Harnessing the Internet to Meet their Needs:
Can Adapting to the Digital Age Help Close the Literacy Gap?

by

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Abstract

Research was conducted with 10 low literate and 10 medium to high literate students at the University of Baltimore to understand how traditional literacy impacts search habits for new college freshman. Five low literate, non-student participants were included in the research as a control group for the two student populations. It was hypothesized that low literate students had learned adaptive search skills that were unique to their demographic (low literate, college-degree seeking).

Participants completed three search tasks designed to mimic a low-level college science task on the Tobii t60 eye tracker at the University of Baltimore usability research lab. Results were analyzed for total number of searches, time spent on task, reading behaviors, and participant ratings for task difficulty, mental effort, and performance satisfaction. Low literate students were found to have search habits similar to the medium to high literate student group. Prior work on low literate search habits by researchers had shown that low literate users tended to have less evolved search habits than their medium to high literate peers. This study shows that degree-seeking students seem to have develop digital literacy skills independently of their traditional literacy skills.

Acknowledgments

I would like to thank my dissertation committee, Drs. Summers, Kohl, and Manning for their support and input as I worked through my dissertation. Their feedback has helped shaped my research and made my dissertation better than I could have hoped for. To all the other professors who helped teach me, I would not have succeeded without your support. To Dr. Summers, thank you for guiding me every step of the way; without your guidance and support, I would never have made it.

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And finally, I have to thank Ben Mayfield, my husband, for his constant encouragement as I worked towards finishing my dissertation. He solo parented our son through most of the writing, and for that I am truly grateful. This dissertation never would have been finished, if not for him.

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Chapter 1: Introduction

Imagine growing up knowing that you did not read as well as your peers. No matter how hard you tried or how much you read, you still dreaded reading aloud in class. You sat in trepidation, listening to your classmates reading. One student after another reads without any problems; your palms get sweaty — your turn is coming, and you know that everyone is about to find out that you are not a great reader. They will assume you are stupid, that you are not able to read. It is your turn. You look down at the page and you blink. The words swim before you, but you take a deep breath, and you start. Slowly. Each word takes effort to read and speak. You get through it, but you can hear the whispers and snickers.

If this was your daily experience in school, you would start to doubt your abilities. You may think "I should just give up; I will never be as good at reading as they are." But what if you are? What if you are just as smart and capable as the smartest kid in your school, but you have an (un)diagnosed learning disability? You are smart enough to be accepted into a good college, but when you are tested for reading abilities, you test as reading well below your grade level (e.g., eighth grade or below)[1]. How can this be?

This misplaced link between intelligence and reading skills comes from a misunderstanding of literacy[2]. There is an assumption that everyone with low literacy is

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[1] For the purpose of this dissertation, we will be using the REALM (Rapid Estimate of Adult Literacy in Medicine) as our literacy testing method. The REALM is a list of 66 words that vary in familiarity and complexity. Readers are graded on correct pronunciation of the word; a score of 60 or fewer qualifies a reader as low-iterate (45–60 words correct correlates to a 7–8th grad reading level). More discussion will be given to this testing method later in the dissertation.

[2] Literacy rates in a testing environment can be impacted by specific learning disabilities.

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uneducated, often unemployed (or over employed: working multiple low-paying jobs), and low income. While this is true for much of the low literate population[3], there is a portion[4] of the population that is highly-educated and working alongside their medium to high literate compatriots.

When I first met my new coworker on the Accessibility team at an online, non-profit university, I was excited. She was competent, intelligent, excited, and dedicated to making sure our courses were accessible for all our students. It was only after working with her for a few months, that she revealed that she had learned — in college— that she had a learning disability. She is dyslexic. She had made it all the way into a great university without ever knowing that she had a learning disability. She had always struggled with reading aloud, but she had never let it hold her back.

Despite her degree in computer science and her desire to pursue advanced degrees, she would be considered low literate by some measures, because her ability to read is impaired by her learning disability. When her dyslexia was diagnosed, she was given a literacy test that showed she read just below an eighth grade level, but her literacy rate dropped further when a time component was added to the test. Her struggle has increased her capacity to empathize with others who struggle to fit this world, and she is a fierce advocate for them.

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[3] Literacy has a high correlation for success in high school and the pursuit of additional education after high school graduation. According to the National Center for Education Statistics, in 2003 persons rated with below basic reading skills were more likely to drop out of high school (around 50%) (Kutner, et al. 2007). Low literate, full-time workers are likely to earn less than $300/week (Wood, 2010).

[4] Wood (2010) found that 14% of persons deemed “low literate” had finished an undergraduate degree or more.

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Like my coworker, some students with learning disabilities and low literacy will make it to college, and some will find success despite the uphill battle they often face. The current study is founded in the belief that students with low literacy can find ways to adapt to the challenge of college. Today's students are digital natives, and technology can help all students, especially those with disabilities. Pierce (2015) found that "incorporating technology across the curriculum and helping students identify the right tool for the task is a large part of helping them succeed after they leave the K-12 environment" (p. 22).

The purpose of this study is to better understand the search habits of college freshman, especially those of low literate freshman. There is a growing body of work on information retrieval behaviors for both high and low literate individuals, but education has not been a major factor in that research to date. The following questions motivated this experiment:

1. Have low literate college-degree seeking persons developed search techniques that are different from their medium to high literate contemporaries?
2. Do the search techniques of college-degree seeking persons with low literacy differ from the search techniques of similar-aged persons with low literacy who are not seeking college degrees?

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Based on these questions, the following hypotheses have been made:

H1. Search Techniques

H1a. Degree-seeking students with low literacy skills will search with adaptive techniques that help them compensate for their lower literacy skills in the university setting. Their search behaviors will differ from medium to high literacy degree-seeking students, who will have more sophisticated information search strategies.

H1b. Degree-seeking students with low literacy will search with different and more developed techniques than non-degree seeking adults with low literacy skills.

Experiment Overview

This study will present research on the information search habits of low- and medium- to high-literate college freshman at one university and a community college in Baltimore. Freshmen students were recruited during their first or second semesters, and they were asked to perform internet searches for science-related[5] classes. Each of the tasks focused on a different type of search requirement (basic historical overview, diagramming a process, and biographical sketch) so that students would be required to visit different types of resources for each task.

[5] The challenging vocabulary of science-related coursework is particularly difficult for students with low-literacy and learning disabilities. Students with learning disabilities relied on their peers to help facilitate learning (McGrath & Hughes, 2018).

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1. **Historical Background:** students were asked to search for information about Pluto from discovery and classification as a planet, to the recent downgrade to dwarf planet.
2. **Diagram a Process:** students were asked to diagram the similarities and differences between mitosis and meiosis.
3. **Biographical Sketch:** students were asked to create an outline of Johannes Kepler's life.

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Chapter 2: Literature Review

This chapter will start with a discussion on literacy in the United States and how it has been measured over the years, covering both the National Assessment of Adult Literacy and the Program for the International Assessment of Adult Competencies. Second, it will focus on literacy in education and how (un)diagnosed specific learning disabilities (SLDs) often account for lower literacy ratings. Third, this chapter will look at Generation Z, members of which have been called 'digital natives,' and how they have been shaped by the world and technology. Finally, this chapter will explore information literacy and information retrieval research.

Literacy in the United States

According to the Program for the International Assessment of Adult Competencies (PIAAC) literacy can be defined as "understanding, evaluating, using and engaging with written text to participate in the society, to achieve one's goals and to develop one's knowledge and potential" (Goodman, et al., 2013, p. 2). This definition is closely related to the National Assessment of Adult Literacy's (NAAL[6]) definition and will be used as the standard definition throughout this dissertation. These definitions imply that literacy is more than the ability to sound out words and string them together; literacy goes beyond that to include application of what has been read. By elevating literacy to include of understanding and application, we begin to see how low literacy can

[6] The NAAL used the following definition: "Using printed and written information to function in society, to achieve one's goals, and to develop one's knowledge and potential"

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impact every aspect of a person's life. Low literacy correlates with higher levels of poverty, incarceration, and unemployment (ProLiteracy, 2018). Further, a lack of literacy impedes persons from "making choices about their rights or government through voting" (The Room, 2018).

Exemplifying how literacy impacts all aspects of life, Kher, Johnson, and Griffith (2017) found only seven percent (5 out of 70) health websites were written at or below the recommend sixth grade reading level[7]. Seitz et al. (2017) found that of fifty-five (55) tested government and health websites, not one met the readability guidelines set forth by U.S. Department of Health & Human Services. When vital websites are not being written at an accessible level, people with low literacy skills are cut off from programs that could help them improve their economic and physical health. Despite the passing of the Plain Writing Act of 2010, websites are not required to meet these standards, so many remain inaccessible to the at-risk groups that most need them.

