should Know” (Kwek, 2011). This article used Russell at Google for affirmation. Remarkably it claimed that in a survey by Google, only 10% if those surveyed knew what Ctrl + F does in a computer. Russell commented:

> While we don’t keep “stats” on operator use, it’s possible for me to compute them on demand. For various (security) reasons, I can’t tell you the details, but I can give you this quick summary:
>
> Most-frequent to least-frequent:
>
> site:
>
> filetype:
>
> minus (e.g., -term)
>
> .. (number range)
>
> cache:
>
> everything else is REALLY low frequency. (Around 0.001% or less). While we don’t keep “stats” on operator use. (personal communication, January 8, 2018)

This insight from Russell was remarkable, as it confirmed my own thoughts. What was key in this communique was his comment “everything else is REALLY low frequency, around

0.001% or less" as this incredibly low number included my most used tool, a syntax command operator provided by Google that executes a proximity search. My indexing and searching software provided such a search, and I used it every day in my studies. It turns out that very few students use these syntax command operators, although very powerful.

In gathering peer-reviewed articles, there were many from Sweller and others on cognitive load. In conclusion to an article Sweller (2016) suggested "that the knowledge acquired in academic contexts consists of biologically secondary, domain-specific rather than generic-cognitive information. It may be the only information that can be taught" (Sweller, 2016b, p. 366). A few paragraphs later, Sweller commented:

> That literature emphasizes the critical importance of the well-known characteristics of human cognition when devising instructional procedures. The constraints of working memory when acquiring novel, biologically secondary information and the elimination of those constraints when dealing with familiar information stored in long-term memory are 0central to this work. *Without this critical knowledge of human cognition, instructional design is blind*. (Sweller, 2016b, p. 366)

Sweller's first article was written in 1988, and the article mentioned is from 2016. Sweller has concluded by reasoning, draw as a logical conclusion from the research in the article and if he is correct, it points to a fundamental problem in teaching and learning. My qualitative case study research explores why adult students avoid using these higher-level syntax command operators provided by Google and others. The insight gathered would allow consideration of possible better instructional design approaches on using syntax command operators for students and faculty.

Currently, I am the Managing Director of two educational websites. Another principal and I are working to provide 66,000 digital books to rural schools in northern Arizona in addition to the websites. The setting of data collection was chosen by the researcher based on location, relationship with collegiate faculty, and the researcher's prior attendance in classes at this college before transferring to a four-year university.

Data Collection

Detailed, varied, and specific data collection tools are essential in qualitative research. I plan to collect data through semi-structured interviews in a closed office location. I plan to also triangulate the data through face-to-face interviews, direct observations of participants in the natural setting, and the implementation of focus groups to obtain participant experiences in a group setting.

Interviews

Interviews are the primary source of information gathering strategies utilized in qualitative research investigations (Creswell, 2013; Yin, 2014). The interviews will occur in a place that is familiar, natural, and comfortable for participants. I plan to conduct interviews with individual participants in person at a community college located in the Prescott, Arizona area. The following questions will be included in the interview process with participants. Questions that involved the first research question are 3, 4 and 5 Questions involving research question two are 7, 8, 9, 10, 11,12,13, 14 and 17. Questions that address research question three include 20, 21, and 22. Question 4 are 15, 16, and 18 aided me in addressing research. Finally, questions that involve answering research question 5 are 19, 20, 21, 22, 23, 24, 25, and 26.

Interview Questions

1. My name is Don Campbell, and your name is?
2. My understanding is the community college had four general areas in terms of mission:

the production of courses and materials for learning at a distance, the promotion of external degree programs, the development of research on the adult learner and learning at a distance and learning searching skills.

3. What skill are you at using computer technology to do work needed for your classes?
4. What technology skills are you good at?
5. What technology skills are you weak at?
6. What are your feelings about the use of technology in courses?
7. What skills you may acquire in using the Internet for entertainment transfer to your school work?
8. What are the components of those skills?
9. What technology had instructors used in the courses you had taken?
10. What are advantages of technology in your courses do you observe?
11. What are disadvantages in the use of technology in your courses?
12. What technology in your courses helped n your learning?
13. What do you think your instructors are skilled at in the use of technology in teaching?
14. What are the major obstacles to more effective use of computer and information technology in your courses?
15. What are the search skills you had developed since starting school?
16. What do you wish your college would had taught in respect to search skills?
17. How do you feel about other courses, leaving little time for instructions on searching?
18. Why do you think this college avoided instructed in search skills?
19. What specialized search techniques did you used before going to college?
20. What are some advanced techniques for searching?

21. What are syntax command operators for searching?

22. What are some ideas of their function?

23. What is the meaning of the term “proximity search?”

24. How can syntax command operators improve the quality of search results?

25. How would you expect syntax command operators to improve your learning experience over your education journey?

26. Can I schedule a time for an instruction routine to learn these syntax commands?

Second Meeting Procedures

1) Instruction (15 minutes)

a) Background

What do you use for searching on the computer? Most use Google.

Do you use Ctrl-F? (only about 10% do.

Do you recognize “x AROUND(10)y”? Only about 0.1% do. This is a syntax command.

Searching requires a lot of cognitive load (cognitive load refers to the effort being used in the working memory).and I am trying to help you find ways to reduce the cognitive load for your searches.

i) In the Google universe “Only one in 10 know what Ctrl-F does.”

ii) Do you recognize this “x AROUND(10) y”? If not, you belong to 99.9% of the people who use Google. This Google syntax operator command must be 100% accurate to function.

iii) Only 0.0001% (1 in 1,000,000) or less of Google users take advantage of Google syntax commands (Russell, personal communication, January 8, 2018).

iv) Requiring learners to search for information imposes a very heavy, extraneous cognitive load (Sweller, 2013).

v) The problem is how to reduce this extraneous cognitive load on students so they will not give up.

vi) "Based on knowledge of human cognition, cognitive load theory was devised to facilitate academic learning by developing appropriate instructional procedures" (Sweller, 2015).

b) Purpose

If you choose, I will teach you how to use syntax commands to make searching easier and more effective. During this process I will ask you if you are more comfortable and feel the mental (cognitive) load is less.

i) Qualitative case study: explore the usefulness of high-level search techniques to reduce students' cognitive load.

ii) This study will prepare participants to do advanced searches using syntax commands.

iii) Students will be asked to evaluate their cognitive load during data finding.

iv) Computers are well suited for indexing, but they present a maze of approaches and produce further complexity in the manner they provide results through the use syntax command operations while searching (Savolainen, 2016).

v) There were two key people that influenced the outcome of this research, John Sweller and Daniel Russell.

c) The Question

i) The central question of the study is "what causes students of higher education to avoid using syntax operator commands to provide better search results?”

2) Participation in Use of Instruction (30 Minutes)

Now I will show you some syntax commands for advanced searching (proximity searching).

The reason to use proximity searching is to get more pertinent hits with less junk.

You can do searches of one word near another or you can specify one word within x words of another.

You can use syntax proximity searching on Google.

If you have your own body of data (articles, books, etc.) and your own search software, you can be more precise.

a) Proximity

i) Proximity searching is a way to search for two or more words that occur within a certain number of words from each other. The proximity operators are composed of a letter (N or W) and a number (to specify the number of words)

ii) Proximity searching is a way to search for two or more words that occur within a certain number of words from each other. The proximity operators are composed of a letter (N or W) and a number (to specify the number of words). The number cannot exceed 255.

iii) The proximity operator is placed between the words that are to be searched, as follows:

iv) Near Operator (N): N5 finds the words if they are within five words of one another, regardless of the order in which they appear. For example, type tax N5 reform to find results that would match tax reform as well as reform of income tax.

v) Within Operator (W): W8 finds the words if they are within eight words of one another, in the order in which you entered them. For example, type tax W8 reform to find results that would match tax reform but would not match reform of income tax.

vi) In addition, multiple terms can be used on either side of the operator. See the following examples:

(1) (tax OR tariff) N5 reform oil W3 (disaster OR clean-up OR contamination) (baseball OR football OR basketball) N5 (teams OR players)

b) Proximity by Google

i) People use Google for 3.5 billion searches per day but less than 1 in a million (0.0001%) use the Google syntax operator command.

ii) The Google syntax command operator “x AROUND(10) y” (precision required as it functions like software).

iii) Example Sherman AROUND(10) march [this referring to General Sherman march through Georgia in the Civil War].

(1) Google Result - About 63,800,000 results (0.79 seconds) because Google searches 100 million websites to get this answer.

c) Proximity by Other

(1) If you had your own content indexed (like only 62,000 documents,

it might look like this - Your search for “sherman /10/ march” found 257,251 hits in 2,400 documents. (0.73 seconds).

(2) Example of a result - Two days before the Battle of the Crater, final operations against Atlanta had been begun by Sherman. On September 2 it was to fall and the march to the sea follow. Note software highlights two keywords.

3) Review and Question (15 minutes)

a) Only 2 techniques demonstrated

i) Google

ii) Private brand

b) Higher education libraries do not offer proximity searching except WorldCAT.org.

c) Most school libraries use these systems. (Neither offer proximity searching).

i) Summon (ProQuest) - “Summon is the only resource that really seemed to grab some of our student’s’ attention” (Buck & Mellinger, 2011, p. 178).

ii) EBSCO Discovery Service’s (EDS)

d) Index your own content forever with indexing software.

i) Gather from any source and index with automatic index updates.

ii) Indexing is not time intensive as it happens at 30 million words a minute.

iii) Gather documents in PDF and Word.docx.

(1) You can index over 100 other formats but PDF and Word.docx are most used in researching and writing scholarly papers.

iv) Most indexing software will activate a Word.docx file if it shows in the results list.

Observations

Direct observation is one of the primary data collection techniques used in qualitative research (Creswell, 2013). Observations allow the researcher to maintain an outside role in the study, enabling their development of a theory. The researcher will observe participants as they utilize the syntax command approach and the GUI approach to search engine technology. This will last for one hour two separate times as each feature is allocated one hour each. The researcher will record how many questions the participants had, what the questions were pertaining to, and any other factors that seemed essential to the relevant research investigation. The researcher will notify participants that they can ask questions at any time during observations, which meant that the researcher will be in a middle-ground position making them neither a participant nor a non-participant. The researcher as an observer will focus on students' experiences as they learn more about the use of two approaches to search engine technology. The researcher will function as a nonparticipant/observer as participant, which means that the researcher will serve as the group's outsider, taking field notes from a distance. Questions that will be addressed through observation are the type of searching techniques the students are utilizing, the relative efficiency of the students' ability to use syntax commands while searching, and if they had differing search findings using GUI versus the use of syntax commands.

Focus Groups

The role of a focus group is to obtain a group perspective on the issue of interest of which little is often known (Byers & Wilcox, 1991). A focus group combines the aspect of interviewing with the aspect of participant observation. Qualitative data collection provides the researcher the opportunity to observe the process in action with a group of individuals. The researcher can observe the interactions “between and among participants, and how they respond and react to each other” (Byers & Wilcox, 1991, p. 64). It allows the researcher to obtain factual data information that would not be obtainable through questionnaires or other self-report measures.

The researcher will conduct one focus group with the participants or interviewees in a two-week period. The focus group will be conducted in a private room reserved by the researcher in the campus library. The focus group will contain six group members and the researcher will attempt to equalize gender and age as much as possible throughout the groups. The researcher utilized a series of structured questions that would determine participant’s opinions, beliefs, and feelings about their use of search engine technology, their satisfaction with search engine training provided by the school, and the use of syntax commands versus GUI. The focus group questions will involve similar questions as the interview questions but occur in a group context where the group interaction enables the production of data that would not be possible without the group condition.

Focus Group Questions

1. You have now all been interviewed for this study about the use of advanced computer search techniques, particularly proximity searching. Before this study, explain your idea of advanced searching techniques?
2. How do you feel these advanced search techniques will be helpful in your research? Why would you be likely to use them? How would the complexity of the search command operators affect your likelihood of using them?
3. What is your opinion about the responsibility of schools in teaching advanced search techniques before requiring research? How do you feel about teaching a research class that would encourage advanced search techniques? Why?

4. How do you determine the GUI or TUI helpful? If that was available all the time, how would that influence your likelihood of doing advanced searches? Why?

5. How did you feel about doing the research as you got more comfortable with proximity searching? What were the results? Contrast the effort it takes to advanced level searches.

6. What do you believe are the advantages and disadvantages of advanced search techniques?

During each focus group session, the researcher took notes as well as use a recording device to track all communications between participants and ensure that all data is recorded. The audio recording data was utilized to fill in gaps and verify quotations or specific responses made by the participants. It was also used to confirm when responses were common and occurred in more than one session by differing participants.

Data Analysis

In a case study, data analysis starts by developing an analytic strategy that relates data to the propositions of the research investigation (Yin, 2014). Yin (2002) defined analysis that "consists of examining, categorizing, tabulating, testing, or otherwise recombining both quantitative and qualitative evidence to address the initial propositions of the study" (p. 109). Qualitative research requires that the researcher use highly structured analytic protocols and guidelines since case study research suffers from well-examined analytic techniques. The analytic techniques are aimed to enhance the validity and reliability of procedures used in case study research.

According to Yin (2014), five qualitative strategies exist that allow the researcher to analyze data, and these include pattern matching logic, explanation building, time-series analysis, the development of logic models, and cross-case analysis, which is used with the analysis of multiple case studies. Exploratory case studies utilize a process of hypothesis generation, which meant that the goal of the study is to develop ideas or a framework for further and future study. Merriam (1998) defines data analysis as

> the process of making sense out of the data. And making sense out of the data involves consolidating, reducing, and interpreting what people had said and what the researcher has seen, and read---it is the process of making meaning. (p. 178)

Therefore, the qualitative researcher will gather information for interpretation, and then develop a constructed framework or idea based on the reality of multiple people and knowledge gathered through data collection methods (Yazan, 2015). This inductive approach builds broad themes from data, using participant interviews, observations, and focus groups as data sources, and formulates these themes into a model or theory (Yin, 2014). The analytical procedures permit the researcher to assign codes to data with each code meant to represent a concept or phenomenon of interest.

The use of logical models as an analytic technique "consists of matching empirically observed events to theoretically predicted events" (Yin, 2014). Logic models were first utilized by Joseph Wholey (1979) for a public intervention program. The intervention was perceived to lead to initial activities termed immediate outcomes, which then produced intermediate outcomes. The intermediate outcomes were then thought to result in ultimate or final outcomes.

In this case study design, the hypothetical intervention is for students to learn and practice the use of syntax command operators (immediate outcome). The result of the immediate outcome is evidence by enhanced understanding of the topic and its use in the educational process (intermediate outcome). Finally, practicing these techniques, interviewing about these techniques, and conducting focus groups about these techniques will be evidenced by increased understanding of the benefits of proximity searching using syntax commands, and better grades in coursework (ultimate outcome).

Individual-level logic models assume that the case study is about an individual or a group of individuals (Yin, 2014). It showed a hypothetical path or sequence of events that lead to a specific outcome. The individual-level logic model can provide the researcher with insight into the development of events, which can contribute to new knowledge for both research related purposes and practical uses. The researcher will also consider any contextual conditions that might be contributing to change in the model of logic such as differing outcomes or responses expected from students and the feedback they provide.

Cross case analysis is a data analytic technique that involves the analysis of multiple participants or cases in a study (Yin, 2014). Each individual or participant is a separate study, and the cases should include at least two to perform a cross-case analysis. However, having greater than two cases can strengthen the findings even further suggesting that 12 cases in the present study will produce strong findings. This case study will focus on creating word tables to determine whether the cases are being replicated or in contrast to one another. “An important caveat in conducting this kind of cross-case synthesis is that the examination of word table for cross-case patterns will rely strongly on argumentative interpretation, not numeric tallies” (Yin, 2014, p. 67).