Due to the negative impact low literacy can have on the lives of people, there have been efforts over the years to document and understand literacy in the United States. In the early 2000s, the National Assessment of Adult Literacy set out to understand and record adult literacy rates in America, and their findings were published in a government report. For years, this report was the standard by which literacy was understood; in 2012 the Program for the International Assessment of Adult Competencies took over the role

[7] This grade-level assignment is based on the guidelines provided by Plain Writing Act of 2010. However, it is not common practice to use grade-level rankings, as they can be unreliable and less precise than they appear.

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of documenting and understanding literacy, not only in the United States, but for the world.

National Assessment of Adult Literacy. In 2003, the National Assessment of Adult Literacy (NAAL), from the National Center for Education Statistics (NCES), reported that forty-three percent (43%) of adult Americans read at or below a Basic level[8] (see Figure 1). The 2003 National Assessment of Adult Literacy did not rely on self-report, but instead "measured literacy directly by tasks representing a range of literacy activities that adults are likely to face in their daily lives" (Kutner, et al., 2007, p. 2). To completely understand what these numbers represent, we must first understand the definition used for the literacy levels in the NAAL; these levels are defined with examples in Table 1.

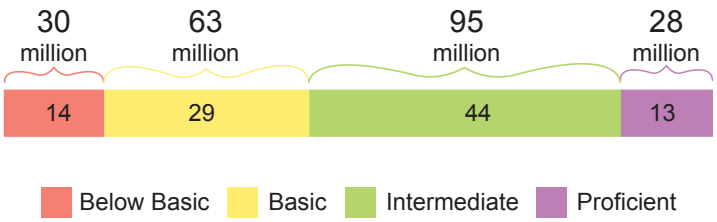

Figure 1. 2002 adult literacy rates with population counts (U.S. Department of Education, 2003)

[8] A Basic level of literacy allows a person to 'perform simple and everyday literacy activities' (Kutner, et al., 2007, p. 4)

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Table 1

NAAL literacy levels with definitions.

Level	Definition	Example
Below Basic Score Ranges: Prose: 0–209 Document: 0–204 Quantitative: 0–234	No more than the most simple and concrete literacy skills	Range from non-literate to locating easily identifiable information in short, commonplace texts. Following simple written instructions
Basic Score Ranges: Prose: 210–264 Document: 205–249 Quantitative: 235–289	Skills necessary to perform simple and everyday literacy activities	Reading and understanding information in short, commonplace texts and documents.
Intermediate Score Ranges: Prose: 265–339 Document: 250–334 Quantitative: 290–349	Skill necessary to perform moderately challenging literacy activities	Reading and understanding moderately dense, less common texts and summarizing an author's purpose Locating information in dense, complex documents, and making inferences about the information.
Proficient Score Ranges: Prose: 340–500 Document: 335–500 Quantitative: 350–500	Skills necessary to perform more complex and challenging literacy activities	Reading lengthy, complex, and abstract text and synthesizing information. Integrating, synthesizing, and analyzing multiple pieces of information.

Note. From Kutner, et al., 2007, p. 4

Taken together, Figure 1 and Table 1 begin to paint a picture of how adult literacy actually affects adults in the United States. Understanding that most necessary (governmental and health) sites, are not written in accordance with the Plain Writing Act, we can now understand that persons with Basic literacy would struggle to access vital

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information. Therefore, the forty-three percent (43%) of adults rated as Basic of Below Basic means that 93 million adults are unable to fully function in modern society.

Testing Parameters and Limitations. The NAAL used two different population types: (1) a national household sample, and (2) a national prison sample (Kutner, et al., 2007). The selection of these groups was based on extensive criteria to ensure a representative cross-section of the U.S. population. An initial survey selected over 35,000 households to participate, of which just over 18,000 participated (Baer, Kutner, & Sabatini, 2009, p. 46). The test measured literacy based on three scales (as seen in Table 1): prose, document, and quantitative. Tasks in each of these scales try to "simulate the types of demands that adults encounter in everyday life" (Kirsch, Jungeblut, Jenkins, & Kolstad, 2002, p. 118). Further, materials for the testing were selected to match use cases for the common U.S. adult; an effort was made to guarantee inclusion of "as broad a range as possible and to select universally relevant contexts and contents to ensure that the materials would be familiar to all participants" (p. 120).

The NAAL tested individuals using a paper and pencil approach. After demographic questions were answered, participants were asked to complete a reading comprehension exam in a booklet provided by the interviewer. After the first seven questions were answered, the interviewer would grade those responses and pass the participant on to the main exam or to a supplementary exam. Those participants who had failed to answer the first seven questions correclty were passed to the supplemental exam. This meant they measured at Below Basic and the supplemental exam worked to find their abilities using sight words and then moved to connected texts. The remaining

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participants determined to have Basic of above literacy skills, were directed to the main more robust exam.

At the time that these exams were administered, paper and pencil approaches would have been an acceptable form of assessment. However, paper and pencil exams are static and cannot test to minute levels of ability, meaning they are less precise, and cannot provide a detailed understanding of a person's literacy.

Program for the International Assessment of Adult Competencies. In 2012, the Program for the International Assessment of Adult Competencies (PIAAC) tackled testing the literacy of adults worldwide. The United States was included in this assessment, and the PIAAC has been used to define literacy rates in the U.S. since its inception, effectively replacing the NAAL. According to the PIAAC, fifty percent (50%) of adults in the U.S. read at or below a Level 2. Figure 2 documents the levels of literacy for the 2012 PIAAC.

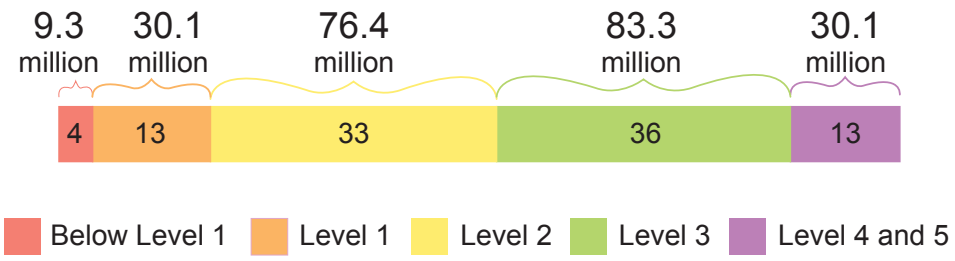

Figure 2. 2012 adult literacy rates with population counts (Goodman, et al. 2013)

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Table 2

PIAAC literacy levels with definitions.

Level	Definition
Below Level 1 0–175	The tasks at this level require the respondent to read brief texts on familiar topics to locate a single piece of specific information. There is seldom any competing information in the text and the requested information is identical in form to information in the question or directive. The respondent may be required to locate information in short continuous texts. However, in this case, the information can be located as if the text were non-continuous in format. Only basic vocabulary knowledge is required, and the reader is not required to understand the structure of sentences or paragraphs or make use of other text features. Tasks below Level 1 do not make use of any features specific to digital texts.
Level 1 176–225	Most of the tasks at this level require the respondent to read relatively short digital or print continuous, non-continuous, or mixed texts to locate a single piece of information that is identical to or synonymous with the information given in the question or directive. Some tasks, such as those involving non-continuous texts, may require the respondent to enter personal information onto a document. Little, if any, competing information is present. Some tasks may require simple cycling through more than one piece of information. Knowledge and skill in recognizing basic vocabulary determining the meaning of sentences, and reading paragraphs of text is expected.
Level 2 226–275	At this level, the medium of texts may be digital or printed, and texts may comprise continuous, non-continuous, or mixed types. Tasks at this level require respondents to make matches between the text and information and may require paraphrasing or low-level inferences. Some competing pieces of information may be present. Some tasks require the respondent to cycle through or integrate two or more pieces of information based on criteria; compare and contrast or reason about information requested in the question; or navigate within digital texts to access and identify information from various parts of a document.
Level 3 276–325	Texts at this level are often dense or lengthy, and include continuous, non-continuous, mixed, or multiple pages of text. Understanding text and rhetorical structures become more central to successfully completing tasks, especially navigating complex digital texts. Tasks require the respondent to identify, interpret, or evaluate one or more pieces of information, and often require varying levels of inference. Many tasks require the respondent to construct meaning across larger chunks of text or perform multi-step operations in order to identify and formulate responses. Often tasks also demand that the respondent disregard irrelevant or inappropriate content to answer accurately. Competing information is often present, but it is not more prominent than the correct information.
Level 4 326–375	Tasks at this level often require respondents to perform multiple-step operations to integrate, interpret, or synthesize information from complex or lengthy continuous, non-continuous, mixed, or multiple type texts. Complex inferences and application of background knowledge may be needed to perform the task successfully. Many tasks require identifying and understanding one or more specific, non-central idea(s) in the text in order to interpret or evaluate subtle evidence-claim or persuasive discourse relationships. Conditional information is frequently present in tasks at this level and must be taken into consideration by the respondent. Competing information is present and sometimes seemingly as prominent as correct information.
Level 5 376–500	At this level, tasks may require the respondent to search for and integrate information across multiple, dense texts; construct syntheses of similar and contrasting ideas or points of view; or evaluate evidence based arguments. Application and evaluation of logical and conceptual models of ideas may be required to accomplish tasks. Evaluating reliability of evidentiary sources and selecting key information is frequently a requirement. Tasks often require respondents to be aware of subtle, rhetorical cues and to make high-level inferences or use specialized background knowledge.