Pattern matching is one of the most commonly used and most desirable analysis techniques in case study research (Yin, 2014). It is utilized to compare empirically based findings or patterns from a case study to the predicted outcome made prior to data collection. It can strengthen the internal validity of a case study if empirical findings and predicted patterns seemed comparable. Pattern matching can also be used with rival independent variables. In this study, syntax commands and GUIs will be utilized by students to evaluate the success of their literature searching strategy. The successful matching of independent variables and their predicted outcomes, if found over multiple cases, then "literal replication of the single cases would have been accomplished, and the cross-case results might be stated even more assertively" (Yin, 2014, p. 146).

I plan to collect data directly from participants through conducting interviews that will occur in an individual fashion. This meant that only the researcher and the participant will be in the room when data collection occurs. The researcher will conduct individual interviews and the data will then be triangulated to synthesize the findings from differing participants. Triangulating the data from multiple sources will allow the researcher to gain a greater understanding of underlying constructs or themes that are occurring among participants (Creswell, 2013; Yin, 2014). Since this study will be exploratory, the goal involves generating ideas about concepts that will allow for future studies to occur on this topic or similar topics.

Data management is the first part of organizing the data for analysis (Creswell, 2013). Once the data has been organized into a database, the database will be scanned in order to find important organizing ideas. In order to conduct an analysis of the qualitative data, the researcher will develop a coding scheme, and then conduct a content analysis (Patton, 2002). The content analysis will seek to identify, code, categorize, classify, and label patterns the researcher finds in the qualitative interview data. The meaning behind this is to identify and analyze the essential content found from the interviews in order to find what is significant to the study.

According to Patton (2002), "qualitative and quantitative data can be fruitfully combined to elucidate complementary aspects of the same phenomenon" (p. 558). Moreover, using triangulation to combine both qualitative and quantitative data can allow the researcher to perform a comparative analysis. Therefore, for the purpose of this study, the qualitative interview data will be combined with the quantitative observational data. The observational data were quantitative in nature. The researcher and his secondary collector looked to determine the frequency of use of differing forms of searching techniques and differences in the relative number of search findings based on proximity searching techniques versus GUI interface.

Finally, the focus group is an interview between the researcher and the participants in a group setting, with generally six to 10 people (Patton, 2002). For this study's purpose, one focus group was conducted to enhance the number of perspectives gathered and had greater confidence in the themes that emerge. The focus group interviews were qualitative. Similar research techniques involving the development of themes, a content analysis, and the use of a coding scheme were utilized to seek clarification behind themes reported by the participants. It is thought that the participants' interactions would increase the quality of the data derived and the themes that may develop as a result of the focus group.

Trustworthiness

Trustworthiness involves four components which include: credibility, dependability, transferability, and confirmability (Creswell, 2013). Trustworthiness is essential in qualitative research because it allows the researcher to establish validity using qualitative research techniques and helped strengthen the meaning behind the study. The researcher will utilize triangulation to discuss confirm the trustworthiness of the data collection procedures.

Credibility

Credibility concerns the extent to which the data can define participants' reality with an expected level of precision (Creswell, 2013). In qualitative research, established credibility meant that the researcher has accurately described the participant's reality or experience from his or her individual perspective to confirm the reliability of differing data collection techniques, the researcher will combine interviews, participants’ observations, and documents together collectively to confirm their accuracy level (Creswell. 2013; Yin, 2014).

Dependability and Confirmability

Dependability in qualitative research refers to the consistency of findings from the investigation and the study’s ability to be replicated (Creswell, 2013). Confirmability also involves the degree in which other researchers can assess the researcher’s data and arrive at the same conclusions. Therefore, dependability and confirmability establish the reliability of the data collection techniques for arriving at the same findings, while minimizing the risk of errors or biases occurring (Yin, 2014). Dependability and confirmability will be established by a thorough audit of the research process (Creswell, 2013). This will be established through triangulation techniques used by the researcher and the secondary collector to confirm that similar themes or findings are found.

Transferability

Transferability involves the ability for information obtained from the research investigation to be applied to differing contexts (Creswell, 2013). In other words, the researcher’s findings can be utilized with similar participants different, but similar settings the researcher will include a thorough description of the research context and any assumptions that were a key part of the research investigation. In order for transferability to be incorporated into the study, the researcher must be able to utilize the findings from the study and be able to generalize them to other settings. This study involves the use of proximity searching with a groups of college students, and this should make it relatively easy to incorporate into other collegiate settings.

Ethical Considerations

Participation in the research study will be voluntary in nature, which meant that participants are able to withdraw from participation at any time. Participants will also be required to provide written consent to the researcher prior to any data collection. Data will be stored in a locked drawer within a locked office that requires a key for entry. No identifying information (e.g., name, address) was obtained from participants during data collection. Participants were assigned numbers in place of their names for the researcher to distinguish between individuals. In order to obtain approval from the IRB, the researcher obtained a consent form from the study participants that includes background information to complete the study, procedures involved in the study, the voluntary nature of participation in the study, risks and benefits of participation, confidentiality, the ability to withdraw at any time, and the researcher's contact information if participants had any follow-up questions or concerns.

Summary

Chapter Three provides methods to implement the design for the collective case study, which will be done at a local community college to assess how students gather information in web-based environments. The research plan has provided a well-documented body of knowledge regarding CLT and information seeking theory. The study aims to determine if students are prepared by institutions of higher learning are able to prepare beginning students with basic and advanced searching skill instructions. The research is qualitative and exploratory, and the case study will be used to analyze beginning students to observe if they can be trained to use these existing syntax command operators. The researcher discussed the design, data management techniques, and how data analysis will occur. Chapter Four will include a brief review of the study's purpose, results of data collection, and the data analysis findings. Chapter Five will provide an interpretation, a discussion of the research findings, and follow-up with suggestions for future research.

CHAPTER FOUR: FINDINGS

Overview

The purpose of this case study is to explore what causes students of higher education to avoid using syntax operator commands to provide better search results for web or school library research. Five participants from a community college in northern Arizona were selected and interviewed individually, and a focus group consisting of three participants was also held. Participants are discussed in detail given the unique perspectives concerning their use of searching basics versus higher-level syntax command operator searching. The triangulation of data was established to enhance the accuracy of the study, with the attempt to reach saturation of data (Creswell, 2013).

Participants

Four female participants and one male participant took part in this study. Participants were selected from freshman and sophomore classes of one community college located in Arizona in the United States. All participants had classroom experience ranging from a low of completing the first year to a high of two years of experience with a median of one year.

All participants were individually interviewed in a face-to-face format over the course of two months. A focus group was conducted with three students. Member checking methods were used to establish trustworthiness within the study and allow participants the emotional satisfaction of knowing that their knowledge and contribution to the topic discussion had been correctly perceived and validated. Participants were given the opportunity to view their transcript data and respond in order to correct any errors or reconcile discrepancies (Creswell, 2015), and participants were given the opportunity to review and respond to “preliminary analyses consisting of description or themes” (Creswell, 2013, p. 252). A pseudonym was used for each participant in the study.

Vicky

I met Vicky in the community college library in a meeting room. Vicky is a first-year student at the community college. She attended a small-town high school that had limited resources but had good computer ability. The first meeting was an interview to develop a background on the subject participant to provide insight into what necessary searching skills the participant might have. The first interview consisted of 24 questions designed by the researcher to understand the search abilities of the participant. During this interview, the researcher explained the nature of the syntax command operator for proximity searching. This would usually appear as “X AROUND (10) Y” such as it does in the Google syntax command operator for proximity searching. Vicky had never heard of this before meeting the researcher. She had heard of the Ctrl + F syntax command operator. Vicky was among the 10% who took part in a pre-interview class survey who knew what Ctrl+ F meant in searching most text document formats.

While the pre-interview class survey findings were not surprising as Russell of Google had established that only 10% of Google users knew Ctrl + F operator, it was surprising to find it was also true of first-year students in a community college. Vicky identified herself as having intermediate computer technology skills, although the researcher noted she was very proficient at using her Apple devices such as her iPad and iPhone. When responding to the question about technology in school courses, she indicated that she preferred face-to-face interaction in the classroom to online classes, although she had not taken any online courses. Vicky was solicited in a classroom course, and this is not unexpected, but with more exposure over time, Vicky might modify her opinion on this issue. Vicky felt that social media is a factor in the development of skills useful for learning and applying technology. Vicky perceived that technology could sidetrack a person from objectives established earlier. Vicky believes that instructors are not as skilled in some of the technology environments as students. This is idea is supported by Ferrari (2001). When asked what may have limited her development so far, Vicky blamed the small school she attended before the community college. Vicky had no awareness that syntax command operators were available in search environments such as Google.

Vicky expressed an interest in learning about such operators. Vicky wondered why the community college did not provide training skills in higher-level searching. Her current skills comprised the Ctrl + F command and an array of common Boolean commands. She did not comprehend how a syntax command operator would execute an operation on the computer, but after the researcher explained it was like computer software coding, she did understand. An appointment was made to instruct Vicky how to use a syntax command operator in both Google and specific search software called ISYS available in a web server and a unique PC environment. Today, there is search software for the Apple Macintosh, so the instruction could be implemented on a Macintosh as well. Vicky was proficient in technological skills in using her iPad and iPhone. She used an Apple Macintosh computer for schoolwork.

Ann

I met Ann in the community college library in a designated meeting room. Ann is a first-year student at the community college, although she had course work while serving in the U.S. Air Force and was several years older than Vicky. Ann was sent a copy of the interview questions and confirmed she had received them. The researcher described proximity as it applies to search and how it parses content to more germane value. The researcher also described Ctrl +

F features and benefits and limitations. The researcher described the differences between the two interviews that would be conducted, with the background information being gathered in the first interview and instruction occurring during the second interview. The researcher administered a survey in a researcher's intensive class, the results of which showed that 15 graduate students had no awareness of indexing software. The researcher described student preface for a single access point for searching such as Google. The researcher explains how, over time, Google has become dominant in the search environment, with the single box or point of query.

Ann described herself as being at an intermediate skill level with computer technology, although she showed great skill with her Chromebook during the time we interacted. Ann is a U.S. Air Force veteran and gained experience as a dispatcher. As a dispatcher, Ann had to write a lot of documents. She also learned to speak in third person. Writing in third person requires the writer to refer to people or characters by name.

Ann asked about the dissertation process and length of time to complete. The researcher provided background on his college experience, followed by his experience at Grand Canyon University. The researcher explained that the tools he used during school he had acquired from the business world, and he had experience using them before using them at school. The researcher discussed the nature of search software using the basic elements of this search tool, including economic cost variations running from $0.00 to $70,000. The researcher indicated that price is not a factor as good search software is available for $0.00 to $200.00. Ann asked again about the dissertation timeline, and the researcher explained it would be about nine years from the time he began at college to when he would complete the dissertation process. The researcher learned about cognitive load while in a class in his Ed.S. degree and felt it impacted his learning.

Ann indicated while in the military, she gained experience with all Microsoft products, and Excel was among those benefitted her the most. Ann said she learned how to do reports that used the features in the Microsoft Office system. Ann and the researcher discussed the virtues of using Excel.

When asked by the researcher which of her skills Ann considered weak, she indicated she needed to be taught some more complex issues. The researcher suggested that complex issues might cause cognitive load, and the researcher described the CLT. The researcher explained the problems with short-term memory in contrast to long-term memory and the role schema plays in this problem. The researcher discussed Miller and the telephone number issue to provide an underlying foundation for understanding how short-term memory is handicapped by cognitive load.

Ann felt the use of technology in coursework is beneficial and believed social media platforms provide insight to communications between instructors and students. Ann indicated that Microsoft Office was used in the military, and that is where Ann perfected her skills in using Microsoft Office. Ann found the skills learned in the military migrated to her current schoolwork. Ann, like Vicky, thought face-to-face interaction in the classroom had significant value. Ann had been impressed by the instructors' use of computer technology.

Regarding limitations on technology, Ann provided as an example that both wireless Internet and Bluetooth have distance limits that inhibit their use. Ann also does like some of the very small screens on devices. When asked what skills she had improved, Ann mentioned the use of the Google search engine.

Ann was asked, "Why a college would avoid instruction in search skills?" Ann felt that instructors want the student to go through the same experiences the instructor did. Ann and the researcher discussed the military boot camp that all military personnel endure compared to an educational instructor. Ann felt that instructors do not want you to bypass what they went through.

When asked what specialized search techniques she had used before going to college, Ann responded she was a heavy user of basic single box search technique and was not aware of special operators such as the Google syntax command operator or other operators. The researcher provided Ann with five pages of Google syntax command operators. Ann expressed she was unaware of any advanced techniques for searching. The researcher equated software coding to writing a macro. When the researcher explained how a proximity search operator functioned, Ann agreed it could influence the quality of a student's work and reduce searching time.

Courtney

I met Courtney in the community college library in a designated meeting room. Courtney was the only participant that was recruited through the flyer provided by the researcher. Courtney was in her last year of community college and had specific goals of completing a master's degree in the future. Courtney was 25 years old at the time of the interview.

When the researched explained the ease of use of indexing software and told Courtney that the entire Bible could be indexed in eight minutes, she expressed surprise at the speed of computer indexing. The researcher then described proximity and the need for accuracy in using a syntax command operator. Courtney agrees that proximity would seem more valuable than single word searches as it has more permutations. An example was provided by the researcher.

When researcher inquired as to Courtney's technology skill level, she indicated she had intermediate skills concerning computer technology. Courtney indicated she was good at searching ProQuest at the library. The researcher told Courtney that Liberty University uses

Summon. Courtney showed that she thought Google was not as good as ProQuest and believed it is biased, whereas ProQuest was not so much. Courtney did not know about Summon. The researcher explained that there are five central library systems, and only WorldCat Discovery has proximity searches. Courtney was surprised.

When asked Question 5, regarding which of her skills were weak, Courtney responded she did not like all the typing. When asked how she felt about the use of technology in her courses, Courtney indicated she felt positively about this part of her education. In her response to Question 7 on which Internet skills used for entertainment transfer to schoolwork, Courtney expressed concerned about the trustworthiness of sources from the Internet. When asked specifically what the components of those skills are in the following question, Courtney explained it is mostly copy and paste. The researcher indicated that many people do not know the shortcuts for copy and paste, such as Ctrl + A, Ctrl + C, and Ctrl + V. The researcher told Courtney that these commands are like syntax commands. Courtney expressed surprise at this statement.

In response to Question 9, which asked what technology instructors used in courses taken, Courtney indicated that all Office 365 software such as Word, Excel, and PowerPoint, as well as Zoom and Skype, were used in her classes. When asked about the advantages of technology she had observed in her courses, Courtney stated she believes group activities using Zoom as well as Skype were beneficial. Courtney believes it is easier to contact people using technology. Courtney explained that her college had multiple campuses, and with technology, she did not need to drive to meet people at different campuses, as she could use Zoom or Skype.

When asked Question 11 on the disadvantages in the use of technology in her courses, Courtney stated she believed that the lack of human interaction is a negative issue. Courtney believed that people forget how to do the basics, like going to the library. She acknowledged people prefer not to talk, and the researcher agreed. On Question 12 regarding what technology has helped her in learning, Courtney responded that she believed she is a visual learner. She said,

> So sometimes reading if I'm looking at a big block a text I don't know, I like to watch YouTube videos of people lecturing the subject now. I don't want to try it, and that is but teaching with you to the reason for that is I think you can capture young people's minds with a video better.

The researcher mentioned that YouTube is replacing Facebook in certain age groups. He and Courtney discussed text messaging versus emailing, as well as the virtues of YouTube as an educational tool. In response to Question 13, regarding instructors' skill at the use of technology in teaching, Courtney stated she was impressed with instructors' use of Office 365 (Word, Excel, and PowerPoint), email, and Zoom, as well as the use of plagiarism tools by instructors.

Question 14 asked "What are the major obstacles to more effective use of computer and information technology in your courses?" and Courtney responded she believed there is too much content. When asked Question 15, on what search skills she had developed since starting school, Courtney said none and indicated she does value Zoom for group learning. In response to Question 16, "What do you wish your college would teach in respect to search skills?" Courtney did not have a direct answer to this question but thought there should be more instruction on searching. For Question 17, "How do you feel about other courses regarding leaving less time for instructions on searching?" Courtney answered that she thinks searching should be a course. Courtney told the researcher that she had gone to a technology workshop, and she was the only one that showed up. When asked Question 18, "Why do you think a college would avoid instruction in search skills?" Courtney expressed her belief that the schools do not want to change their procedures. The researcher suggested the schools believe the student already knows how to search as they have used Google. Courtney agreed.

On Question 19 “What specialized search techniques did you use before going to college?” Courtney answered that she used Google. The researcher explained that Google had 50 syntax command operators, and Courtney was surprised and impressed. When asked to list some advanced techniques for searching, she stated she was unaware of any advanced methods.

Regarding Question 21, “How could words (a syntax command) perform a proximity search?” Courtney answered that she was not aware of this technology, but the researcher explained the basics of using DOS commands prior to Windows software programing to get results.

Eric

Eric was a member of Dr. Lovell’s class and volunteered to participate. Eric had some programming experience and understood what a syntax command operator was, whereas all the others in this study did not realize what a syntax command operator was. Eric considered himself to be an advanced user in regard to a skill level of computer technology, which was higher than anyone else in the study. This factor alone set him apart from all other participants and shaped most of his responses.

When asked what technology skills he was good at, Eric responded, “troubleshooting, and maintenance/repair of computer devices.” Eric considered himself a quick learner. The researcher believes that Eric had developed schema over time that allowed him to facilitate syntax command operators in a way unique among the participants. For Eric, the syntax command operator was a known concept, and for the other participants, it was unknown. Eric considers himself weak in typing skills. He alleged that was “due to my unorthodox typing style." However, that did not seem obvious in reading Eric's responses to interview questions. As to weaknesses, Eric expressed, "I tend to avoid doing work."

As to Eric's feelings about the use of technology in courses, he expressed this thought: "I feel like most of the time if it is not a computer course, the use of technology can create a disconnect from student to instructor." When asked "What skills acquired in using the Internet for entertainment transfer to your schoolwork?" Eric responded that he thought the act of typing and the "use of the of the Microsoft Office Suite" was primary. When asked about the use of entertainment skills, such as Facebook, he suggested typing and the Microsoft Office 365 suite were primary. As to what are the components of those skills, Eric provided "typing and memorization of shortcuts and hotkeys." His suggestion of memorization in this discussion reflects his acknowledgment he has a schema for this skill (Kalyuga & Singh, 2015).

In responding to the interview question regarding the technology used by instructors, Eric thought it was primarily Microsoft Office and Mac OSX. Eric thought "the ability to type a final draft for a paper and the ability to access information quickly and efficiently" was an advantage in using technology. As to disadvantages, Eric felt technology could be distracting and/or possibly inaccurate. Regarding the question, "What technology in your courses has helped in your learning?" Eric, like many others, thought search engines were an important feature. To the question regarding the skills that instructors might use, Eric responded, "Yes and no. Yes, they are using the tech, and no, because most of the time, it isn't done very quickly or cleanly." Eric next addressed the interview question, "What are the major obstacles to more effective use of computer and information technology in your courses?" He responded, "Getting accurate information quickly rather than exploring 2–3 pages down from the first page of search results." Proximity searches reduce the number of responses.

To the question about skills developed since starting school, Eric responded, “Putting quotation marks around key words so that the results must include them.” This is a tool that is useful in proximity searching as well. Most participants had no or little experience in refining any search. Eric’s software coding experience put him significantly ahead of other participants. When asked how he felt about his college teaching search skills, Eric said would like to learn “what to do if you cannot find what you are looking for. Although Eric answered that question directly, most of the participants felt the same way. Eric addresses the question of, “How do you feel about other courses regarding leaving less time for instructions on searching?” with this answer: “There is no time for instruction on searching 95% of the time.” Time was mentioned frequently by the participants.

When Eric was asked “Why do you think a college would avoid instruction in search skills?” his answer was, “It would be wasted time from their end, they have to teach a certain curriculum within a certain time period, most wouldn’t bother sparing a class period or 2 for something that doesn’t directly relate to the course.” The answer addressed the time issue again. When asked if he used any specialized techniques before college, his answer was “none,” although he did use Google. When Eric was asked “What are some advanced techniques for searching?” he responded “Ctrl + F.” The researcher does not consider this an advanced technique as it is a basic technique but unknown among 90% of Google users (D. M. personal communication, Russell January 8, 2018). Eric addressed the question “How could words (a syntax command) perform a proximity search?” and answered simply, “Find X near Y,” and that was correct. Most participants missed that simple answer. To the next question, “What do the words do?” Eric responded, “Tell someone or something what to do, it is a command.” This response is correct and reflects that Eric understood the concept of a syntax command operator. Eric had a schema for software coding, and the other participants did not have this framework.

When Eric was presented with the question, “How would you expect proximity searching to improve your learning experience over your education journey?” he answered, “By spending less time on information gathering (searching). I would have more time to do other things such as work on my analysis of the data or other activities altogether.” This response returns to the issue of a shortage of time mentioned by other participants. In response to the last question, “Why would you want to use proximity searching?” Eric provided,

> When I’m searching databases such as ProQuest for articles for an English project. It would be useful to not only search using keywords but finding what I need in X paragraph, so I don’t have to read the whole document.

Once again, this response reflected that Eric was looking for time control.

Denise

Denise (age 18) was another student from Dr. Lovell’s class and indicated she considers herself as having a novice/beginner skill level. Denise plans on going to a university to major in advertising and felt that she needed more advanced technology skills. To the interview question “What technology skills are you good at?” she responded,

> I am good at the basics right now. I can look things up and do simple things like copy and paste. I have grown up with technology, so I am fairly competent on the phone, but I have not spent much time learning skills to use on a computer.

In regard to her strengths in technology, she responded, “My strengths are taking a bunch of information from different sources and making it make sense. I like finding data and facts to make solid arguments. I am also good at using social media to back my points up.” This last comment about social media is attractive to the researcher as this is not accepted in graduate studies.

In response to the question of “What technology skills are you weak at?” Denise answered, “I need to work on accessing the information. I am not very good at deciphering between truthful websites and ones with false information. Often, I choose the easiest website and don’t check its accuracy.” Denise’s answer was common among the participants, as others also expressed that the time it took to do research was a factor, and effective research was constrained by the time available to the student. On the question “What are your weaknesses?” Denise responded that the answer was the same as the question before. To the next question, “What are your feelings about the use of technology in courses?” Denise answered that in two parts “I am thankful for the use of technology in courses. I only use technology I never look to books anymore for research. Although I like it and appreciate it I feel like it has made me lazy,” and “I don’t have to search for information, and I can get it very quickly and easily. Overall, I am grateful for the use of technology in my classes.”

As to the next question, “What skills acquired in using the Internet for entertainment transfer to your schoolwork?” Denise answered, “Through using the Internet for entertainment, I have to create digital media and to decipher how social media algorithms work.” The researcher notes that not all social media use algorithms. Social media algorithms sort posts in the users’ feed using relevancy instead of publishing time. When asked the question “What are the components of those skills?” Denise responded, “Those skills are able to use the Internet to create things and use social media for research.” Again, Denise is using social media to support her assumptions, but considering Denise is going into advertising, she could be justified in the conclusions she drew.

To the next question, “What technology did instructors use in the courses you’ve previously taken?” Denise answered:

> I’ve taken hybrid classes where half of the class is face to face, and half is online. I’ve had to use Zoom to stream some of my lectures, and I’ve had to take quizzes and turn in assignments online. My teachers have also used technology by having us play games in class. For example, the whole class would connect to the same Kahoots game online to practice for upcoming tests.

In her answer to the question, “What advantages of technology do you observe in your courses?” Denise claimed, “The advantage of having technology in my courses is easier access to information. I can find the answer to any question I have in less than a second.” In this response, Denise addressed the need for speed, an element whose importance was emphasized by many students in this research. Google provides speed, but the library systems shun Google and rely mostly on Boolean searches. Denise responded to the next question, “What are disadvantages in the use of technology in your courses?” with this answer: “A disadvantage to the use of technology is there is less face-to-face action which can lead to things being easily misunderstood or miscommunicated.” Others expressed similar thoughts. All the students in this research were classroom attendees, although some took online classes as well. To the next question, “What technology in your courses has helped in your learning?” Denise’s response was, “Obviously, Google has helped me to look up answers to questions I have. The online flashcards on Quizlet have helped me learn a ton. It makes learning and retain information easier for me.” Research participants saw Google as a primary tool for research, whereas the library systems avoid Google as a source (Georgas, 2013). Georgas’s three article series on “Google vs. the Library: Student Preferences and Perceptions When Doing Research Using Google and a

Federated Search Tool" is an exhaustive analysis of the use of Google versus the library by students. In regard to the next question, "What do you think your instructors are skilled at in the use of technology in teaching?" Denise answered, "Instructors would have to be good at making PowerPoints and educational videos to aid in learning." Videos were not mentioned in other interviews, although YouTube is becoming a common tool for instruction. The next question, "What are the major obstacles to more effective use of computer and information technology in your courses?" was answered by Denise's comment, "The major obstacles are just taking the time to learn technology tricks and shortcuts." Here, time was mentioned again. Shortcuts are a big help but require using steps that must be memorized like a macro or a syntax command operator. If the student does not have a schema for the process, he or she will have difficulty utilizing the shortcut (Leahy & Sweller, 2016).

The next question asked, "What search skills have you developed since starting school?" Denise responded,

> I've developed the skill of taking a lot of information (like thousands of different options popping up from one search) and picking the ones that look the most reliable. I've also learned what words to search in order to get the results I want.

In her response, Denise pointed out that sorting information is key to finding good results. To the next question, "What do you wish your college would teach in respect to search skills?" Denise answered, "I wish my college would teach how to find reliable sources. This is because when writing papers, you can find ten articles that back you up with facts and ten articles that don't back you up with facts." Denise and others in this research have not had a good exposure to peer-reviewed sources so far in their education. If these students do on to graduate programs, the impact of this will become clearer, although the amount of content gathered will be significant.

When asked next question, “How do you feel about other courses regarding leaving less time for instructions on searching?” Denise was uncertain as to a reply but provided this statement: “I don’t really understand this question. I feel like they leave less time for instruction on searching because it’s not supposed to be a class on searching, so why teach that.” As the school does not offer such a class, the students had not considered that issue. Several students had difficulty with this line of questioning. Regarding the next question, “Why do you think a college would avoid instruction in search skills?” Denise offered this answer:

> I think a college would avoid instructions in search skills because they may view it as a waste of time, assuming that most people already have search skills. They may just not want to waste time teaching something that is not related to the class content.

To the next question, “what specialized search techniques did you use before going to college?” Denise answered, “I didn’t use any specialized search techniques before going to college.” In her response the next question, “What are some advanced techniques for searching?” Denise commented, “There is proximity searching, Boolean searching, and broadening/narrowing searches.” Although 90% of her class did not know what “Ctrl + F” was, some did understand Boolean concepts. The next question, “How could words (a syntax command) perform a proximity search?” was answered by Denise in this manner:

> Words are used because in a proximity search you are finding words that are within a certain number of each other. For example, you can type president W8 salary and it will find president salary and if they are in 8 words of each other.

When asked the next question, “What do the words do?” Denise responded, “They tell the search what words to search for and how many words in between we want.” On the next question, “How do they make the search work?” Denise commented, “I don’t really know how to answer this question. I don't know how they make it work; I just know you type in the commands and it works." Unless students have software coding experience, they are unlikely to understand how a syntax command operator work. Even a basic macro has programming behind the macro command for it to work. The next question asked was "How can word commands for a proximity search improve the search results?" and Denise responded:

> It makes your search results more accurate to what you are looking for. It makes almost every article that pops up relevant to what you're looking for instead of normal searches when you have to weed out the articles that don't apply.

On the next question, "How would you expect proximity searching to improve your learning experience over your education journey?" Denise answered, "I expect it will make research easier in my educational journey. I will be able to have more accurate information without having to search hard for it." Denise provided insight into the issue of time and accuracy on doing research that the other students focused on. For the last question in the interview, "Why would you want to use proximity searching?" Denise responded, "I would want to use proximity searching to speed up the process of looking for things. I probably won't use it unless I am doing papers or things like that." As Denise does not yet have a schema for using it, is understandable that she is hesitant about using the process (Leahy & Sweller, 2016).

Results

The central question of the study was, "What causes students of higher education to avoid using syntax operator commands to provide better search results?" The participant population was uniformly young as they were all from a community college.

This qualitative multiple case study was developed by careful analysis of the data collected through individual interviews, focus group interviews, and observation. This multiple case study used both a within-case synthesis and a cross-case synthesis to explain the findings. The within-case analysis is an in-depth advancement of a single case as a stand-alone unit. This enables researchers to be fully engaged in the data inside a single case. The cross-case analysis is a research process in which knowledge from specific case studies is organized. Yin (2014) suggested that utilization of case knowledge happens when the researchers gather such knowledge, compare cases, and, thus, produce new knowledge. Interview transcripts were used to create codes. These codes were then developed into themes used throughout the cases. Participant responses were implemented to satisfy the central research question and the five sub-questions. Manual, open coding was utilized with the interview transcripts, the focus group transcripts, and the observations. 37 codes were compared across the different stakeholder participant groups and the focus group. The codes were then compared with select observations to determine similarities. Five themes were developed from the codes.

Within-Case Synthesis

The community college chosen for this study was located in a southwestern state. The student population is estimated at 7,842 students, which reflects a 32% drop since 2013. Full-time students represent 26% of all students. Minority enrollment is 32% of the student body (majority Hispanic), which is less than the state average of 48%. The college is the only community college within the county.

The researcher took advantage of an instructor's help at the community college and invited the researcher to make a presentation to two different classes, where four out of the five participants were recruited. One participant was recruited to the study by a flyer at the school library. The researcher attended this college between 2008 and 2009 and took a course with the instructor that helped. The participants were either freshmen or sophomores, and their ages were

18–25. Four were female, and one was male. Although six other potential participants signed consent agreements, they failed to complete the process. As 2019 ended, the researcher was preparing to seek additional participants, but at the start of the new spring semester in 2020, the outbreak of COVID-19 caused the school to cease in-class schooling and only provide online learning. After consulting with his chair, the researcher decided to complete the research with the five participants, as face-to-face meetings would remain impossible until an indefinite point in the future.

Theme Development

Themes were developed from one-on-one interviews, a focus group, and observations. All transcripts provided 37 codes that appeared in two or more participants' data. These codes were compared for common features and then tabulated in a Microsoft Word document to demonstrate common aspects of the varied sources of data (see Appendix S). These codes were condensed to six significant themes (see Appendix T). The themes that emerged are as follows: (a) cognitive load, (b) searching Google, (c) searching school libraries, (d) syntax commands, (e) operators, and (f) GUI.

The theory that guided the researcher in this study is Sweller's theory of cognitive load. Sweller emphasized the difficulty beginning students had with the searching exercise due to extraneous cognitive load, Sweller (1988). Throughout the researcher's current study, higher-level searching skills were ignored when available. Many beginning students did not use simple keyboard shortcuts and also avoided any other available searching tools. This avoidance was consistent and the avoidance was also unknown to the beginning students. CLT explains this issue through the idea of extraneous load. When "the limitations of working memory occur, it is important that instruction reduces all sources of an extraneous cognitive load. Explicit instruction is likely to reduce the working memory load imposed compared to instructional procedures that rely on minimal guidance" (Sweller, 2016, p. 362). Although the understanding of the extraneous cognitive load burden is well known by those that write peer-reviewed articles on cognitive load, it is also unknown to beginning students, as this study has confirmed.

Authors of peer-reviewed articles on CLT have not discussed proximity searching, but by reducing the search results by 90%, proximity searching reduces extraneous load by 90%. Beginning students will have more working memory available. A schema for these working memory situations is developed easily.