Note. Adapted from Goodman et al., 2007, p. B-3

The PIAAC used six distinct levels by which to rate literacy, giving more nuance to how literacy is understood. Table 2 (above) defines each of these levels in detail. In the Below Level 1 category, participants were not asked questions that relied on the structure

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of sentences; participants were asked questions that had them match single words or concepts. For example, at this level a participant would be asked to count the number of votes each candidate received and identify the candidate with the fewest votes. This level required very little ability to read and understand texts — simple word recognition would be enough. Level 2 meant that participants were able to read and match information in the text and able to paraphrase simple inferences from the texts presented; Level 1 fell in between these two. Based on our operational definitions of low literacy, some adults who test as Level 2 and any adults testing below Level 2 would be considered low literate.

Revisiting the definition of literacy, as provided by the PIAAC, we can start to understand the importance of the nuanced approach taken by the organization:

> Literacy is *understanding*, *evaluating*, *using* and *engaging* with *written texts* to *participate in society*, to *achieve one's goals*, and to *develop one's knowledge and potential* (Goodman, et al, 2013, p. 2, emphasis added)

According to the PIAAC literacy framework (PIAAC Literacy Expert Group, 2009), each word has an important definition summarized in Table 3. Each word was carefully chosen to represent a key concept in literacy; it's a layered approach to defining literacy, that informs how the PIAAC tested adult literacy.

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Table 3

PIAAC literacy framework

Keyword	Definition
understanding	Understanding a text can range from simply understanding the words being read, to gleaning complex themes and arguments.
evaluating	During reading, adults are constantly making judgment calls about the text. Is it useful? Does it have what I need? Is it credible? This ability is especially important when it comes to electronic texts.
using	Adults often read with the intention of directly (and immediately) apply the information in the text. Readers approach texts for a specific purpose.
engaging with	Adults may only read when compelled, while others find great joy in reading. The level of engagement with texts is directly correlated with cognitive measures, without engagement understanding, we cannot fully understand literacy.
written text	Prior tests focused mainly on informative texts, and the PIAAC expanded the range of texts used in testing. Adults use electronic devices to navigate their daily lives; for this reason, the PIAAC also moved beyond printed text to electronic texts for this reason.
participate in society	The use of "participating" was purposefully chosen to show a more active role for the individual than simply functioning within a society. Literacy allows adults to engage with the world around them and to contribute to their community.
achieve one's goals	Adults have a range of needs — from survival to personal happiness to profession — even a task as simple as grocery shopping will require reading.
develop one's potential	Adults pursue learning throughout their lives, even in informal ways. This learning requires the use of printed and electronic materials

Note. Summarized from PIAAC Literacy Expert Group, 2009, p. 8–9

Testing Parameters and Limitations. The PIAAC crafted real-world, culturally aware tasks that are important or relevant across different contexts. (Goodman, et al. 2013). The tasks in the PIAAC were designed to reflect real world experiences that could be encountered during a normal day's activities. The PIAAC randomized the types of tasks across the participants, meaning not every participant would encounter each type of task. Like any person in the real world wouldn't necessarily interact with every type of reading task available, so too the PIAAC randomized the situations presented. Further, the reading exam focused on the following elements: "reading vocabulary, sentence comprehension, and basic passage comprehension" (p. 2).

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The PIAAC had a unique method of delivery for the assessment, which was available in two formats: computer-based and paper-based. Initially, the PIAAC was "conceived…as a computer-based assessment (CBA)", but it had to include the "option of taking the literacy…[component]…in paper-based format (PBA)" for those adults who lacked basic computer skills (OECD, 2016, p. 47). Figure 3 diagrams the potential pathways for test administration. Over seventy percent (70%) of people taking the PIAAC were able to complete the assessment using the CBA. The CBA had an adaptive design component, as participants answered questions, the CBA predicted their ability and adapted, providing different blocks of items based on their estimated skill level (OECD, 2016). By using an adaptive model, a participant's final score could more accurately define their literacy. Compared to the test administered by the NAAL, the PIAAC could present tasks to the participant that incrementally increased (or decreased) in difficulty to ascertain nuance in their literacy abilities.

The PIAAC chose to sample the "non-institutionalised [sic] population, aged 16-65 years, residing in the country at the time of data collection, irrespective of nationality, citizenship, or language status" (OECD, 2016, p. 51). A "representative probability sample of 9,468 households" went through the first round of screening, and of that number "a total of 5,686…households with eligible adults completed the screener" (Goodman, et al., 2013, p. C-2). In the end, 4,820 participants completed the literacy assessment, with an additional 22 unable to complete it due to literacy problems (p. C-2).

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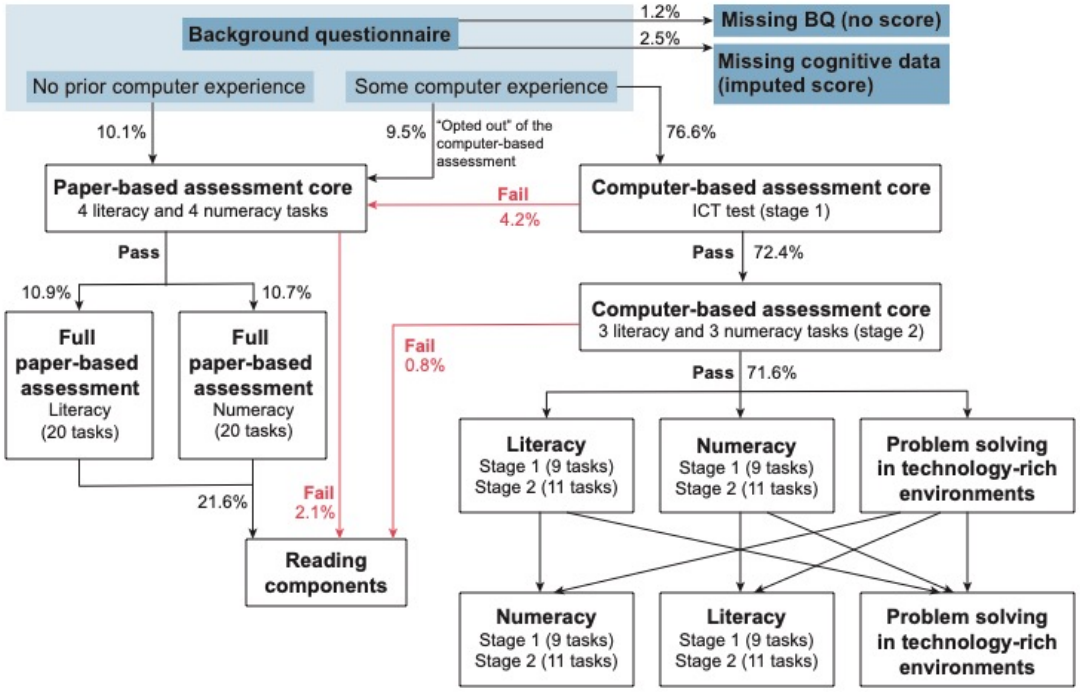

Figure 3. Possible pathways for cognitive assessment in the PIAAC CBA. (OECD, 2016, p. 48).

The PIAAC submitted their data to an adjudication process in order "to determine whether it was sufficient quality to be reported and released to the public" (OECD, 2016, p. 60). The process found that the results met the defined quality standards, except in two cases, and steps have been taken to rectify those concerns (OECD, 2016). The steps taken to ensure the quality, accuracy, and detail of the PIAAC make it an excellent resource for understanding the state of literacy in the United States.

Unfortunately, it is not possible to say with certainty that there is a trend either up or down for literacy rates, as the test parameters changed sufficiently between the NAAL and the PIAAC that the results may not indicate an actual trend. It could be that the

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changed definition or testing parameters affected the changes seen in the data, rather than a true change in the population. What we can say for certain, is that there is still a need for understanding and supporting the low literate community in the United States.