Cognitive Load

Cognitive load is a fundamental roadblock to learning, and searching creates extraneous cognitive load, according to Sweller (personal communication, November 25, 2013). None of the five participants, Vicky, Ann, Autumn, Eric, and Denise, had ever heard of any of the three types of cognitive load. The researcher provided the first exposure to the term for all the participants. In addition to being unfamiliar with the term, each participant indicated surprise at the effect of cognitive load on learning. Vicky said, "I use Ctrl + F all the time to narrow search results and thought a 101 course would help." She added, "It would provide better grades and consume less time than a Google search." Ann echoed the idea that a 101 course would have merit, and Courtney said, "I never knew Ctrl + F existed before this training." Eric stated that before he went to college, the only advanced technique he knew for searching was Ctrl + F. Denise commented, "I didn't use any specialized search techniques before going to college." None of the participants had considered that extraneous cognitive load was adversely impacting their searching experience.

Developing a schema is a possible way to reduce extraneous cognitive load. The researcher introduced a developed schema to the five participants with the intent to reduce extraneous cognitive load. Schema is developed over time and is retained in long-term memory. Therefore, the solution to the short-term memory is a practice that puts the schema in long-term memory. Thus, programmers have a schema for using syntax commands, whereas students would have to develop one. Notably, as Eric had some programming experience and would comprehend this issue, the researcher discussed it. All of the subjects felt they had an intuitive understanding of schema. Eric said,

> When I'm searching databases such as ProQuest for articles for an English project, it would be useful to not only search using keywords but finding exactly what I need in X paragraph, so I don't have to read the whole document.

Searching Google

All five participants indicated that searching Google was a significant part of their student experience. None of the participants were aware Google had 42 syntax command operators to enhance searching. Vicky said she used Google as her primary search tool. Google, being used a primary search source by students was discussed by Georgas (2013). Ann commented her use of Google had improved at school from the way she previously used it with the U.S. Air Force. Autumn mentioned in the focus group that she had never heard of the keyboard shortcut Ctrl + F, but she used Google frequently.

Eric, the sole male, considered his search skills to be advanced, whereas none of the other participants claimed that distinction. Eric also commented that search engines helped in his learning. Eric was the sole participant to claim that some search engines had specific benefits. He indicated, "By spending less time on information gathering (searching), I would have more time to do other things such as work on my analysis of the data or other activities altogether." Eric was also the only participant who provided supplemental documents that entailed additional insight into specialized searching, although he perceived some gain, he felt some techniques cost too much time to use. The perception that specialized searching would be time-consuming to learn was common among all the participants, who felt that they did not have enough time to learn faster or better ways to search. Eric demonstrated he had some schema developed but thought he did not have enough time for higher-level searching.

Denise commented she used Google and had given up on books and used only websites. She believed the ease of gathering online data was making her lazy. Denise also indicated that time was an issue. Eric, on the other hand, saw a trade-off in efficiency by using the right tool. Denise indicated her skills were primarily using her cell phone and not the computer, stating, "I am fairly competent on a phone, but I have not spent much time learning skills to use on a computer."

Searching School Libraries

Courtney and Eric observed the presence of ProQuest at the school library. The researcher had talked to the head librarian, who stated that proximity searching was not available. The researcher did discuss the six major library systems (EDS, Encore Synergy, Primo, Summon, and WorldCat Local and Discovery library systems) and their limitations regarding special syntax command operators,

None of the participants were aware that higher education libraries do not endorse Google as a suitable search tool. Denise took an interest in that fact, stating, "I am going to be attending a university soon and majoring in advertising, where I will need to have more advanced technology skills." All the participants believed Google was an excellent search tool and were unaware that libraries did not provide a default option on the library website for students (Georgas, 2013). Google's ease of use was essential to all of the participants.

Syntax Commands

Of all the participants, only Eric had an awareness of syntax command operators, as he had some amateur programming experience with them. There were some earlier discussions about the shortcut Ctrl + F that Eric did know, but none of the other participants were aware that there were many shortcuts, although most knew copy and paste. In a document provided after the initial interview, Eric stated.

> I still find the simple Ctrl + F to be one of the most versatile operators that even works on tests. It's simple to execute, no need to worry about typing out a word right with the right capitalization or anything. Not only that, but it works on every website with nearly every browser (the biggest advantage). That's why I love it. (Note: Sorry to my instructors, but I simply cannot waste 20 minutes reading a bunch of fluff to answer my questions)

Denise had good cell phone skills but limited experience with computers and therefore had no experience with keyboard shortcuts. Early DOS users often used syntax commands, but the arrival of GUIs reduced the need for syntax command operators' foremost users.

Proximity operators were a new concept to all participants, although Eric grasped the idea quickly. In his first interview, Eric commented on one benefit of learning advanced search techniques such as proximity searches: "By spending less time on information gathering (searching), I would have more time to do other things such as work on my analysis of the data or other activities altogether." When asked, "Why would you want to use proximity searching?" Eric answered, "When I'm searching databases such as ProQuest for articles on an English project. It would be useful to not only search using keywords but finding exactly what I need in X paragraph, so I don't have to read the whole document."

Eric uniquely provided a separate document (Appendix U), made available before the focus group meeting, that provided insight on the understanding he had gained since the first interview. This is Eric's first comment in this document:

> To elaborate, I avoid doing unnecessary or time-consuming work. The more time you spend on an assignment, the more burned out you become as you continue working. I feel like this is how most people are, and you could argue by using syntax operators, people can drastically cut down on the "work" people do when researching which would result in less burnout and more actual work being done.

Eric, like many others, thought search engines were an important feature. He stated:

> I may also add a file system. Not only should syntax operators be used in search engines, they are almost a necessity in file management. You know how people have talked about how being organized can really help a student out? This applies to here too, and the entire process can be sped up using commands!
>
> Eric further elaborated regarding searching for file types:
>
> > This also applies to Google where you can use filetype:pdf as well, but it's pretty rare that anybody would have to use it. There is an instance where I have used it. When coming up with some extra data for a final of one of my other classes, I had to find a PDF from a credible source. To be specific, it had to be a legal document of sorts explaining the process of creating a town in each state. So I had to find a .gov website (they are your best bet when it comes to government stuff) with a PDF. An example of a command that would do this is .gov ext:pdf.

Eric commented on syntax:

> Yes there is a "source:" syntax which can sort your stuff to only being from a certain source of Google news (their format in which to find news). However, with the amount of "clickbait" out there, this is pretty much useless. (Another problem, not every command is always useful)

Eric remarked on time issues:

> There is no time for instructions on searching 95% of the time. Even if instructors found the time to do it once or twice, something that involves memorization needs to be repeated multiple times before it becomes a habit to use it. Otherwise, students would just go back to their old ways of searching without any operators.

Finally, Eric commented on versions of operators:

> Another big obstacle you should note is how each platform has its own versions of the same operators. Take for example: Google uses "X" around(n) Y while site A may use X n8 Y. There needs to be a standardized system where it's the same no matter where you go so things like proximity searching can be as well known as Ctrl + F.

Eric, throughout his document, supported the researcher's theory. His insights were only possible because he had a schema for the conditions he experienced and shared. Eric's thoughts indicate for all students to comprehend that search tools will not only perform well but also save the time that all the participants indicated was in short supply.

Operators

The researcher explained to the participants that syntax command operators are like macros. Ann, Courtney, and Denise had some understanding of macros, while Eric understood them completely. Complex syntax commands require a schema, as the user would access their long-term memory for repetitive commands. Proximity operators vary by software program. If a student uses only one software program, they will develop a schema for that program only.

Eric’s memo to the researcher provided excellent insight into the contemporary student’s attitudes about time management and time allocation. It appeared to the researcher that anything new (requiring a new schema) was a threat in spite of the possible benefits.

Graphical User Interface

The GUI is considered by all participants a better solution to learning a new schema, such as a syntax command operator or operator. This was agreed upon by all participants, and the focus group emphasized this belief. During the focus group meeting, Courtney commented that she did not know the keyboard shortcut Ctrl + F existed. This lack of knowledge of basic syntax command operators is common, as 90% of Google users are unaware of it as well (citation). Russell (personal communication, January 8, 2018) of Google pointed out that only one out of one million user uses Google operators, even though Google provides significant data on them (see Appendixes D and E). None of the 42 syntax command operators provided by Google are GUI enabled, but some could be. The researcher has created a GUI for this purpose by using a proximity operator with a software searching solution. It uses two boxes for the two keywords or phrases with a slider bar to select the distance between the two words or phrases. The tool also indicates how many files are available to consider. A GUI can be built to multitask a set of instructions, whereas a syntax operator is seldom used for such a function. This was demonstrated to the participants. They all thought it was easier and better than a syntax command. The slider bar is adjusted incrementally by the user to refine the results.

Research Question Responses

Central Question

The central question of the study is, "What causes students of higher education to avoid using syntax operator commands to provide better search results?" The results of this research demonstrated that reasons students of higher education avoid using syntax operator commands include extraneous cognitive load and short-term memory limitations that prevent schema development.

Sub-Question One

The first sub-question was: What motivates students to avoid or fail to use powerful syntax commands for searching on the Internet or other content sources? The themes of cognitive load and syntax command operators provided insight used to answer this question. The shortcut Ctrl + F was a useful example to the researcher, as the researcher found only 10% of participants knew what Ctrl + F was and what it meant. This was expected, and most (90%) were unaware of what this simple shortcut provided. It is logical to conclude if these participants did not know Ctrl + F was a search tool, they would not comprehend what syntax command operators were. The one exception was Eric, who had some programming experience. Eric was unique. Eric provided this comment: "work should be 'work' since it is in a quotation." And while this is obvious to those with scholarly knowledge on cognitive load, it is virtually unknown to beginning students at the college level, as was the case with the other four participants.

Sub-Question Two

The second sub-question was: How do complex syntax command operators induce cognitive load or self-efficacy on students who are learning to do searches? The themes of cognitive load, syntax command, and operators provided insight used to answer this question.

Vicky, Ann, Courtney, and Denise had no understanding of these terms before the instructional process by the researcher, whereas Eric had used some limited amount of them in his search efforts. Courtney and Eric indicated that Google was their favorite search engine, and Vicky, Ann, and Denise also favored a single search box like Google. A single search box dominated all participants' mindsets. The Ctrl + F aspect also indicated a limited amount of exposure to syntax command operators for all the participants except Eric. Even those with limited use of Ctrl + F often did not understand the ubiquitous nature of Ctrl + F, except Eric, who understood that Ctrl + F worked on most software programs. Courtney commented in the focus group that she had never heard of it until the researcher discussed it in the instructional process. The researcher mentioned that syntax commands and operators were similar to macros used in most Microsoft Office programs, but only Eric understood such tools for searching. In this study, only Eric understood what tools are commonly used by programmers. The researcher, based on his understanding of cognitive load, believes that the lack of schema by Vicky, Ann, Courtney, and Denise diminished their ability to start to learn syntax commands and operators. Eric, on the other hand, only considered the utility of using such tools. For Eric, it was balancing the use of such tools with how much time it took to learn them so that his schema could quickly be useful. It appears that without previously developed schema for using syntax commands or operators, students and others will not take the time to learn these search tools. The researcher believes this is a solvable issue with the introduction of a required course for higher education students in their first year of college.

None of the participants except Eric comprehended the value of search tools such as syntax commands or operators. The researcher benefitted in the research by contacting Daniel M. Russell at Google regarding an article discussing Ctrl+F usage by Google users, "Daniel M.

Russell is an American computer scientist who is a senior research scientist at Google. He teaches on the subject of effective web-search strategies, using large-scale teaching systems developed by him at Google" (Russell, 2019). This was instigated by a direct phone call and followed up with relevant e-mails. Russell (personal communication, January 8, 2018) of Google pointed out that only one out of one million user uses Google operators, even though Google provides significant data on them (see Appendixes D and E). One issue mentioned by both the researcher and Eric is different software developers use different operators for the same function, thus complicating the schema issue. In summary, Vicky, Ann, Courtney, and Denise all agreed that they avoided implementing anything complex. Eric at first considered that time was the only constraint, as he used some syntax operators in his hobbies and part-time employment. Eric ultimately realized that with proper application of these syntax commands, they could shorten his timelines to perform computer searches. In all circumstances, all participants were apprehensive to learn any additional concepts as they perceived that the time spent would not be profitable.

Sub-Question Three

The third sub-question was: What do students feel more comfortable with, Syntax command or GUI? The themes of cognitive load, syntax command, and operators provided insight used to answer this question. Vicky, Ann, Courtney, and Denise had no understanding of these terms before the instructional process by the researcher, whereas Eric had used some limited amount of them in his search efforts. The focus group event provided an opportunity for this understanding to be developed. Courtney was explicit in confirming her lack of knowledge in this area but believed a GUI for syntax commands would be better than a syntax operator command, as it was easy to make entry mistakes with a syntax command operator, whereas a

GUI fulfilled part of the text command structure. Using a GUI allowed the key element to be two words, each having a box, versus being in a string of words and other symbols. All the participants claimed time demands in their life made it difficult to study effectively. Syntax operator commands create a cognitive load and thus handicap the development of a schema that would yield a useful command. The GUI executes programming that yields the answer sought but with fewer keyboard strokes. There is nothing fuzzy about a syntax command operator, but the GUI could be programmed with some fuzzy aspects, such as if a user misspelled a word, the GUI might suggest the correct spelling or alternatives such as some existing search programs do.

These GUI enhancements are possible, whereas a syntax command operator is inflexible. Eric explained that file management uses syntax command operators such as ".*." but, remarkably, many students do not know any of them. Eric illustrated with this example: "Another amazingly useful operator for Windows is date:mm/dd/yyyy .. mm/dd/yyyy, which makes it so you can only see stuff from between those two dates. So you can sort out old stuff from before your research to the current new stuff."

Sub-Question Four

The fourth sub-question was: How did proximity searches benefit students by decreasing the distance between keywords? The themes of cognitive load, syntax command, and operators provided insight used to answer this question. Students benefit from using proximity searches as it removes 90% of the content, which is usually not pertinent to search results. Single search results can be considerable. A proximity search is between two germane words. The proximity operator only finds results in which these two words are close to each other, such as within ten spaces. Commercial Internet search engines tend to produce too many matches (known as recall) for the average search query. Proximity searching is a way to reduce the number of pages matches and to better the relevance of the matched pages. Until the introduction of this concept to the participants, they had never considered proximity, with the exception of Eric. Eric had never used the proximity operator but had seen it mentioned. After Eric understood the potential of the syntax command operator, he provided this comment: “If you don’t find a nice like use the proximity search all the time, then your likeliness of you’re going to learn it as a lot lower.” In this statement, Eric identified the difficulty with a syntax command. If there is no schema for it, then it is more difficult to recall the syntax command.

A general search, like a Google search, using two words looks for each word separately. The distance between the words is not taken into account. Therefore, there is not an implicit relationship between the words. In a proximity search, the distance between the words is entered. The implication is that the closer the words are to each other, the more the relationship. Thus, if you are looking for the social studies program “Man: A Course of Study”, and you enter “Man” and “Course” into a google search, the resulting 1.7 billion hits will include golf courses, racecourses, and much more. Finding “Man: A Course of Study” in the results is nearly impossible. However, a proximity search of “man” within 4 words of “course” produces a first result of “Man: A Course of Study” along with several other pertinent results. The search could have been done with eight words between the two target words, increasing the number of the results and giving a wider range of less pertinent hits. However, all of the subjects indicated that they would probably not remember that the syntax command for searching one word within 4 words of another word in Google is “man AROUND(4) course”. However, all participants did agree that using the GUI where they simply entered the first word, chose the distance between words and entered the second word was much more likely for them.

Sub-Question Five

The fifth sub-question was: What do students like/felt more comfortable with, syntax command or GUI? The themes of cognitive load, syntax command, and operators provided insight used to answer this question. When a GUI can be used, the search's complexity is reduced, as evidenced by Courtney's and Ann's indications that they would consider using the GUI versus the syntax operator command. As a programmer, Eric liked the syntax command, but he had a schema for that type of syntax command before considering a GUI. Earlier, Eric had commented,

> Even if instructors found the time to do it once or twice, something that involves memorization needs to be repeated multiple times before it becomes a habit to use it. Otherwise, students would just go back to their old ways of searching without any operators.