Education and Literacy

Evidence suggests that learning disabilities will often deter students from even attempting college, which will lead to a larger financial burden on government support systems (Hildreth, Candler-Lotven, & Macke, 1994; Wise, 2009; Alliance for Excellent Education, 2017). In our ever-shifting economy, college can be essential path to greater job opportunities[9]. It has become increasingly necessary for students with learning disabilities — and consequently low literacy abilities — to attend college despite the challenges they will face.

McCleary-Jones (2008) stated that learning disabilities are the "most common form of disability found in the college-age population" (p. 14) and the term is "used to describe the seeming unexplained difficulty … a person…has in acquiring basic academic skills" (p. 15). The Individuals with Disabilities Education Act (IDEA, 2004) defines specific learning disabilities (SLD) as

> "a disorder in one or more of the basic psychological processes involved in **understanding or in using language, spoken or written**, which

[9] According to the Bureau of Labor Statistics, attaining an associate degree or more results in an unemployment rate of 2.5%, a high school diploma or some college has an unemployment rate of 5.3% and no high school diploma a 7.7% unemployment rate, among people 25 and older. (Unemployment rate 2.5 percent for college grads, 2017)

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> disorder may manifest itself in the imperfect ability to listen, speak, **read, write, spell**, or do mathematical calculations" (emphasis added).

In 2013, the National Assessment of Educational Progress (NAEP), found that students with specific learning disabilities (SLD) were more likely to test at the "below basic" reading level than students with any physical disability or their non-disabled counterparts (see Figure 4).

Students with SLDs tend to have average or above-average intelligence, but their SLD is strongly correlated with lower reading test scores (Horowitz, Rawe, & Whittaker (2017). Patterson and Mellard (2008) found that adult learners with SLD tested ten to twenty-five percent (10%–25%) lower on reading comprehension and fifteen to thirty percent (15%–30%) lower on functional reading skills than their non-SLD counterparts; however, their general intelligence measure was not significantly different (1%–7%) (p.10). In Patterson and Mellard's (2008) work, Wechsler's definition of intelligence (and the corresponding testing method) was employed; namely, that intelligence is "the global capacity of a person to act purposefully, to think rationally, and to deal effectively with his environment" (Wechsler, 1958, p. 7).

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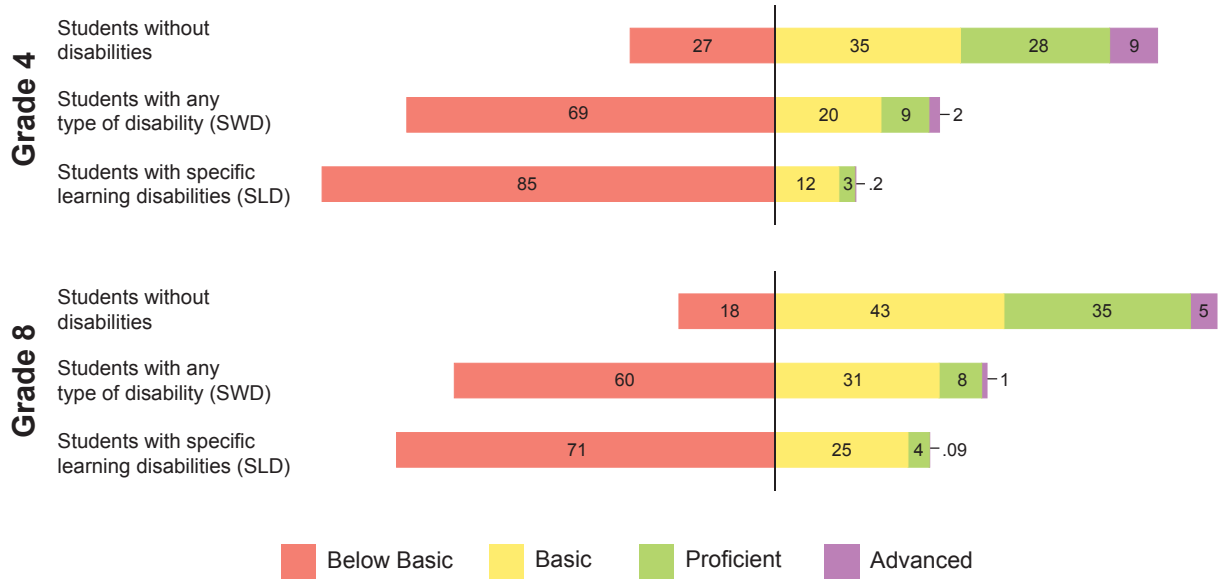

Figure 4. NAEP—Reading proficiency test results for Grade 4 and 8 by disability type.

Literacy is a fundamental component of academic success; Wise (2009) stated that "literacy — reading, writing, speaking, and thinking — is such a fundamental skill that all other success hinges on it" (p. 373). Literacy is such an important factor in success, that the No Child Left Behind Act (NCLB, 2002) included specific guidelines and support for foundational literacy in early education; however, there were no such provisions beyond elementary school. Thanks to these supports, "literacy skills in the lower grades have risen over the past 30 years," however, the lack of secondary school provisions means that "adolescent literacy rates have remained virtually stagnant" (Wise, 2009, p. 373). The National Assessment of Educational Progress (NAEP) first tested reading levels of students in 1992 and most recently they tested 4th and 12th graders in 2015. Over the 23 years between the first and most recent assessments, students in the 12th grade have seen an eight point (20% to 28%) increase in students who read at a

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Below Basic level, and a decrease of three points (40% to 37%) of students rated as having “proficient” or “advanced” literacy. Conversely, 4th graders rated as reading at a Below Basic level decreased by seven points (38% to 31%), while proficient and advanced readers incrased by eight points (28% to 36%). For more details, see Figure 5 below.

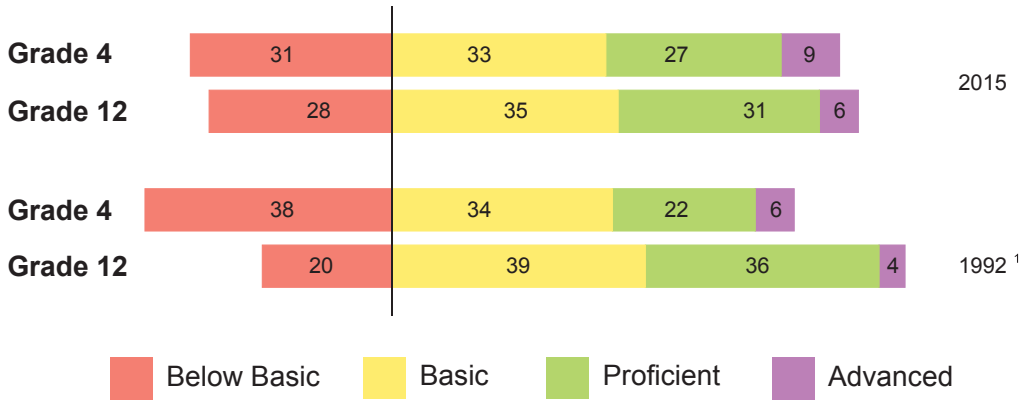

Figure 5. NAEP—Reading proficiency test results for grades 4 and 12 for 1992 and 2015

To put this into concrete numbers, those students enrolled in the twelfth grade who read at or elow a basic level, account for 1.18 million students. A below basic reading ability means that students are unable to “demonstrate an overall understanding…of the text” (U.S. Department of Education, 2015) or —more succinctly—students lack even “partial mastery of fundamental skills” (McFarland et. al, 2018, p. 96). This means (from Table 1) that these students are only able to locate easily identifiable information in short, commonplace texts and may be able to follow simple written instructions, but they would not be able to take various information from different

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texts and synthesize them into useful information[10]. If students have not mastered a basic level of literacy before they graduate from high school, their chances of success in college will be limited. Biancarosa and Snow (2006) indicated that even students with basic skills (as defined by McFarland et al.) will not be fully prepared for success, as literacy is the keystone of success in all other courses. Wise (2009) echoes this point of view and indicates that "higher levels of literacy contributed to greater college enrollment and higher grades in all college courses" (p. 373).

Success in high school, and consequently college plays a large role in the financial health of a nation. Wise (2009) reported that students who dropped out of high school in 2008 will cost the United States (U.S.) an estimated "additional $319 billion in income over their lifetimes"; a single student makes up $260,000 of that lost income (p. 371). Further, increasing the graduation rate and matriculation to college for male students by "only 5% would lead to a combined crime-related savings and additional revenue of almost $8 billion each year" (p. 371). The Alliance for Excellent Education published a report in October of 2017 that found that if the U.S. high school graduation rate had reached 90%, the country would see

- $664 million more federal, state, and local taxes,
- $2.5 billion more in spending,
- $534 million more in car sales, and

[10] Evidence from the National Center for Education Statistics shows that literacy is a primary factor in educational success, roughly fifty percent of low literate students (those without basic reading skills) will drop out of high school (Kutner, et al., 2007)

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- $7.8 billion more in home sales

This would lead to a $5.7 billion economic increase for the United States. Conversely, students who do not have the literacy skills necessary to graduate from high school and succeed in college will face financial difficulties and will be more likely to rely on government-funded assistance programs (Wood, 2010).