Here, Eric indicated the time demands of studying prohibit learning new schemas that are time savers. Time was mentioned by all participants at some point in their participation, but none had tried the proximity operator as they had never heard of one. Denise commented,

> I think a college would avoid instructions in search skills because they may view it as a waste of time assuming that most people already have search skills. They may just not want to waste time on teaching something that isn't related to the class content.

The consensus among the participants was that a GUI was better than a syntax operator as it appeared as a widget versus a syntax statement.

Summary

This chapter described the research results of the interviews, focus groups and observations. The purpose was to understand the skill sets that beginning students had relative to searching and introduce these students to higher-level search skills. Face-to-face interviews, focus groups, observation, and within-case evaluation revealed significant shortcomings as well as new opportunities to improve search skills. A synthesis of the data from all sources allowed the development of six themes: cognitive load, searching Google, searching school libraries, syntax commands, operators, and GUIs. This synthesis assisted in developing an answer to the central question and five sub-questions of this research study.

CHAPTER FIVE: CONCLUSION

Overview

This qualitative case study aims to explore the usefulness of high-level search techniques to reduce students' cognitive load. The study's central phenomenon is what causes students to avoid learning syntax operator commands (Yin, 2014). Higher-level search techniques are defined as the use of a syntax operator command technique or a GUI technique to more quickly discover pertinent answers to questions on previously gathered content (Vuurens & Vries, 2014). This research took place at a community college in Arizona, and participants are students in their early college-level classes. The theory guiding this study is CLT.

Summary of Findings

Data for this research study were collected from individual interviews with five participants, a focus group, and observations. The participants were all either freshmen or sophomores at a community college in Arizona. The research was completed before COVID-19 interfered with planned face-to-face interviews. COVID-19 caused the curtailing of face-to-face interviews at five participants. Data were compiled using open coding and then analyzed to develop themes. The themes were cognitive load, searching Google, searching school libraries, syntax commands, operators, and GUIs. With a detailed assessment of the findings, within-case indicate paths for future research and unresolved issues that need focus, specifically the lack of searching skills by beginning students.

The central question for the research was, "What causes students of higher education to avoid using syntax operator commands to provide better search results?" The research themes and observations provided clear insight that students do not embrace syntax operator commands unless being aware of them, or without a schema for doing so. A student that has no knowledge of a subject cannot have a schema. Therefore, if enhanced search skills are justified, the teaching of these skills is a necessary prerequisite.

The first sub-question asked: What motivates students to avoid or fail to use powerful syntax commands for searching on the internet or other content sources? (e.g., proximity searching). The themes of cognitive load and syntax command operators provided insight used to answer this question. Of the five participants, Vicky, Ann, Courtney, Denise, and Eric, none had ever heard of cognitive load. None of them had heard of the concept of schema a key factor in finding a way to overcome the cognitive load. Although all participants had been aware of short-term memory concepts, they had not associated short-term memory with the cognitive load even though it is a key factor. None of the participants comprehended the concept of syntax commands except Eric, who had some practical experience with programming.

The second sub-question asked: How do complex syntax command operators induce cognitive load or self-efficacy on students who are learning to do searches? The themes of cognitive load and syntax command operators provided insight used to answer this question. Syntax command operators are important tools for developers and programmers, as syntax commands and operators perform precise functions and are not fuzzy. Learning them does create cognitive load when the user does not have a schema for either. In order for syntax commands or operators to become part of long-term memory, they must become part of a person's schema. The development of schema is time-intensive; thus, it creates a cognitive load. None of the participants, except Eric, had a schema for syntax commands or operators. Therefore, beginning students are not prepared for the cognitive load limitations created by searching. Redundant use of syntax commands or operators will induce a schema.

The third sub-question asked: Does substituting a GUI for syntax commands impact a student's use of complex search techniques? The themes of cognitive load, syntax command, searching Google, and operators provided insight used to answer this question. All the participants claimed that they used Google's single word search feature as a GUI that bypasses the syntax command or operator. Operators are added and removed from the Google operator list from time to time, and therefore, the list is not static. The GUI does the syntax command or operator seamlessly without action by the user and can often be programmed with a fuzzy attribute not possible with a syntax command or operator. This provides an excellent opportunity for Google to enhance the experience by adding fuzzy features such as spell check or spelling alternatives, among others.

A GUI, such as a slider-bar, is preferable to the syntax command or operator. It is easy to imagine the function it provides as it is visual. It is possible to combine several syntax commands in one GUI. Google offers a syntax operator command/operator for proximity searching but does not provide a GUI for that function. This function could be added to a GUI as has been done by the researcher to make the operator more visual and fuzzier. The GUI version of the proximity search was demonstrated, and all the participants in the focus group collectively endorsed it as a superior process to the syntax command. So, while students are attracted to Google's single word search qualities, they do not have a GUI from Google to perform the proximity search offered.

The searching Google theme illustrates the significance of a single search box. If a person uses a PC, they should note that the monitor's bottom-left corner shows an empty search box. This is an acknowledgment by Microsoft that people prefer a single search box. Google's approach demonstrates the ubiquitous of the single search box. This confounds librarians, as they do not believe students should rely on Google as much as they do. All the participants knew their library used ProQuest, but none knew that the ProQuest system did not provide proximity searching.

The fourth sub-question asked: How did proximity searches benefit students by decreasing the distance between keywords? The themes of cognitive load, syntax command, and operators provided insight used to answer this question. The reduction of cognitive load is a prime goal of educators, but no attention has been given to reducing cognitive load created by searching; Sweller's communications with the researcher well define that issue. Searching creates cognitive load as well as higher-level and more effective syntax commands that only a programmer would have the schema for, which adds to the initial cognitive load's difficulty. Therefore, a GUI would not need a refined schema as it is visual, and the user can see all the parameters in a visual moment and take fewer steps to execute. This topic was discussed in the focus group, and all participants agreed they would prefer a widget for the search if possible. Even Eric decided in the focus group that a widget was preferable to a syntax command. As Eric pointed out in his memo, the problem with syntax commands is there is no standardization. Companies usually write these commands differently, compounding the development of a schema.

The fifth sub-question asked: What do students like/felt more comfortable with, syntax command or GUI? The themes of cognitive load, syntax command, and operators provided insight used to answer this question. All participants chose the widget GUI over the syntax command. The researcher believes that the lack of a schema drove the participants to make this decision.

Discussion

The purpose of the study's empirical evidence demonstrates a complete lack of understanding of fundamental searching techniques available on behalf of beginning students If 90% of them do not know what Ctrl + F does, then the possibilities that these students would learn even more advanced tools for searching that would include syntax commands is not probable.

Empirical Foundations

The central question for the research was, "What causes students of higher education to avoid using syntax operator commands to provide better search results?" Although other research efforts do not explicitly address this question, there were some clues. There was an abundance of peer-reviewed articles on the effects of cognitive load, but they did not comment on the impact on cognitive load on searching. The other researchers' focus was on the process of learning, not searching. Despite this shortcoming, it was useful to analyze these articles to note the deficiencies.

Searching creates cognitive load. Studying articles on cognitive load helped me understand "extraneous cognitive load" and, in turn, to comprehend schema and its role in influencing long-term memory. Unless a student has a schema for using syntax commands such as a programmer would use frequently, they would not use available syntax commands.

My research study was notably different from the peer-reviewed articles as I sought a narrow distinction with the research question, "What causes students of higher education to avoid using syntax operator commands to provide better search results?" Although syntax command operators have been around since computers were used, only programmers had an affinity to use them. Syntax command operators are complex for those that do not use them frequently. For programmers, syntax command operators are necessary to fulfill their jobs.

My study has added a new dimension to the research on the use of a complex syntax command by suggesting the creation of a widget/GUI for the execution of the command. This is frequently done for some issues but has not been adopted by programmers as they are comfortable with the syntax command. While syntax commands are tightly structured in a manner with no exceptions, the widget/GUI can be programmed so that it is fuzzy and has additional features such as finding germane alternative words or spellchecking.

Theoretical Foundations

No previous studies have addressed the central question, "What causes higher education students to avoid using syntax operator commands to provide better search results?" As this issue is associated with cognitive load (Sweller, 1988), there was considerable data, and some were relevant to this study. I contacted John Sweller regarding cognitive load for a beginning student searching for data for their studies, and Sweller verified that the cognitive load for such a student is very high. Extraneous cognitive load refers to the way information or tasks are presented to a learner. Intrinsic cognitive load is the effort associated with a specific topic. Extraneous cognitive load refers to how information or tasks are presented to a learner, and germane cognitive load refers to the work put into creating a permanent store of knowledge or a schema. A schema is a cognitive structure that helps organize and interpret information. Schemas allow the brain to take shortcuts in deciphering the excessive amount of available data in many situations.

The lack of schema in beginning students for syntax commands is significant. Amateur programmers have had an opportunity to be exposed to a syntax operator command. It is a fundamental concept in programming and is familiar to programmers. As Kalyuga1 and Singh (2015) demonstrated in an article:

> Until the 1998 article by Sweller, Van Merriënboer & Paas, cognitive load theory primarily concentrated on the reduction of extraneous cognitive load. With this article, cognitive load researchers began to seek ways of redesigning instruction to redirect what would be extraneous load, to now be focused on schema construction (germane load). Thus it is very important for instructional designers to reduce extraneous cognitive load and redirect learners' attention to cognitive processes that are directly relevant to the construction of schemas.

The research study confirmed Sweller's theory of extraneous cognitive load. Vicky, Ann, Courtney, and Denise all indicated a preference due the extraneous load Sweller confirmed in personal correspondence. Eric, who has a history of limited programing, at first thought the syntax command was preferable, but migrated to the GUI/widget approach when taught to new students.

Implications

This study explores what causes higher education students to avoid using syntax operator commands to get better search results. Syntax operator commands are abundant and simple to use but are overlooked by nearly all students. This poses a learning issue, as the searching process is a first step to learning. The reasons students avoid using syntax commands were never considered by researchers previously, although there were some clues. Discussions about cognitive load was a clue.

Theoretical

John Sweller developed CLT and first presented it in a paper in the journal *Cognitive Science* in 1988. “Cognitive load” relates to the amount of information that working memory can hold at one time. There was no discussion by Sweller as to the central question. Still, in e-mail communications, Sweller (personal communication, November 25, 2013) confirmed that beginning students would have a significant extraneous cognitive load. In Sweller’s research, there is a substantial consideration of the three main types of cognitive load: intrinsic, extraneous, and germane. Scholars frequently discuss extraneous cognitive load, as it negatively impacts learning. In 2002, Kirschner’s stated the following in the article “Cognitive Load Theory: Implications of Cognitive Load Theory on the Design of Learning”:

> Learning, reflected by performance change, requires working-memory capacity. It imposes a germane CL on the learner (Sweller, van Merrienboer, & Paas, 1998). Germane CL is required for the construction and storage of schemata into long-term memory. The construction of adequate and rich schemata is especially important in complex learning tasks where it will require more effort, because the elements contained by the to-be-learned material are highly interconnected (see, for example, the article in this issue by Pollock et al.). This is referred to as intrinsic CL, which is the portion of load that is imposed by the intrinsic characteristics of the task or subject matter. According to CLT the limitations of working memory are rarely taken into account in conventional instruction. Conventional instructions tend to impose an extraneous CL on working memory, whereas learning something requires shifting from extraneous to germane CL. (p. 4)

Sweller (2013) has claimed that searching is a highly extraneous load, and extraneous load is one of the pillars of cognitive load. Research on this issue is appropriate and timely. The participants in this study indicated universally that time constraints impacted what choices they made. Extraneous does impact learning, and that is pertinent to this study.

Empirical

Searching would seem to be ubiquitous and, therefore, undeserving of attention. Educators ignore searching skills at the curriculum level. As a result, new students are hindered in developing good results and experience extraneous cognitive load, (Sweller, 2013). This not surprising, as many students (90%) are unfamiliar with the keyboard shortcut Ctrl + F (Russell, 2018). Colaric (2003) commented on students regarding searching:

> Users searching the Web have difficulty using search engines and developing queries. Searches tend to be simple, and Boolean operators are used infrequently and incorrectly. Users also are unaware that search engines operate differently from other information retrieval systems. Yet, there is little research on effective instructional methods for teaching users how to search the Web. Research has looked at instructional methods for other types of information retrieval, but these systems differ a great deal from the Web. The purpose of this study was to determine what undergraduate students know about search engines and to examine instructional treatments to aid searchers in using a search engine. (p. 111)

It is becoming more evident to researchers that students engaged in higher learning in the university systems do not search effectively. Ferrari (2001) discussed how chronic procrastinators demonstrated “that objective self-awareness under high cognitive load and time limitations produce self-regulation failure of performance speed and accuracy” (p. 403). Chronic procrastinators did not suitably regulate performance skills to the right ratio of speed to accuracy when time constraints were imposed. During experiments, chronic procrastinators exhibited inferior performance results and seemed to “choke under pressure, versus doing well under pressure” (Ferrari, 2001, p .402).

Although there has been some attention given to the search issue in the scholarly literature, it has gone mostly unnoticed by administrators, librarians, and instructors. Instructor Lovell was surprised to learn that 90% of people who use Google did not know that Ctrl + F was a shortcut. Instructor Lovell and the researcher surveyed two of his classes and discovered that precisely 90% did not know that Ctrl + F would find text in most software, and although it was not a scientific survey, it did point out to an instructor that search technique was untaught at this school. As Colaric (2003) pointed out in her quantitative research, “Users also are unaware that search engines operate differently from other information retrieval systems” (p. 111). Yet, there is little research on effective instructional methods for teaching users how to search the web. Georgas (2013) described in her three articles that students prefer the Google single word search box. Georgas and Colaric are both librarians. During Fall 2015 and Spring 2016, CCL-EAR conducted a comparison review of Discovery Services for the California Community Colleges. This study by librarians of university libraries compared EDS, Encore Synergy, Primo, Summon, and WorldCat Local and Discovery systems. Only WorldCat provided a proximity search method. The other four systems did not use any syntax command operators, as most used only Boolean operators.

Practical

There are several practical implications of this study that merit attention. First, the results provide evidence that beginning students are deficient in searching skills. Second, students need a basic course in the fundamentals starting with shortcuts such as Ctrl + F so they can see the benefit of learning these simple tools. Third, instructors need to be aware that these tools are available and advise students to master fundamental search tools. Fourth, libraries should be persuaded to encourage students to learn a basic set of syntax operators to refine searches. Fifth, future research should review the big six library systems (EDS, Encore Synergy, Primo, Summon, WorldCat Local, and WorldCat Discovery) for the best features, including any syntax command operators. Finally, student should be aware that only one of these systems, WorldCat Local, includes a proximity syntax command operator, one of the most useful.

Delimitations and Limitations

Limitations include the possibility that participants' gender influenced their responses, as more females volunteered than males. The only male volunteer, Eric, had basic programming knowledge and was valuable to the research as he knew what syntax command operators were, whereas none of the females knew what they were. The researcher believes that there are more male programmers. Numbers from the Bureau of Labor Statistics and Catalyst in 2006 indicated that women make up 27%–29% of the computing workforce. A National Public Radio report in 2013 stated that about 20% of all U.S. computer programmers are female.

The delimitations of this study include only selecting participants 18 and older, choosing freshman or sophomore community college students, allowing both genders, and relying on the flyer to attract participants.

Recommendations for Future Research

Future quantitative research on what students do know about searching as they enter college would provide the higher education system with some baseline information. The reasons for their level of knowledge can then be determined. As the new number of new students is vast, a significant sample should be easy to collect. It is crucial to urge new students to develop lifelong habits of using syntax operators. Also, students should learn how to index their content. As few have ever tried to index a document manually, they would discover that a computer can index the entire Bible in less than a minute, and any word or phrase can be retrieved in less than a second. A student needs to collect data and index the same with searching software. Students need to understand that neither Google nor the school library index their school data. The goal of future research could be to determine learning benefits among those that use such learned processes and compare them with those who do not learn these processes. Two groups would be used over a three-year period, with about 15 in each group.

Summary

The purpose of this study was to discover what causes students of higher education to avoid using syntax operator commands to provide better search results. The focus was on beginning students in the first year of college or university. Beginning students are faced with a significant burden for research requiring searching skills.