Part of the reason students who fail to graduate and matriculate are facing financial hardships is that the job market has shifted. Once, students with just a high school diploma could make enough income to support families, but now the U.S. Department of Labor (2019) predicts that over fifty percent of job growth by 2026 will require some post-secondary education. Further, education is the "primary determinant of occupational status" meaning, school success will directly impact a students' aspirations in college and beyond (Hildreth, Candler-Lotven, & Macke, 1994, p. 418). Students need to attend colleges and technical training schools if they want to succeed in modern American life.

Because students with learning disabilities (and consequently low literacy) may feel like they will not be successful in college, they "often do not consider college as an option" for themselves (Hildreth, Candler-Lotven, & Macke, 1994, p. 418). If they do attend college, the lack of skills necessary to succeed will cost "$3.7 billion a year in costs associated with college remediation[11]" (Wise, 2009, p. 372). That is assuming that

[11] Remediations may include private tutors, specialized classes, or providing multiple (extra) formats for the required course content, to name a few.

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colleges will even be prepared to help students succeed. Pierce (2015) found that "the chances are high that the supports [students] had in high school won't exist for them in higher education" (p. 21). This is despite the Higher Education Opportunity Act of 2008 which requires colleges to "support students with learning disabilities" (p. 22). Unfortunately, the Act offered no substantial requirements because each college will have a different levels of resources available to support students, and so colleges are allowed to create their own policies and procedures for supporting students with learning disabilities with little or no oversight to ensure compliance with the law.

McCleary-Jones (2008) conducted a study on students with learning disabilities who were attending community colleges, and their findings showed that student supports varied widely; some students felt supported and cared for, while others felt that the schools had no idea how to support them. Even in schools with administrational support, students found that professors were another layer of potential support or lack of understanding. One student related that "some professors don't understand students with disabilities and shared that after she told a teacher she read at the 4th grade level, the teacher commented 'Well, what are you doing in college? College students should read at a 13 level'" (p. 16). This lack of consistent support and understanding leads to vastly different outcomes for students — students with adequate supports will have a higher chance of successfully completely their college education, while students who lack sufficient support will tend to drop out of school.

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Defining a New Generation

To understand current students enrolled in the university setting, it's important to understand the way the world they grew up in has influenced them. Since the current college student population is no longer made up of just Millennial students, this section will seek to define the generation that follows Millennials: Generation Z. In 2018, the Pew Research Center took the time to look at their generational data and set about defining the end of the Millennial generation and the start of the so-called "Post-Millennial" generation (Dimock, 2019). Since their definition of the Post-Millennial generation came out, the moniker of Generation Z has taken hold as the official name for the new generation (see Merriam-Webster and Oxford English Dictionary); a generation that is defined as coming of age in the social media and smartphone saturated world (Dr. Jean Twenge). Some groups define the start of Gen Z as early as 1993, while the Pew Research group uses a slightly later year, 1997[12]. Other groups put the start of Gen Z later, into the early 2000s. But no matter where we draw the line officially, Generation Z has experienced a world that is different in significant ways than the world of the generations that preceded it (Dimock, 2019).

Dimock (2019) defined the Millennial generation as the generation that grew up with the specter of the Iraq and Afghanistan wars of the early 90s, and most of this

[12] Statistics Canada puts the start of Gen Z at 1993 (White 2018), while Twenge puts the start at 1995 (Dr. Jean Twenge). The American Marketing Association defines their start at 9/11 (Fishman, 2015), and Neil Howe (2014) puts the start sometime in the late aughts of 2000 (he tentatively says 2005, but then admits you can't really know where history will start a generation).

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generation was old enough to understand the implications of 9/11 and how that moment changed the world forever. These evens sharpened the view of Millennials and polarized the political views of the generation that is shaping our current political landscape. Further, the 2008 election was largely shaped by the younger, Millennial vote. And up until the newer Generation Z, Millennials were the most diverse generation American had ever seen. The Great Recession struck just as most older Millennials were leaving college and trying to enter the workforce. Jobs were hard to find, and this changed the way the generation viewed their job potential. No longer was it necessarily about earning a high income, the generation wanted jobs that meant something, that contributed to a cause. Finally, Millennials did not grow up in a world already inundated by the internet, rather this generation came of age just as the internet exploded.

Understanding the basics that defined the Millennial generation will help us to better understand where Generation Z differs from the Millennials, and where they are the same. In particular we will focus on how the experiences of Generation Z shaped the new generation, how their world shaped the way they interact with information on the internet, and how they have been taught to harness that information for their education. While there is still little written in the scholarly journals about Generation Z, this paper will report on what research has been done and what it could mean for the future of education.

Generation Z: Who are They. Howe (2014) proposed the name "Homelander" for Generation Z, because there was a sense post-9/11 that the homeland was no longer safe, the Department of Homeland Security was formed, there was a push for

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nationalism, localism, and identifying with your roots. Further, he claimed that this "generation of children is literally kept more at 'home' than any earlier generation of kids" because of over protective, helicopter parents. While Howe's name did not stick for the generation, his ideas for why the generation should be called Homelander do help us identify and understand Generation Z.

Generation Z does not remember a time pre-9/11 (Dimock, 2019; Howe, 2014); thus, they have no memory of a time when the United States was not engaged in the "War on Terror" both internally and externally. Generation Z has grown up in a world that seems to be in almost constant threat from outside forces; they are a generation of survivors; while Millennials experienced the first mass shooting at a school, Generation Z has never known a time when gun violence was not a part of their lives (Diaz, 2018; Miller, 2018). This has led to a string of activism in recent years where students have pushed for reform in ways prior generations never did. They used social media as the primary means of action (Mejia 2018).

The choice to engage in social media activism comes from the way Generation Z has been steeped in technology from a very young age. For Generation Z social media is not just a platform where things happen occasionally; social media is an ingrained part of their everyday life (Hardie, 2018). They were on social media even before they were actively participating it in it. Buzzetto-Hollywood and Alade (2018) found that most of Generation Z has had their entire lives catalogued online by their parents, everything they have ever done or will do has been dominated by social media. Generation Z has been

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molded by the constant access and exposure to electronic devices in ways no other generation has (Gibson, 2016; Törőcsik, Szűcs, & Kehl, 2014).

When the Millennial generation was growing up, they were touted as the most diverse generation in the United States (Dimock, 2019). However, Generation Z is set to take that title from the Millennials despite a drop in immigration to the U.S. Fry (2018) noted that the foreign-born Hispanic population has been cut in half, while there has been an increase in both U.S. born children to immigrant and U.S. parents; meaning, most of the Hispanic population has always lived in the U.S., they are not immigrants, but (grand)children of immigrants. As of 2018, nearly half of all Generation Z was non-white, and by 2026 Generation Z is projected to be majority non-white (Fry, 2018). The racial diversity of Generation Z has set them up to be the most accepting and open generation to date (Wang, 2018). Based on this racial diversity, Miller (2018) believes that this generation does not spend time focused on race, religion, or sexual orientation, and claims Generation Z is more interested in "honesty, sincerity, and — perhaps most important — competence" (p. 56).

Based on the trends we see in the educational force of Generation Z, it is being predicted that they will be the most well-educated demographic (Fry, 2018). Forty-three percent of Generation Z were raised in houses where at least one parent had a bachelor's degree or more; this is a more than ten percent increase over Millennials. Generation Z has been able to witness the benefits and necessity of education, meaning they view education with more favor than prior generations (Miller, 2018). In fact, according to Fry (2018) the United States has seen a decrease in high school drop rates in Generation Z

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from the last two generations; only six percent[13] 18- to 20-year-olds had dropped out of high school in 2017.

In 2017, eighty percent of Generation Z had finished high school, which is only a small increase over prior generations[14]; however, of those who have graduated, Generation Z is matriculating to college at higher rates than Millennials at comparable ages (Fry, 2018). The Pew Research Center reported that fifty-nine percent of Generation Z had enrolled in college in 2017, compared to fifty-three percent of Millennials and forty-four percent of Generation X at comparable ages (Fry, 2018). It has also been found that it is the minorities that are showing the biggest improvements in completing high school and enrolling in college. The amount of white Generation Z students completing high school has remained stagnant, but black youth have increased their college enrollment by seven percent over Millennials and twenty percent of Generation X. The Hispanic population has seen an even bigger increase with fifty-five percent enrolling in college, compared to thirty-four percent of Hispanic Millennials and twenty-eight percent in Generation X (Fry, 2018).