Google publishes 42 syntax command operators for the general public. Google is not the only source of these types of syntax command operators, but Google provided insight into how infrequently Google users use these tools. An executive, D. M. Russell (personal communication, January 8, 2018), told the researcher that only one person in a million used any of these operators. Sweller said to the researcher,

> One of the major findings (in fact, the very first finding) of CLT is that requiring learners to search for information imposes a very heavy, extraneous cognitive load. The search process overloads working memory with processes that are extraneous to learning. (personal communication, November 25, 2013)

Sweller (personal communication, November 25, 2013) and Russell (personal communication, January 8, 2018) provided insight into the degree of avoidance and a logical reason people avoid complex text, and these insights are supported by others such as Kirschner (2002). Using indexing and search systems on my computer, I found 53 authors other than Sweller who commented on extraneous cognitive load impacting a person's ability to function. Deue and vam de Leemput (2014) stated:

> Extraneous Load (EL) refers to those mental resources devoted to elements that do not contribute to learning and schemata acquisition or automation. It is mainly related to the information presentation and the instructional format that could both increase the user's overall cognitive load without enhancing learning.
>
> Although instructional interventions can alter both extraneous cognitive load and germane cognitive load, extraneous cognitive load reflects the effort required to process inadequately designed instruction. The germane cognitive load reveals the attempt that contributes to the construction of schemas. Appropriate instructional designs decrease extraneous cognitive load but increase the germane cognitive load (as cited in Sweller et al., 1998).

With Sweller and significant others agreeing that extraneous cognitive load is created by poorly designed instruction (or in this situation, no instruction), there is no schema for the beginning student for complex syntax command operators. Therefore, beginning students have not been prepared for new complex instruction such as syntax command operators that programmers design. To add to this complexity, programmers use a multitude of instructions for a singular result, such as sets in a proximity search: Following is a list of some proximity operators that can be used to search for "police" within 10 words of "donut":

Google: donut around(10) police

ISYS: donut /10/ police

Logos: (donut) WITHIN 10 Words (police)

dtSearch: donut w/10 police

Lucene (including DocFetcher): “donut police"--10~

FAST: near(donut,police,n=-10)

Autonomy: donut NEAR10 police

Coveo: donut NEAR:10 police

Copernic: donut NEAR police

Each of these syntax commands would require a separate schema, and as a programmer only works with one software system at a time, it is not difficult. However, developing multiple schemas is too complicated for the beginning student. Participant Eric, the amateur programmer, commented on this:

> Another big obstacle you should note is how each platform has its versions of the same operators. Take, for example; Google uses ‘X’ around(n) Y while site A may use X n8 Y. There needs to be a standardized system where it is the same no matter where you go so, things like proximity searching can be as well-known as Ctrl + F.

Dr. Sweller was an immense help separating issues on cognitive load, and in one e-mail, the researcher mentioned syntax proximity operators. Sweller quickly informed the researcher that he “knew nothing about syntax proximity operators” (personal communication, November 25, 2013). Afterward, the researcher thought Sweller did not have a schema for syntax operator commands.

All participants complained about time constraints. The proximity syntax command operator reduces search results by about 90%, providing less material to review. Although using a proximity syntax command operator such as "donut around(10) police" requires a schema, a programmer at Google could make a widget to do this same function, and the schema for the widget would not be complicated, as it takes on the aspect of a GUI instead of looking like a programmer's code. The use of GUIs started with Windows 1.0. (1985) but did not gain favor until Windows 3.0 was introduced. Widgets provide users with the possibility of multiple steps or commands that a syntax command operator cannot do. Therefore, users can develop a schema more easily for a GUI than for a syntax command operator. Command widgets are used for command entry and provide a built-in command history mechanism. The command widgets include a text input field, a label for the text input field, and a command history window. The use of a GUI advanced quickly after the development of Windows 3.0. All the participants were positive that the GUI/widget application was superior to the syntax command operator. Beginning students should be provided with suitable searching skills within a well-designed framework. When students have these skills, the instructors, the school, and students will benefit.

Sweller (2016) encouraged researchers with this comment:

> The closer our ideas are to the prevailing zeitgeist, the more acceptable they will be. Most research papers support the prevailing views, whatever those views might be. Therefore, do not hesitate to advance ideas conflicting with the current zeitgeist. They may be ignored for a while but, if they do have merit, they are very likely to be ultimately recognized. (p. 111)

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Appendix A: IRB Approval Letter

LIBERTY UNIVERSITY
INSTITUTIONAL REVIEW BOARD

August 12, 2019

Donald G. Campbell
IRB Exemption 3697.081219: Proximity Search Techniques to Reduce Cognitive Load: A Case Study

Dear Donald G. Campbell,

The Liberty University Institutional Review Board has reviewed your application in accordance with the Office for Human Research Protections (OHRP) and Food and Drug Administration (FDA) regulations and finds your study to be exempt from further IRB review. This means you may begin your research with the data safeguarding methods mentioned in your approved application, and no further IRB oversight is required.

Your study falls under exemption category 46.101(b)(2), which identifies specific situations in which human participants research is exempt from the policy set forth in 45 CFR 46:101(b):

> (2) Research that only includes interactions involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior (including visual or auditory recording) if at least one of the following criteria is met:
>
> > (ii) Any disclosure of the human subjects' responses outside the research would not reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, educational advancement, or reputation; or

Please note that this exemption only applies to your current research application, and any changes to your protocol must be reported to the Liberty IRB for verification of continued exemption status. You may report these changes by submitting a change in protocol form or a new application to the IRB and referencing the above IRB Exemption number.

If you have any questions about this exemption or need assistance in determining whether possible changes to your protocol would change your exemption status, please email us at irb@liberty.edu.

Sincerely,
G. Michele Baker, MA, CIP
Administrative Chair of Institutional Research
Research Ethics Office

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Appendix B: Consent Form

PROXIMITY SEARCH TECHNIQUES TO REDUCE COGNITIVE LOAD: A CASE STUDY

1. INFORMED CONSENT FORM FOR ADULTS

1. Donald G. Campbell, who is a graduate student, has requested my participation in a research study at this institution.

2. I have been informed that the purpose of the research is to do a research study on learning proximity searching to enable students to reduce effort and find what they are looking for in a quicker and more accurate way. There will be 12 participants selected because you are a freshman or sophomore level student at a community college, in your 1st2nd year of college, and you are 18 years old or older. These 12 participants are to be selected as they have had minimum exposure to advanced searching techniques. The purpose of this study is to discover what causes students of higher education to avoid using syntax operator commands to provide better search results.

3. My participation will involve being interviewed, be taught how to use a syntax operator proximity search command and participate in a focus group. The procedures will involve three separate meetings, and each meeting should take approximately 45 to 60 minutes. My name and other identifying information will be requested as part of my participation, but this information will remain confidential. Participation in this study is voluntary. My decision whether to participate will not affect my current or future relations with Liberty University. If I decide to participate, I am free to not answer any question or withdraw at any time within two weeks after the initial meeting.

4. There are no foreseeable risks or discomforts.

6. I understand that the possible benefits of my participation in the research are that participants should expect to receive from taking part in this study is the opportunity to learn to use proximity search techniques, which will enable them to improve their academic performance. The use of proximity search techniques will provide increased accuracy of internet search efforts for society.

7. I understand that the results of the research study may be published but that my name or identity will not be revealed. In order to maintain confidentiality of my records, the records of this study will be kept private. In any sort of report Donald G. Campbell might publish, will not include any information that will make it possible to identify a subject. Research records will be stored securely, and only the researcher will have access to the records.

- Participants will be assigned a pseudonym. Donald G. Campbell will conduct the interviews in a location where others will not easily overhear the conversation.
- Data will be stored on a password locked computer and may be used in future presentations. After three years, all electronic records will be deleted
- Interviews and focus groups will be recorded and transcribed. Recordings will be stored on a password locked computer for three years and then erased. Only the researcher will have access to these recordings.

- Donald G. Campbell cannot assure participants that other members of the focus group will not share what was discussed with persons outside of the group.

9. I have been informed that I will be compensated for my participation as follows: Participants will be compensated for participating in this study. An Amazon gift card valued at $25 will be issued to participants who complete all interviews.

10. I have been informed that any questions I have concerning the research study or my participation in it, before or after my consent, will be answered by Donald G. Campbell, [redacted], telephone [redacted]. This refers to the researcher. You may also contact the researcher's faculty chair, Dr. John R. Duryea, at [redacted].

11. If I have questions about my rights as a subject/participant in this research, or if I feel I have been placed at risk, I can contact the Director, Office of Institutional Research.

12. I have read the above informed consent. The nature, demands, benefits and any risk of the project have been explained to me. I knowingly assume any risks involved. I understand that I may withdraw my consent and discontinue participation at any time without penalty or loss of benefit to myself. In signing this consent form, I am not waiving any legal claims, rights, or remedies. I can obtain further information from Donald G. Campbell, a graduate student at [redacted]. A copy of this consent form will be given to me.

I understand that I will be recorded or videotaped by the researcher. These [*tapes/electronic recordings]* will be kept by the researcher on a password protected computer. I understand that only the researcher will have access to these recordings and that they will be destroyed by December 2022.

<u>Video recording of study activities</u>

Interviews may be recorded using video devices to assist with the accuracy of your responses. You have the right to refuse the video recording. Please select one of the following options:

I consent to video recording: Yes _______ No_______

<u>Audio Recording of Study Activities</u>

Interviews may be recorded using audio recording to assist with the accuracy of your responses. You have the right to refuse the audio recording. Please select one of the following options:

I consent to audio recording: Yes _______ No_______

____ ________________
Subject's Signature Date

13. "I certify that I have explained to the above individual the nature and purpose, the potential benefits and possible risks associated with participation in this research study, have answered any questions that have been raised, and have witnessed the above signature."

14. "I have provided the subject/participant a copy of this signed consent document."

____ ________________
Researcher's Signature Date

Appendix C: Focus Group

Other Data Collection Procedures

Focus Group

1. Using focus groups, the group will discuss cognitive load theory (CLT) and searching skills. While complex to those not familiar with the term "cognitive load" a very short YouTube video showing the basics will help facilitate this discussion. Also, a short PowerPoint presentation will complete the basics. Frequently, when people have this explained to them they perceive how this has impacted their lives before this explanation.

2. Using a focus group, the group will discuss the benefit of improved searching skills to learning and grade improvement.

Appendix D: Advanced Google Search Operators

Table 1

Advanced Google Search Operators

Operator	Function	Example Use
Cache	Using the cache operator, you can find out what the most recent cache of a specified webpage is. This is useful for identifying when a page was last crawled.	cache:websitename.com
Allintext	This operator will help you find whether all the terms that you are looking for shows up in the text of that page. This operator, however, isn't pin-accurate because it won't look for text on the page that appears close together.	allintext:content social links
Intext	This operator is a more global operator that allows you to find any terms showing up on a webpage in any area – like the title, the page itself, the URL, and elsewhere. This is useful if you want to perform research into how others' on-page footprints are being categorized by Google.	word one intext: other term
Inposttitle	If you are performing blog research, this operator is useful for finding blogs with certain search terms in the blog title.	inposttitle:weight loss goals
Allintitle	This search operator is a great way to find blogs that match the content you are writing about. For example, you could use allintitle to research what others are doing for that particular topic. Then, you could write your post to be better than theirs.	allintitle:how to write content for Liberty
Intitle	This is a narrower operator that will help you find more targeted results for specific search phrases. If you wanted to find pages that are all about "drawing with micron pens" for example, the following is how you would use it:	intitle:drawing with micron pens
Allinurl	This one allows you to find pages with your requested search terms within the URL in internal search pages. For example, say you wanted to perform research on pages on a site that had the terms "drawing tablet". You would use the following	allinurl:amazon drawing tablet

Imurl	If you wanted to find pages on a site that has your targeted search term in the URL, and the second term in content on a website, you could use this operator. This is useful for finding sites with strong on-page optimization for the topics you are researching.	inurl:drawing portraits
Allinanchor	This operator is useful for performing research on pages that have all terms after “inanchor:” in anchor text linking back to the page. Using this operator can help you find	allinanchor:”how to draw anime”
Inanchor	It is possible to identify pages with inbound links that contain the anchor text specified. However, data is only sampled and doesn’t provide accurate global results.	inanchor:”digital painting”
Filetype	Do you want to find images that only fall under a specific file type (e.g., .jpg, .png, or .gif)? This is a great way to narrow research on infographics or memes. But, it can also help you identify stray images and other files (like PDFs) that may have been picked up by Google.	apple filetype:pdf / apple ext:pdf
Around() (Proximity)	This is a proximity search tool. If you want to narrow the focus of your results to be super narrow? This is a great way to identify search results where two or more terms appear on the page, and also appear very close to each other (denoted by the number in the parentheses).	Sherman AROUND(5) Savannah Campaign
Or	This command will help you search for pages that have one word or the other. If you wanted to find the words drawing or painting, but not both, you could use this command to do so.	digital drawing OR digital painting
Quotes (“word”)	Using quotes around the phrases you are searching for will help you find results that are exact match results, rather than the broad results you will get with standard search.	“search term 1”
Exclude words: (-)	The minus sign is an exclusion symbol. This command will help you exclude words that you don’t want to appear in the search results. Say for some reason that you wanted to find pages that have the word content marketing but not pages from Business Insider that contain this phrase	“content marketing -businessinsider.com”

Add words: (+)	You can use a plus sign to add words that you want to be included in the search results.	“content marketing + SEO”
Site:	If you are in need of more specific results that are catered to a single website, this command will help you bring those results up. For example, if you wanted to search your favorite SEO website for articles on 404 errors, you would use the following	“site:searchenginejournal.com 404 errors
Related	If you’re in a situation where you need any results that have more than one website with similar content to a site you are familiar with, just use the following:	“related:domainname.com ”
Related:	This one will help you find information related to the domain that you are searching. It will help you identify things like pages with the domain text on-page (not necessarily linked), similar on-site pages, and the website’s cache	secure URLs -404 errors
Info:	This one will help you find information related to the domain that you are searching. It will help you identify things like pages with the domain text on-page (not necessarily linked), similar on-site pages, and the website’s cache	“info:domainname.com”
Exclude specific terms that aren’t helpful to you	Example use: term1 -term2. Say you were doing research for SEO content that talks about secure URLs, but you wanted to exclude anything that mentioned 404 errors. Because, for your purposes, 404 errors won’t help you. The following would suffice:	secure URLs -404 errors
Exclude more than one term	Example use: term1 -term2 -term3 -term4 If your content research revolved around 404 errors, but all you want are pages that talk about 404 errors (and pages that do not mention 404 errors for canonicals, 500 errors, and the like), you can use this combination:	secure urls -404 errors -canonicals -500 errors
Exclude terms that are exact	If you want to find pages that mention technical SEO audits but do not include 404 errors or XML sitemaps in the topical discussion, this operator will help. Please note that it will include XML sitemap unless it’s specified to exclude.	technical seo -”404 errors

Appendix E: Google Search Operators by Google

Table 2

Google Search Operators by Google

Operator	Function	Example Use
Search social media	Put @ in front of a word to search social media.	@twitter.
Search for a price	Put $ in front of a number.	camera $400.
Search hashtags	Put # in front of a word.	#throwbackthursday
Exclude words from your search	Put - in front of a word you want to leave out.	jaguar speed -car .
Search for an exact match	Put a word or phrase inside quotes.	"tallest building"
Search for wildcards or unknown words	Put a * in your word or phrase where you want to leave a placeholder.	"largest * in the world"
Search within a range of numbers	Put .. between two numbers.	camera $50..$100.
Combine searches	Put "OR" between each search query.	marathon OR race.
Search for a specific site	Put "site:" in front of a site or domain.	site:youtube.com or site:.gov
Search for related sites	Put "related:" in front of a web address you already know.	related:time.com
See Google's cached version of a site	Put "cache:" in front of the site address.	cache: google.com/websearch/answer/2466433?hl=en. ("Refine web searches," 2018)

Note. Adapted from "Google Search Operators: The Complete List (42 Advanced Operators), by J. Hardwick, August 3, 2020 (https://ahrefs.com/blog/google-advanced-search-operators/). Copyright 2020 by *Ahrefs blog.*

Appendix F: Microsoft Advanced Query Syntax

Table 3

Microsoft Advanced Query Syntax

File Type Restricted	Use	Example
All file types	everything	kind:everything
Communication	communications	kind:communications
Contacts	contacts	kind:contacts
E-mail	e-mail	kind:email
Instant messenger conversations	im	kind:im
Meetings	meetings	kind:meetings
Tasks	tasks	kind:tasks
Notes	notes	kind:notes
Documents	docs	kind:docs
Text documents	text	kind:text
Spreadsheets	spreadsheets	kind:spreadsheets
Presentations	presentations	kind:presentations
Music	music	kind:music
Pictures	pictures	kind:pics
Videos	videos	kind:videos
Folders	folders	kind:folders
Folder name	foldername	kind:mydocs
Favorites	favorites	kind:favorites
Programs	programs	kind:programs

Note. Adapted from “Using Advanced Query Syntax,” by Microsoft, May 31, 2018 (https://docs.microsoft.com/en-us/windows/win32/search/-search-3x-advancedquerysyntax). Copyright 2018 by Microsoft.

Appendix G: Microsoft Table of Boolean Operators

Table 4

Microsoft Table of Boolean Operators

Keyword/Symbol	Example	Function
NOT	Social NOT security	Finds items that contain social, but not security.
…	Social…security	Finds items that contain social, but not security.
OR	Social OR security	Finds items that contain social or security.
Quotation marks	“social security”	Finds items that contain the exact phrase social security.
Parentheses	(social security)	Finds items that contain social and security in any order.
>	date:>11/05/17	Finds items with a date after 11/05/17.
	size:>500	Finds items with a size greater than 500 bytes.
<	date:<11/05/17	Finds items with a date before 11/05/17.
	size:<500	Finds items with a size less than 500 bytes.
..	date:11/05/04..11/10/17	Finds items with a date beginning on 11/05/17 and ending on 11/10/17

Note. The operators NOT and OR must be in uppercase and cannot be combined in one query (e.g., social OR security NOT retirement). Adapted from “Using Advanced Query Syntax,” by Microsoft, May 31, 2018 (https://docs.microsoft.com/en-us/windows/win32/search/-search-3x-advancedquerysyntax). Copyright 2018 by Microsoft.

Appendix H: Microsoft Table of Boolean Properties

Table 5

Microsoft Table of Boolean Properties

Property	Example	Function
is:attachment	report is:attachment	Finds items that have attachments that contain report. Same as isattachment:true.
isonline:	report isonline:true	Finds items that are online and which contain report.
isrecurring:	report isrecurring:true	Finds items that are recurring and which contain report.
isflagged:	report isflagged:true	Finds items that are flagged (Review, Follow up, for example) and which contain report. .
isdeleted:	report isdeleted:true	Finds items that are flagged as deleted (Recycle Bin or Deleted Items, for example) and which contain report.
iscompleted:	report is completed:false	Finds items that are not flagged as complete and which contain report.
hasattachment:	report hasattachment:true	Finds items containing report and having attachments
hasflag:	report hasflag:true	Finds items containing report and having flags.

Note. Adapted from "Using Advanced Query Syntax," by Microsoft, May 31, 2018 (https://docs.microsoft.com/en-us/windows/win32/search/-search-3x-advancedquerysyntax). Copyright 2018 by Microsoft.

Appendix I: Microsoft Table of Dates

Table 6

Microsoft Table of Dates

Relative to	Syntax example	Result
Day	date:today	Finds items with today’s date.
	date:tomorrow	Finds items with tomorrow’s date.
	date:yesterday	Finds items with yesterday’s date.
Week/Month/year	date:this week	Finds items with a date falling within the current week.
	date:last week	Finds items with a date falling within the previous week.
	date:next month	Finds items with a date falling within the upcoming week.
	date:past month	Finds items with a date falling within the previous month.
	date:coming year	Finds items with a date falling within the upcoming year.

Note. Adapted from “Using Advanced Query Syntax,” by Microsoft, May 31, 2018 (https://docs.microsoft.com/en-us/windows/win32/search/-search-3x-advancedquerysyntax). Copyright 2018 by Microsoft.

Appendix J: Microsoft Table of Properties by File Kind

Table 7

Microsoft Table of Properties by File Kind

Property	Use	Example Use
Title	title, subject or about	title:"Quarterly Financial"
Status	status	status:complete
Date	date	date:last week .
Date modified	datemodified or modified	modified:last week
Importance	importance or priority	importance:high
Size	size	size:> 50
Deleted	deleted or isdeleted	isdeleted:true
Is attachment	isattachment	isattachment:true
To	to or toname	to:jane
Cc	cc or ccname	cc:don
Company	company	company:Apple
Location	location	location:"Conference Suite 115"
Category	category	category:Science
Keywords	keywords	keywords:"production quotas"
Album	album	album:" Flowers of Edinburgh "
File name	filename or file	filename:MyLife
Genre	genre	genre:celtic
Author	author or by	author:"David Goldman"
People	people or with	with:(judy or dave)
Folder	folder, under or path	folder:downloads
File extension	ext or fileext	Ext:.txt These are properties common to all file kinds. To include all types of files in a query, the syntax is: kind:everything <property>:<value> where <property> is a property listed below and <value> is the user-specified search term.

Note. Adapted from "Using Advanced Query Syntax," by Microsoft, May 31, 2018 (https://docs.microsoft.com/en-us/windows/win32/search/-search-3x-advancedquerysyntax).

Appendix K: Microsoft Properties Common to Contacts

Table 8

Microsoft Properties Common to Contacts

Property	Use	Example Use
Job title	Jobttle	jobtitle:CEO
IM address	imaddress	imaddress:bob_smith@idm.com
Assistant's phone	assistantsphone	assistantsphone:123-6789
Assistant name	assistantname	assistantname:Sam
Profession	profession	profession:nurse
Nickname	nickname	nickname:Rob
Spouse	spouse.	spouse:Judy
Business city	businesscity	businesscity:Portland
Business postal code	businesspostalcode	businesspostalcode:86303
Business home page	businesshomepage	businesshomepage:www.apple.com
Callback phone number	callbackphonenumber	callbackphonenumber:123-456-7891
Car phone	carphone	carphone:444-444-8911
Children	children	children:Tommy
First name	firstname	firstname:Don
Last name	lastname	lastname:Smith
Home fax	homefax	homefax:123-456-7891
Manager's name	managersname	managersname:Jack
Pager	pager	pager:123-456-7891
Business phone	businessphone	businessphone:789-123-4567
Home phone	homephone	homephone:333-333-4567
Mobile phone	mobilephone	mobilephone:234-333-4567
Office	office	office:example
Anniversary	anniversary	anniversary:1/2/18
Birthday	birthday	birthday:1/10/18
Web page	webpage	webpage:www.microsoft.com
		These are properties common to contacts. To limit the search to contacts only, the syntax is: kind:contacts <property>:<value> where <property> is a property listed below and <value> is the user-specified search term.

Note. Adapted from "Using Advanced Query Syntax," by Microsoft, May 31, 2018 (https://docs.microsoft.com/en-us/windows/win32/search/-search-3x-advancedquerysyntax).

Appendix L: Microsoft Properties Common to Communications

Table 9

Microsoft Properties Common to Communications

Property	Use	Example
From	from or organizer	from:don
Received	received or sent	sent:yesterday
Subject	Subject or title	subject:"Monthly Financial"
Has attachment	hasattachments, hasattachment	hasattachment:true .
Attachments	attachments or attachment	attachment:excel.xls
Bcc	bcc, bccname or bccaddress	bcc:rob
Cc address	ccaddress or cc	ccaddress:john_smith@outlook.com
Follow-up flag	followupflag	followupflag:3
Due date	duedate or due	due:last month
Read	read or isread	is:read
Is completed	iscomplete	is:complete
Incomplete	incomplete or isincomplete	is:incomplete
Has flag	hasflag or isflagged	has:flag
Duration	duration	duration:> 40
		These are properties common to communications. To limit the search to communications only, the syntax is: kind:communications <property>:<value> where <property> is a property listed below and <value> is the user-specified search term.

Note. Adapted from "Using Advanced Query Syntax," by Microsoft, May 31, 2018 (https://docs.microsoft.com/en-us/windows/win32/search/-search-3x-advancedquerysyntax). Copyright 2018 by Microsoft.

Appendix M: Microsoft Properties Common to Documents

Table 10

Microsoft Properties Common to Documents

Property	Use	Example Use
Only documents that contain all words from your search request are shown.	The more words you put in your search request, the more precise the search becomes.	movie star
Exact Phrases	This eliminates documents where the words occur but are not next to one another or are in the wrong order.	“to be or not to be”
Exact words	Use the “+” operator to search for the exact word in a document.	This operator also allows you to search for link words (like “the”, “a”, “of”, “or”, “and”) which are ignored by default.
Revision number	revisionnumber	revisionnumber:1.1.5 .
Document format	documentformat	Example use: documentformat:MIMETYPE
Date printed	Datelastprinted	datelastprinted:last month These are properties common to documents. To limit the search to documents only, the syntax is: kind:documents <property>:<value> where <property> is a property listed below and <value> is the user-specified search term.

Note. Adapted from “Using Advanced Query Syntax,” by Microsoft, May 31, 2018 (https://docs.microsoft.com/en-us/windows/win32/search/-search-3x-advancedquerysyntax).

Appendix N: Exaled Web Search Syntax

Table 11

Exalead Web Search Syntax

Property	Use	Example use
Only documents that contain all words from your search request are shown.	The more words you put in your search request, the more precise the search becomes.	movie actor
Exact phrases	Use double quotes to search for an exact phrase.	“to be or not to be”
Exact words, use the “+” operator to search for the exact word in a document.	This operator also allows you to search for link words (like “the”, “a”, “of”, “or”, “and”) which are ignored by default.	+the godmother
Optional terms	The “OPT” operator allows you to specify a term without making its presence mandatory for a document to appear in the search results.	cow OPT mad
Exclude terms	The “-” operator allows you to remove all documents containing a specific word or expression from the search results.	star -movie
Proximity search	The “NEXT” operator finds documents where the query terms are next to each other.	movie NEXT actor
Near	The “NEAR” operator finds documents where the query terms are all in a short range of words.	movie NEAR actor
Logic	The “AND” and “OR” operators can be combined to match documents against advanced boolean logic.	(movie AND actor) OR (famous AND people
Phonetic search	When you do not know how to spell a word, write it as it sounds and use a phonetic search.	soundslike:shakespear
Approximate spelling search	When you are not sure about the spelling of a word, you can search with spelling approximation.	spellslike:dtsearch
Site search	The “site:” operator restricts a search to a particular web site.	movie star site:amazon.com
Title search	The “intitle:” operator allows you to search for a word or a group of words found within the title of a document.	intitle:”official website”

URL search	The “inurl:” operator allows you to search for a word or a group of words found within the URL of a document.	inurl:movie
Link search	The “link:” operator allows you to search for pages that contain a given link.	link:www.idm.com
Search language	The “language:” operator restricts a search to documents written in the given language.	movie star language:fr
Search before a date	The “before:” operator restricts a search to documents created or modified before the given date (in the YYYY/MM/DD format).	movie star before:2017/06/23
Search after a date	The “after:” operator restricts a search to documents created or modified after the given date (in the YYYY/MM/DD format).	movie star after:2017/04/15 (“Web Search Syntax,” 2018)

Adapted from “Web Search Syntax,” by Exalead (https://www.exalead.com/search/web/search-syntax/). Copyright 2000–2021 by Exalead.

Appendix O: Comparison of Two Discovery Systems Table

Table 12

Comparison of Two Discovery Systems Table

Criteria	Summon	Ebsco Discovery Service (EDS)
Content/Search Interface	ProQuest Educational Journals, ProQuest Newsstand, Gale's Academic OneFile, Gale's Science in Context, JSTOR, Lexis-Nexis Databases buried (Not showing up in the first three screens of results):: Westlaw, GVRL, most EBSCOhost databases, Ebrary catalog (books) Relevancy Ranking : Summon uses Dynamic rank and Static rank to the ranking of the record in the results. Dynamic rank focuses on matching up a user's exact query with all of the metadata and full text in the Summon index while Static rank helps boost relevance based on attributes of an item, such as content type, scholarly, publication date, citation counts. In addition, there is "Recommendations" which offers guidance to users at the point of need such as Best bets, Database recommender and related search suggestions	Finds GVRL, EBSCOhost databases, PLoS, Sage Databases buried (Not showing up in the first three screens of results):: Sage, Opposing Viewpoints in Context, Science direct, Lexis-Nexis, JSTOR Quality of metadata Varies. Metadata of local catalog is adapted from library's own MARC records, with added features e.g. 'Books by same author' and 'Reviews'; many EBSCOhost records include abstracts and subject headings; records from other vendors may include rich metadata or in some cases a total absence of abstract and subject headings. Some content from outside vendors can be searched full-text. Relevancy Ranking : Results are weighted to preference local holdings by default, but it can be changed if desired. The major contributing factor in relevance scoring is the frequency of the user's search terms in matching EDS metadata and full-text records.

		The most influential fields in EDS are: 1. Matches on subject headings 2.Term appearance in the title 3. 3. 3. Author-supplied keywords 4. Keywords with abstracts 5.Match on keywords in the full-text
Customization	There are many options for customizing the Summon interface, such as logos, colors, languages, citation formats, and additional options of turning on/off search counts, citation counts, and permalinks. Search facets can be customized by enabling/disabling options and choosing which order they should appear in. You can also customize the order of items in your library's collection; for example, reserves can be listed first over circulating books, reference books, etc. Summon also offers several customization options for search results. Administrators can choose an order of prioritization of meta-data for resources that Summon can directly link to. Two other customizable features include the database recommender and the "Best Bets" feature. The database recommender allows you to suggest additional databases a user should try based on their search. They offer a top queries report to help librarians determine possible recommendations. The "Best Bets" options allows you to direct users to additional content, such as library hours, webpages, events, libguides, etc.	EDS offers interface customization via the administration site that includes: Logos Background Colors, Text/Link Colors, & Toolbars. Extensive further customization of the interface can be accomplished by means of embedded javascript; EBSCO hosts code samples in its wiki and for a fee will manage and host such 'apps'. The EDS API allows even more extensive interface customization, and can be used to host EDS content on a platform other than EBSCOhost. There are not many options for customizing results. Options include enabling the records your library subscribes to as a limiter, deciding which databases should be included in your listings, and setting the order for what resources are listed first with an item (which doesn't change relevancy, only how a user access relevant results). Additionally, you can choose to enable a 'research starter' that links to general

		information (such as what is typically seen in reference materials) about the entered keyword search. .
Mobile or Multimedia Options	Mobile responsive interface	Mobile responsive interface is automatically supplied for small-screen devices. Sample code for creation of a mobile site using the EDS API is available. Application for smartphones & tablets in beta development
Citation Options	8 citation formats are available to view/copy/paste and export to 5 bibliographic managers for both books and articles. Includes limited RefWorks	5 citation formats for books and 8 citation formats for articles are available to view/copy/paste with options for exporting citations which includes 8 direct export options and 4 options for other bibliographic managers.
Initialization and Administration	Initialization requires time to map the catalog. Serials Solutions admin interface includes a Summon section of which the librarian first needs to put in the databases' at its institution in 360 Core and make sure linking capabilities are up with the 360 Link portions. One main challenge with the administrative setting is that it is slow, with long screens to scroll, and there is no way to preview changes that will not happen until one or two days later. Statistics are Counter and SUSHI compliant and there is a clear option to include Google Analytics for the Discovery site if one wishes for further statistics. There's an option by vendor how you want your results prioritized, but EBSCOhost is not included. Good branding sections to sure up the look you want for the page.	Initialization needs at minimum databases selected and base links up. More time is involved if you want the Catalog implemented of which EBSCO will provide assistance for setup. The administrative interface is almost identical to the general EBSCOhost admin interface for all of the databases. One can preview changes by creating a secondary profile. Updates may happen quickly or up to 20 minutes after they are saved. Statistics are available in many varieties, including COUNTER and SUSHI compliant ones. One challenge working with the interface is some changes may seem 'buried' in a 2nd or 3rd level layer, so if you are not seeing the desired changes you

		want, you need to double check at which layer (example: basic search vs. advanced search). Branding page makes it relatively easy to sure up the look you want.
Availability/ Accessibility of Service	Unsure. Product passes one accessibility tool but will not work with another one.	Product can be configured to pass web accessibility tests.