Educating Generation Z has shifted the way the American school system approaches the classroom. Flipped classrooms, innovative use of different technologies, active learning modules, narratives, and storytelling are all techniques used in recent years to help engage Generation Z learners (Shatto & Erwin, 2017). There is evidence to

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[13] Millennials had a dropout rate of 12% and Generation X had a dropout rate of 13 percent at the same point (Fry, 2018).
[14] This is a 4% increase over Millennials and only a 2% increase over Generation X (Fry, 2018).

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support the idea that Generation Z prefers visual approaches to education over the lecture model, as they have been in almost constant connection with technology for most of their lives (Shatto & Erwin, 20160. The use of visual learning techniques, or flipped classrooms, are designed to help engage a generation that has been documented has having a thirty-percent lower attention span than Millennials (Buzzetto-Hollywood & Alade, 2018; Hallowell & Ratey, 2011).

Shatto and Erwin (2016) and Zorn (2017) found that Generation Z adopts new technology quickly, and they do not seem have a high tolerance for people who do not keep up with the shifting world of technology. Educators have faced increased pressure to not only adopt the latest technology in their classroom, but educators have had to increase their digital literacy at the same rate as Generation Z. It is on the educators to help Generation Z learn how to use digital technology to enrich their education, rather than impede it.

Even with how ingrained technology is in the lives of Generation Z, Buzzetto-Hollywood, Elobeid, and Elobaid (2017) found that first-generation students faced digital literacy issues, specifically related to every day computer applications. Students come well-versed in using their mobile devices to engage in online conversations, search for answers to questions, and make content, but some students lack understanding of computer programs designed for more scholarly pursuits; despite this, students seem to recognize that technology will be a big part of their lives after college and they want to be digitally and technologically literate (Buzzetto-Hollywood, 2018).

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Information Literacy and Retrieval

According to Buzzetto-Hollywood (2018), students entering college today are aware of the need of technology and the need to possess the skills necessary to process large amounts of information quickly to inform their decisions in the workplace. Unfortunately, Dixon (2017) says that first-year college students are coming to college with a wide range of abilities when it comes to information literacy, due to a decrease in access to proper school libraries and trained educators to help them learn the skills they will need. Geck (2006) wrote that Generation Z were "amateur Internet searchers" who were unable to effectively evaluate web sites, basically, Geck found that most of today's students lacked information literacy skills they needed to succeed (p. 235). Geck's work was largely dismissive of the current generation of college students and runs counter to the findings of this study. The following section will briefly review traditional and digital literacy, including how they impact each other and barriers to access; a review of work done in information seeking for both high and low literate users, and a brief touch on mental models of information retrieval and work done with Millennial.

Traditional and Digital Literacy. Van Deursen & Van Dijk (2016) conducted research in an attempt to link traditional literacy with digital literacy, citing the disadvantages a lack of internet skills would have in our contemporary society as motivation. Without access to — and an understanding of how to access — the Internet entire populations of people will lack access to information on jobs, health, entertainment, and news.

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Van Deursen & Van Dijk note that there does appear to be a link between traditional literacy[15] skills and Internet skills; however, there had not been substantive empirical research to test the theory. Internet skills are multidimensional, and traditional literacy models did not necessarily take this into account. Van Deursen and Van Dijk (2016) extended the definition of literacy to include digital literacy as "…a general ability to evaluate the validity and reliability of information sources" to "cover the (inter)active engagement required for interactive digital media" (p. 14). Today's students still need to be able to recognize when a print source is reliable, but they also need to understand how to use the internet and evaluate the content they find there for credibility.

Van Deursen and Van Dijk (2016) break digital literacy down into two main skill sets: medium-related and content-related. Table 4 details these two sets of digital skills. Medium-related skills are those skills that are most associated with "button knowledge" and navigation of webpages; content-related skills, however, focus on the abilities of users to choose sites that will give them the best information and harness the internet to meet the user's goals.

Van Deursen and Van Dijk (2016) believed that the Internet has several advantages over traditional texts, as the internet can combine multiple modes of information presentation. For example, icons and pictures would help people with low literacy to understand content more quickly and efficiently than text alone. Adding in video and audio only augments their access.

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[15] Traditional literacy is the ability to use written language to communicate.

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Table 4

Conceptual definitions of internet skills.

Medium-Related Internet Skills	
Operational Internet Skills	Operating an Internet browser, meaning:
"Button Knowledge"	Opening websites by entering the URL in a browser's location bar
	Navigating forward and backward between pages using browser buttons
	Saving files on a hard disk
	Opening various common file formats (e.g., PDFs)
	Bookmarking websites
	Changing a browser's preferences
	Operating Internet-based search engines, meaning:
	Entering keywords in the proper field
	Executing a search operation
	Opening search results in the search results lists
	Operating Internet-based forms, meaning:
	Using the different types of fields and buttons
	Submitting a form
Formal Internet Skills	Navigating the Internet, meaning:
	Using the hyperlinks (e.g., menu links, textual links, and image links) in different menu and website layouts
	Maintaining a sense of location when on the Internet, meaning:
	Not becoming disoriented when navigating within a website
	Not becoming disoriented when navigating between websites
	Not becoming disoriented when opening and browsing through search results
Content-Related Internet Skills	
Information Internet Skills	Locating require information by:
	Choosing a website or search system to seek information
	Defining search options or queries
	Selecting information (on Websites or in search results)
	Evaluating information sources
Strategic Internet Skills	Taking advantage of the Internet by:
	Developing an orientation toward a particular goal
	Taking the right actions to reach this goal
	Making the right decisions to reach this goal
	Gaining the benefits that result form this goal

Note. These concepts are taken from Van Deursen & Van Dijk, 2016, p. 16.

Van Deursen and Van Dijk (2016) hypothesized that traditional literacy skills would have the greatest impact on formal, information, and strategic internet skills as those skills require the ability to quickly read and understand the content of the website. Van Deursen and Van Dijk (2016) stated "it is not clear whether people can acquire the necessary information Internet skills when traditional literacy is insufficient" (p. 17). Online search yields a large amount of results, many of which may not align with the

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intended search goal, meaning that a high level of traditional literacy skills are needed to quickly assess the information provided to find those sources that align to the search goal. People with low literacy often get anxious when presented with large amounts of information that they have to process, potentially making snap judgements without the benefit of full context and understanding (Van Deursen & Van Dijk, 2016).

Information Search Studies. Like many scholars in the field, Van Deursen and Van Dijk (2016) built their research on the work of Summers and Summers (2005), exploring the link between traditional and digital literacy. Summers and Summers (2005) research set out to understand how low literate internet users differed in their use of reading and navigational techniques compared to medium to high literate users. Summers and Summers (2005) found that low literate users did not scan web pages, instead tending to read every word they encountered so as to not miss the needed information. Further, low literate users are so focused on reading, that they are not able to look ahead or behind, and often miss content that is just outside their area of focus. Or they skipped long blocks of text, even if the content they were looking for was properly marked by a heading, list, or properly chunked (Summers and Summers, 2005; Kodagoda, Wong, & Kahan, 2009).

Low literate users tend to become satisfied very quickly with the information they have found, meaning they often settled for incomplete information (Summers & Summers, 2005). In terms of searching, Summers and Summers (2005) found that most low literate users would prefer to avoid using it if possible. When made to use search, one

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low literate user tended to ignore all text except for the site titles and click on the first link or the site title that looked simple and most closely matched their search string.

Kodagoda, Wong, and Kahan (2009) focused their attention on navigational search behaviors of both high and low literate users in an online database. They found, like Summers and Summers (2005), that low literate users were quickly satisfied with their results, read every word on the page, have a narrow area of focus, missing content outside that area, and are more likely to rank their experience as satisfactory instead of admitting that it was difficult for them. Building on the work of Summers and Summers (2005), Kodagoda, Wong, and Kahan found that low literate users do not employ verification techniques when looking for information online, while the medium to high literate users almost always verified the information before moving on. In the medium and difficult tasks, medium to high literate users verified information 100% of the time, while in the easy task, only 80% of the information was verified by medium to high literate users.

Medium to high literate users were able to use clues in the webpage that helped them have similar trajectories during their information seeking tasks. (Kodagoda, Wong, & Kahan, 2009). Low literate users had no similarities in their trajectories. This is in line with Summers and Summers (2005), as they found that low literate users were less able to scan for headings and subheadings, and that low literate users would often 'link hop' hoping to find the right information in a clear and distinct manner eventually. This behavior is also in line with low literate user's narrow field of attention: if they are unable

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to see what is around them on the page, they will miss the cues that would lead them to the right information.

Further, Kodagoda, Wong, and Kahan (2009) found that low literate users are less likely to be able to recover when presented with wrong information, meaning they did not realize they had encountered bad information, so they did not go back to find the right information. Similarly, low literate participants had a perception of where information should be on the page, and if they did not find the information where they expected, they were most likely to abandon the search. In comparison, medium to high literate searchers did not abandon their searches, instead they used context clues on the page to find the information they needed. Kodagoda, Wong, and Kahan (2009) also found that low literate users tended to assume they had been successful, even when they had not entirely completed the task. Low literate users have been documented as being willing to settle for partial answers to avoid further reading (Summers & Summers, 2005; Kodagoda, Wong, & Kahan, 2009).

Building on this research, Kemeny, et al. (2013) focused on how users with low literacy skills could benefit from the addition of rich search results to search engine results pages (SERP). When a simple search has been performed ('mitosis definition') the SERP will surface a quick answer in plain text at the top of the page. This allows the user to quickly find their answer without having to click through to any of the other search results. Traditionally, SERPs tend to offer up links with short descriptions of the page's context; while this gives users the ability to choose the information they need from multiple sources, the point of a 'Rich Search Result' is to give users a contextually

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relevant answer, not just lists of potential answers (Moreville & Calendar, 2010; Google, 2009). Rich search results are now called “Featured Snippets” by Google (no date).

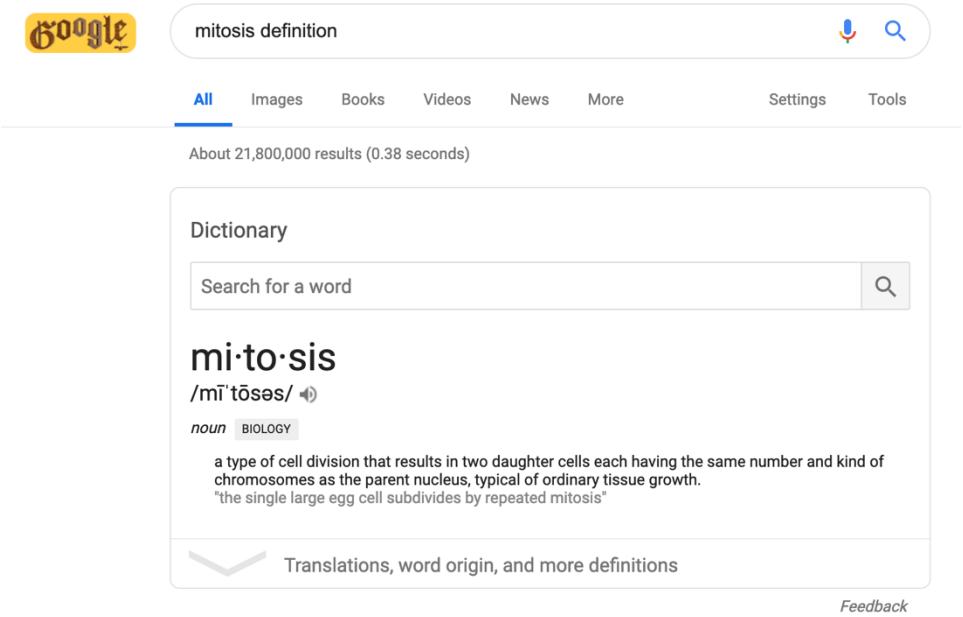

Figure 6. Example of a featured snippet for the search query “mitosis definition”

Kemeny, et al. (2013) found that low literate users who encountered featured snippet were able to understand, read, and process the information found in them rather easily. Overall, low literate users had a positive reaction to the featured snippets. For those low literate users who did not encounter featured snippet, there were a few reasons that the SERP was unable to surface them: first, low literate users tend to use natural language search strings; second, low literate users rely heavily on autocomplete[16] which

[16] Kemeny, et al (2013) notes that autocomplete relies on past-user searches, which can include misspellings; similarly, the farther off the original spelling by the user the less helpful autocomplete will be.

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can lead to misspellings and misinformation; finally, some low literate users simply did not see the featured snippets when they were displayed.

Kemeny, et al. (2013) used a protocol that employed eye tracking so that interactions with featured snippet could be better tracked through the data provided. Kim, et al. (2015) similarly employed eye tracking data to explore how search behaviors change when using a small mobile screen versus a larger computer screen. When using small screens, users exerted considerably more effort extracting information from the web sites they visited. Users on both screens moved from their initial search to their first site at the same pace; however, users on smaller screens took more time reading the site over the users of the larger screens. Eye movements indicated that users tended to skip less content and had fewer regressions on the smaller screens, opting for reading over scanning. On the larger screens, users tended to skip more content and scroll farther down the page than on the small screens. There was very little difference in search performance based on screen size; users were able to find similar answers and visited the similar amount of sites to do so.

According to Marchionini (2006) search activities can be divided into one of two types: lookup and exploratory. Most of the research done on search behavior has focused on 'lookup' searches where the user had a clear goal and completed the task by finding the needed information. Marchionini (2006) believed that the two types of searches were overlapping — explaining that each type was embedded in the other. When a user performs a lookup search, they often start with exploratory search techniques, until they can hone in on the needed information to complete their lookup. Similarly, exploratory

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searches blend with lookup searches as information is found, and the user spends time diving deeper into what they have learned.

Athukorala, et al. (2016) looked at how exploratory search was different than lookup search. Athukorala, et al.'s (2016) goal was to help develop information retrieval systems that could distinguish between the two search behaviors and support the user in their specific search goals. Athukorala, et al.'s (2016) found that the first search of a lookup task tends to have longer queries than in exploratory tasks. This is due to having a clear goal, so that a user can write a query that will specifically address that need. In exploratory searches, the end goal is less well defined, so initial searches tend to be more open-ended over time, the user refines their searches as they start to understand what it is they are looking for.

Information Search Strategies. Markey (2007) reviewed twenty-five years of published research to analyze the types of internet searches that are being performed by internet users. Markey (2007) found that less than 20% of all searches use any type of Boolean search operator. Further, less than 15% of searches use bounding quotation marks which create a search for a specific phrase. Markey (2007) also found that users incorrectly used the advanced search features one third of the time. This research points to the finding (supported by Markey) that internet users are satisfied with using short search statements of two to four words and accepting the search results that are provided by such searches. Most internet users may perform multiple searches, but never will move beyond keyword searching.

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Xie and Joo (2010). identified eight different types of search strategies employed by thirty one participants in an internet search study. Their eight categories focused not on what types of searches were performed, but why they were performed and how they were modified over iterative searches. Their categories included such names as “whole site exploration,” “simultaneous multiple resource search,” and “known-item initiation.” Whole site exploration entailed a searcher browsing a single site for different aspects of a topic. Simultaneous multiple resource search meant a searcher used multiple resources at the same time to find their answers. Known-item searches was a tactic that allowed searchers to explore relevant information as they got started on their search.

Omekwu, Eke, and Agbo (2014) used questionnaires to survey 100 students about their internet search strategies. They asked participants about their search strategies including their use of Boolean operators (not used by students), phrase searching (not used by students), and key words searching (used by students). These were the only three strategies asked about in the survey, though Omekwu, Eke, and Agbo (2014) also identified proximity searches (using an asterisk to represent any words between two provided words) and other wild card searches. They do not give reasons for not asking about these two types of search.

Nachmias and Gilad (2002) had fifty-four graduate students perform simple search tasks after sitting through a “brief review of online search methods” in a forty-five-minute lecture (p. 478). They categorized the search strategies into six types of searches (detailed in Table 5). Nachmias and Gilad found that students used the simple strategies (e.g., direct single keyword search; simple directory, direct typing) most

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frequently, and seldom use more complex strategies. The categories that Nachmias and Gilad (2002) came up with cover the concepts that we see in search behavior, but they are not as well developed as those of Guinee, Eagleton, and Hall (2003), which offer search categories that have particularly descriptive and useful titles.

Table 5

Search Methods Defined by Nachmias & Gilad

Strategy	Definition	Example
Keyword search	exact copy of search prompt	"Mona Lisa"
Wide search definition	broader search than simple copy of prompt	searching for art and painting to find Mona Lisa
Complex search	using more than one keyword	"picture" "Mona Lisa" "Louvre"
Use of general knowledge	using prior knowledge not mentioned in the task	searching for Mona Lisa by mentioning Leonardo DaVinci
Computer convention	using computer verbiage	adding file extension such as ".gif" or ".jpg"
Boolean search	using Boolean syntax	Louvre and Mona Lisa

Though each of these studies offers insights into how internet users formulate their searches, none of them gives as succinct and accessible a list as Guinee, Eagleton, and Hall (2003). Their study focused on evaluating and describing the internet search strategies of 161 adolescent learners. They found that students used seven different methods for constructing search strings, which are detailed in Table 6. Each of the seven methods for search has a clear name (e.g., 'topic + focus' vs 'wide search definition') with a clear definition. The clear naming conventions and definitions allow for quick training to identify search types. These search strategies (described by Guinee, Eagleton, and Hall (2003)) were used by Holman (2009) to categorize the search habits of Millennial students; they were also used in the current study.