Appendix P: Discovery Searching Contrast Table Search #1

Table 13

Discovery Searching Contrast Table Search #1: Climate Change

Criterion	Summon	Ebsco Discovery Service (EDS)
# of results	4,228,046	703,159
Relevance	Very relevant, words but words always appear in the title	Books listed first, very Relevant
Databases or Links to Them Listed First (after Catalog)	public WWW (quality), EBSCOhost (no direct link), Academic OneFile, ProQuest Educational Journals (mostly ProQuest on first screens). If I limit to full text online ProQuest especially dominates on the first screen.	GVRL (first entry by book title, link coming from library catalog), Environment Complete, Business Source Complete
Databases or Links to Them Buried (Not Seen in First 2¬3 Result Pages)	Westlaw, Gale Virtual Reference Library, Science InContext, most EBSCOhost databases	Sage (#53), ScienceDirect (starting at #95), Opposing Viewpoints in Context, JSTOR, LexisNexis
Databases or Links to Them Not Listed At All (Note: Reasons can include lack of agreement between vendors, or vendor does not have its content be open URL compliant)	CQ Researcher, CountryWatch, JSTOR, Project MUSE, Infobase Publishing (Issues and Controversies), Films on Demand	CQ Researcher, Films on Demand, ProQuest eBook Central, CountryWatch
Link to Article Most Often?	About 40% of the time directly to article. Never for EBSCOhost articles. Either a 360 Link record or have to reproduce search in EBSCOhost. Sometimes even ProQuest articles go to the 360 Link record. Most of the time the 360 Link does not go to	Yes to most. GVRL links to ARTICLE level, but No to the following: Informlit (leads to Google results), Error screen on SciTechConnect, Infotrac (search results matching search term), Opposing Viewpoints (sometimes-goes to search results or error screen), GPO leads to error

	article level and goes to the search screen of the database instead. Sometimes goes to an error screen from the database. Westlaw will not authenticate through the system.	screens, CGI error screens for some free open access content, Pubmed (search results), LexisNexis Academic (introductory search screen with a citation term entered),
Leads to Subject Terms?	Subjects is on the left, but you had to click 'See All' to find Climactic Changes (which would have limited search to 82,250)	Yes, in records and subject terms on left. 'Climactic changes' found easily by these methods.
Full Text limiter works as it should?	Yes	'Only Show Content I can Access' (Library's Collection)¬-appears to do the trick better than the separate Full Text limiter.
Noteworthy	Able to limit by TYPE of article (newspaper, magazine, journal, etc.) Database recommendation was appropriate (GreenFile) listed on top.	Able to limit by TYPE of article (newspaper, magazine, journal, etc.) in left column as well as indexing subject terms by EBSCO that sometimes include other databases such as Gale.

Appendix Q: Discovery Searching Contrast Table Search #2

Table 14

Discovery Searching Contrast Table Search #2: Futurologists

Criterion	Summon	Ebsco Discovery Service (EDS)
# of results	8309, need to limit to Library catalog to find books	3,439
Relevance	Very relevant. Words focused of what's in the title.	Relevant, but no books appeared. Needed other search terms to find books
Databases or links to them listed first (after catalog)	Science InContext, ProQuest Health and Medical Complete, JSTOR, Academic OneFile, Academic Search Complete (via 360Link), ProQuest Newsstand, ProQuest Education Journals, LexisNexis Academic, SocIndex with Full Text	EBSCOhost databases (Business Source Complete, MasterFILE Premier, Environment Complete, SocIndex with Full Text), one Sage on first two pages of entries.
Databases or links to them buried	Ebrary, Catalog (books), most EBSCohost databases (though a few did show up higher in this search such as the ones on the left)	Opposing Viewpoints in Context (54 articles), JSTOR, LexisNexis Academic
Databases or links to them not listed at all	See above	See above
Link to article always?	Maybe day was off for climate change as I more often linked to article for EBSCO and others. Still sometimes ended up on error page or search page.	See above
Leads to subject terms?	Disciplines not exactly helpful (outside of business)-left column. Subjects such as forecasts and forecasting may show up in records showing up on the right for each selected for glancing. Not as fruitful as EBSCO or Primo.	On the side is futurologists, forecasting and technological innovations. Granted student may need to be more specific if they were looking for human evolution or cyborgs. New search (or clicking on a record's subject heading's link) would be the only way to find books.
Full text limiter works as it should?	See above	See above

Appendix R: Observational Protocol

Table 15

Observational Protocol (Five participants)

Descriptive Notes	Reflective Notes
Dr. Sweller, a leading scholar on cognitive load, through personal communications, indicated “the major findings (in fact, the very first finding) of CLT is that requiring learners to search for information imposes a very heavy, extraneous cognitive load. The search process overloads working memory with processes that are extraneous to learning” (2013)	None of the students comprehended the concept of cognitive load although all complained about time demands of studying. The time demands are influenced by the requirement to searching for information. The absence of schema for searching inhibited all the participants.
In two classes of 20 students each a survey was taken of those that knew what the keyboard shortcut of using Ctrl=F meant. Only 10% knew what Ctrl+F was a keyboard shortcut for searching.	The researcher had talked to Dr. Russell at Google earlier regarding Russell’s survey that established only 10% of Google users knew what Ctrl=F was. The survey results were provided to the general media by Russell in multiple articles citing Russell. If 90% of college entry students do not know what Ctrl+F means it is unlikely they know or use syntax operator commands.
One of the participants, student 4, had some programming skills whereas the other four had no experience in programming.	Student 4 showed considerable understanding of syntax commands whereas the others had no comprehension of syntax commands.
Four of the five participants had no schema for what they were going to be instructed.	Student 4 had a schema for understanding syntax commands and quickly picked up on the concept.
None of the participants knew anything about using a proximity operator.	Student 4 quickly picked up on concept. The other four participants had never considered that this syntax command operator for proximity results was an abstract concept until taught it had value.
All five participants indicated preference for a Google single search boxes.	This is mentioned by a study of librarians in evaluating five major library search systems, Discovery Comparison Review Date: Spring 2016.While Google provides a significant number of higher-level syntax commands they are virtually unknown outside of Google with only one out of a million using them. The single search box indicates a desire for simplicity that might negate using higher-level tools that are available.

Appendix S: Codes

Source:	A – Student 01 Vicky B – Student 02 Ann C – Student 03 Courtney D - Student 04 Eric E – Student 05 Denise

COGNITIVE LOAD	
1. Never heard of term	A, B, C, D, E
2. Only after introduced by researcher	A, B, C, D, E
3. Schema only after introduced by researcher	A, B, C, D, E
4. Short term memory only after introduced by researcher	A, B, C, D, E
SEARCHING GOOGLE	
1. Most used search engine.	A, B, C, D, E
2. Never heard of Google syntax operator.	A, B, C, D, E
3. Russell of Google discussed only after introduced by researcher	A,D
4. Only 10% of Google users use Ctrl+F.	A, B, C, D, E
5. How to use a Google operator.	A, B
6. Google has become dominant.	B
7. Only one in million use a Google operator only after introduced by researcher	A, B, C, D, E
8. Google single search box preferred.	A, B, C
9. School libraries do not incorporate Google search. introduced by researcher	A, B, C, D, E
SEARCHING SCHOOL LIBRARIES	
1. ProQuest at the YC library.	C, D
2. Six main library systems only after introduced by researcher	C. E
3. Library systems avoid Google only after introduced by researcher	E
4. Participants saw Google as a primary tool for research	A, B, C, D, E
5. Google vs. the Library; lack of syntax operators. Introduced by researcher	A, B, C, D, E
SYNTAX COMMANDS	
1. Google.	D
2. No awareness.	A, B, E
3. Ctrl+F	A, B, C, D, E
4. Macro, only after introduced by researcher	B, C, E
5. Complex.	A
6. Programmers.	D
7. Command	B, C, D
8. Proximity.	A, B, C, D, E
9. Near or around.	A, D, E
12. Boolean operators	A, E

OPERATORS
1. Abbreviate syntax commands
2. A language.
3. Facilitates a syntax command.
4. Ctrl+F

GRAPHICAL USER INTERFACE (GUI)
1. GUI.
2. Slider bar.
3. Incremental.

Appendix T: Themes

Table 17

Themes

Theme	Codes
Cognitive load	Never heard of term; Introduced by researcher; Schema introduced by researcher; Short term memory introduced by researcher
Searching Google	Most used search engine; Never heard of Google syntax operator; Russell of Google discussed; Only 10% of Google users use Ctrl+F; How to use a Google operator; Google has become dominant; Only one in million use a Google operator; Google single search box preferred; School libraries do not incorporate Google search
Searching school libraries	ProQuest at the YC library; Five main library systems; Library systems avoid Google; Participants saw Google as a primary tool for research; Google vs. the Library; Lack of syntax operators
Syntax commands	Google; No awareness; Ctrl+F; Macro; Complex; Common; Programmers; Language; Command; Proximity; Near or around; Boolean operators
Operators	Abbreviate syntax commands, a language; Facilitates a syntax command; Ctrl+F
Graphical user interface (GUI)	GUI; Slider bar; Incremental

Appendix U: Participant Memo

Feedback by Eric regarding Focus Group Questions

Over the summer I've gained more experience using technology, namely running a custom game server for my friends. In this environment I found myself not only researching more, but also having to navigate through a ton of mess to get what I needed, reading your email reminded me about what I'm and thought I should share it.

This document is just some addons to what is currently in the notes you have provided to me. To keep information up to date.

"what technology skills are you good at"
"troubleshooting, configuration, and maintenance/repair of computer devices."
Configuration is now here since i've been doing that a lot recently and already feel pretty good about it.

"I tend to avoid doing work."
To elaborate, I avoid doing unnecessary or time-consuming work. The more time you spend on an assignment, the more burned out you become as you continue working. I feel like this is how most people are, and you could argue by using syntax operators, people can drastically cut down on the "work" people do when researching which would result in less burnout and more actual work being done.

"what skills acquired in using the Internet for entertainment transfer to your schoolwork?"
"the act of typing and the use of the of the Microsoft Office Suite"
By using the internet for entertainment, students are becoming more comfortable, and more familiar with the whole experience, greatly increasing their confidence when communicating online which would then show results in their online assignments.

Eric thought it was primarily Microsoft Office and Mac OSX
Recently, Google docs have become much more prevalent in our daily lives, it's easier to access, syncs with all of our devices, and most of all, it's free. You can even continue typing your essay on your phone while waiting in line at a coffee shop or something, it really is that good.
(Also Mac OSX is an operating system so i'm not sure why that's mentioned here.)

Eric like many others thought search engines were an important feature.
I may also add a file system, not only should syntax operators be used in search engines, they are almost a necessity in file management. You know how people have talked about how being organized can really help a student out? This applies to here too, and the entire process can be sped up using commands!
Take for example: you are trying to sort through your hundreds of different documents with different filetypes in your computer, by adding an asterisk "*" to the end of the extension of the file (windows file manager search syntax), you can sort them by PDF, DOCX and so on.

This also applies to google where you can use filetype:pdf as well, but its [*sic*] pretty rare that anybody would have to use it. There is an instance where i [*sic*] have used it, when coming up with some extra data for a final of one of my other classes i [*sic*] had to find a PDF from a credible source. To be specific it had to be a legal document of sorts explaining the process of creating a town in each state. So i [*sic*]had to find a .gov website (they are your best bet when it comes to government stuff) with a pdf. An example of a command that would do this is .gov ext:pdf

Another amazingly useful operator for windows is date:mm/dd/yyyy .. mm/dd/yyyy which makes it so you can only see stuff from between those two dates. So you can sort out old stuff from before your research to the current new stuff.

Yes, i [*sic*] still find the simple CTRL + F to be one of the most versatile operators that even work on tests, it's simple to execute, no need to worry about typing out a word right with the right capitalization or anything, not only that but **it works on every website with nearly every browser**(the biggest advantage) that's why i [*sic*] love it. (note: Sorry to my instructors, but i [*sic*] simply cannot waste 20 minutes reading a bunch of fluff to answer my questions)

In addition to the major obstacles i've [*sic*] stated, another huge one is "clickbait" where the title suggests something but actual content, research and facts are nowhere to be found making the entire time you used reading the article a waste of time, this can be avoided with the use of the - syntax to exclude certain words. Although it would be nice if there was one to exclude all websites with a ".com" extension (there probably already is, but I'm currently unaware of it)

Yes there is a "source:" syntax which can sort your stuff to only being from a certain source of google news (their format in which to find news) however with the amount of "clickbait" out there, this is pretty much useless. (another problem, not every command is always useful)

"there is no time for instructions on searching 95% of the time."
Even if instructors found the time to do it once or twice, something that involves memorization needs to be repeated multiple times before it becomes a habit to use it, otherwise students would just go back to their old ways of searching without any operators.

Another big obstacle you should note is how each platform has its own versions of the same operators.Take for example: Google uses "X" around(n) Y while site A may use X n8 Y
There needs to be a standardized system where its [*sic*] the same no matter where you go so things like proximity searching can be as well known as "CTRL + F"

Appendix V: Permission to Republish Images: Council of Chief Librarians, Electronic Access and Resources Committee

On Sat, Oct 24, 2020 at 3:40 PM Gregg Atkins <[redacted]> wrote:

Yes, you have permission to use these images with appropriate attribution.

Gregg T. Atkins, Executive Director, CCL

From: Donald Campbell <[redacted]>
Sent: Friday, October 23, 2020 11:51 AM
To: Greg Atkins <[redacted]>
Subject: Permission to republish images

Dear Mr. Atkins,

I am near completion of my dissertation and I used screenshots of part of your report at https://cclibrarians.org/sites/default/files/reviews/Documents/DiscoveryComparisonCCLEAR16.pdf

These are all screenshots of -

● Ebsco Discovery Service (EDS) ● Encore Synergy ● Primo ● Summon ● Worldcat Local and Discovery web pages.

My editor told me that I would need your permission to republish these images not permitted to use.

This was a wonderful article and as I did not have access to the same sources that someone had at your end of this research I could not produce the same images. Your help in this matter would be greatly appreciated.

Best regards,

Don Campbell

Appendix W: Permission to Republish Images: J. Sweller

On Tue, Feb 23, 2021 at 5:20 PM John Sweller [redacted] wrote:

Thank you for your enquiry. I am happy for you to use the published images.

John Sweller

Emeritus Professor of Educational Psychology

School of Education

University of New South Wales

Sydney NSW 2052

Australia

From: Donald Campbell [redacted]
Date: Wednesday, 24 February 2021 at 4:50 am
To: John Sweller [redacted]
Subject: Permission to use your images from your article titled Visualization and Instructional Design

Dear Dr. John Sweller,

I am writing to request your permission to republish your images from your article, Sweller 1992, Sweller, Visualization and instructional designs.

Visualization and Instructional Design

John Sweller

School of Education

University of New South Wales

Sydney NSW 2052

Australia

University of New South Wales

page 1504, Figure 1 and page 1505, Figure 2 [image caption from original work], from your article, [Visualization and Instructional Design, 1992], in my recently defended dissertation, *Proximity Search Techniques to Reduce Cognitive Load: A Case Study*. Proper copyright attribution will be provided in a general note below the figure as required by APA.

Could you reply via e-mail to let me know if I may use your image in my published dissertation? These two figures were helpful in my efforts to illustrate the concept described by your work.

Thank you,

Dr. Donald Campbell