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Table 6

Search Categories as Defined by Guinee, Eagleton, and Hall

Strategy	Definition	Example
Single Term	using the topic term	“James Bond”
Topic + Focus	using a topic term, plus a focus term	“James Bond + actor”
Multiple Terms	using more than two discrete terms when searching	“actors + played + James Bond”
Phrase	taking the terms and writing a complete phrase	“actors that played James Bond”
Question	using a complete question	“How many actors played James Bond”
Combination	discrete terms with a phrase	“James Bond + number of actors”
Repeated Concept	repeated a term or concept	“actors that played James Bond + James Bond actors”

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Chapter 3: Methodology Review

This study was created based on the work of Holman (2009) and Zhang (2009); both research studies looked at search habits in conjunction with mental models. For this research their methods were modified, and mental models were not tested. An overview of their methods and why they were chosen is presented below.

Information Retrieval Research

Zhang (2009) had student participants complete an in-depth questionnaire that measured how long they had been using the internet, how frequently they searched online, what sites they used for searching on a regular basis, and their impressions and understanding of information rich websites. After completing the demographics, participants were allowed to interact with the Medline platform, as this was going to be where they completed their tasks.

After a few minutes of exploration, participants were asked to complete a concept listing, semi-structured interview, and a drawing activity. These activities were meant to help Zhang (2009) ascertain the participants' mental models for information retrieval. Zhang (2009) constructed tasks based on complexity of search request and participants were asked to perform these tasks. Participants were randomly assigned to either the "simple task" or the "complex tasks" groups at this point. After each task, participants rated the difficulty of the task, their mental effort, and their satisfaction with their performance. After the tasks were completed, the participants completed the concept listing, semi-structured interview, and drawing tasks a second time. In this first round of

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testing, participants completed a user experience questionnaire about their experience with the Medline platform.

The participants were then all asked to complete all of the tasks—the four simple tasks and two complex tasks—at this point, with the simple tasks being presented first and the complex tasks presented second. This method of structure is a modified between-subjects pretest-posttest set up. During each round of search tasks, the tasks were randomly presented to the users. After each task, participants were once again asked to rate the task difficulty, their mental effort, and their overall performance satisfaction. Finally, they went through the mental model tasks one final time: concept listing, semi-structured interview, and drawing. All search sessions were recorded for future analyses (Zhang, 2009).

Holman (2009) used a more simplified approach to testing student mental models of information retrieval and focused the research on non-constructed search prompts. Instead, students were invited in to search for one of the current course's assignments while the researcher observed their research process. The research was filmed again, for later analysis. Unlike Zhang (2009), Holman (2009) had students participate in the mental model drawing activity only once, after they had completed their search tasks. In doing this, Holman was able to focus their mappings on the search terms they had used during their activity. Further, Holman (2009) did not ask students to rate their satisfaction, mental effort, or task difficulty, instead focusing on a review of their keyword searches,

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the students' own reflection on their success and possible alternative searches[17], and other oral questions "designed to ascertain the student's conceptual understanding of search tools and how the tools used search terms" (p. 62).

While Zhang (2009) and Holman (2009) focused on mental models of information retrieval, the current research is focused on understanding less about mental models and more about the search behaviors of students. Zhang (2009) found that participants often had faulty mental models, and though their mental models did develop over time, they often still contained misrepresentations of search. Holman (2009) found that Millennial students did not have a working model of information retrieval systems that they could rely on to help them build complex search strategies. For this reason, the researcher decided to focus on search strategies and leave mental models for future research.

Neither Holman (2009) nor Zhang (2009) used eye tracking as part of their standard protocol. Their research was focused more on *how* a student searched for information (keywords, Boolean searches, revising searches, etc.) and not as focused on their reading and scanning habits. However, there is evidence to support using eye tracking as a data collection method in information retrieval studies.

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[17] Students were asked to explain what they were looking for, what kind of searches they performed, other searches they may have performed, and to list what kinds of sites they had expected to find. They were not asked if they thought they had been successful or were satisfied with their searching (Holman, 2009).

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Eye Tracking and Search Behavior Research. While most information retrieval research has relied on video footage for the researcher to review, few of these studies have utilized eye tracking as a method for better insights into participant behavior. Lund (2016) completed a literature review of information retrieval studies in library science that used eye tracking as data collection method and found that in the field of library science, eye tracking is underutilized, though there has been an uptick in recent years. The use of eye tracking in information retrieval research is well documented through work by Kemeny, et al. (2013), Kim, et al. (2015), Heard, Rakow, & Foulsham (2017), and Zhou (2017) to name a few. As we have already discussed a few of these studies in detail, this section will focus on their protocols for employing eye tracking and the metrics used during analysis.

Holman (2009) and Kodagoda, Wong, and Kahan (2009) utilized variations of think-aloud protocols to understand what their participants were interacting with during the search tasks. While a valuable tool, the concurrent think-aloud protocols still cannot show where a participant is looking without including the bias created by the participant's feedback. Bojko (2013) recommends using eye tracking as another data point along with a retrospective verbal protocol. Retrospective protocols have less impact on task performance than a concurrent think-aloud protocol (Bojko, 2013). For this reason, this study will utilize eye tracking as another data point in addition to a retrospective think-aloud protocol.

Kemeny, et al. (2013) read the search prompts aloud to the low literate participants, and then used the Tobii t60 eye tracker to follow along as the participants

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completed their search task. Utilizing the this Tobii system allows the user to have full range of head movement while performing their tasks; in Kim, et al.'s (2015) research, participants had their heads positioned in a chin rest to ensure they did not move their heads during the search tasks. While a chin rest ensures that a participant's gaze is measured with accuracy across all tasks, it limits natural movement and can create less accurate behavioral data; Liston, et al. (2016) found that head movements were most often to blame for inaccurate fixation measurements. Kemeny, et al. (2013) may have had less accuracy in their tracking (as noted by offsets), but participants had a more natural experience.

Kemeny, et al. (2013), Kim, et al. (2015) and Heard, Rakow, and Foulsham (2017) all used eye tracking fixation counts and scan paths as a way to understand what the user was viewing and for how long they interacted with it. Techniques for measurement included using areas of interest (AOIs) to have the eye tracking software calculate time spent and total fixations automatically. Heard, Rakow, and Foulsham (2017) were also interested in how eye tracking could help researchers understand the order in which information was digested, and how often participants moved between two types of information (risks and benefits for treatments).

While each of the studies covered above tended to be interested in a single part of the search behavior, Zhou (2017) utilized eye tracking as a means to understand how various search tasks could change the behavior of the user. Using fixation counts and scan paths, Zhou was able to show that the type of task and the cognitive load of the task effected the way the user searched for information. Users spent more time reading (with

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higher fixation counts) on cognitively demanding tasks. Scan paths showed that users would interact with the information in different ways depending on the goal of the task. Zhou's (2017) work indicates that eye tracking can play an important role in understanding how a user tackles tasks they are presented with.

Current Study Set Up

The study presented in this dissertation will examine Van Deursen and Van Dijk's (2016) question of whether internet skills can be acquired independent of traditional literacy skills. Previous work performed on information retrieval focuses on the habits of the general population, low literate compared with medium to high literate, and search medium (mobile or computer). What this research adds to the conversation is a controlled study that focuses on education in conjunction with literacy levels on search behaviors for school assignments. This study will show that for low literate college students, their digital literacy skills seem to match those of their medium to high literate student contemporaries, and surpasses the skills of non-student, low literate adults.

This study builds on the work of Zhang (2009) and Holman (2009) while incorporating eye tracking as important data point, similar to the work of Kodagoda, Wong, and Kahan (2009). This study used a modified version of Zhang's (2009) demographic questionnaire and followed each task with participant ratings of task difficulty, mental effort, and performance satisfaction. Zhang's (2009) demographic questionnaire included details about search engine preference and search frequency that the researcher was able to use as context for participant feedback and habits. Using a standardized rating for task difficulty, mental effort, and performance satisfaction

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allowed the researcher to measure correlations between participant ratings and their search behavior. However, the researcher felt that Holman (2009) asked more detailed follow up questions that could aid in better understanding search behavior decisions made by the participants. Therefore, this study borrows the after-task questions about key words used, possible other searches, and various questions to understand what motivates a student to choose one site over another, and how they would search in a real-world class assignment setting (Holman, 2009).

Similar to Zhang (2009), this study constructed search prompts that were based on a freshman-level science class, instead of allowing students to search for assignments they were currently working on as in Holman's (2009) study. This method of pre-determined task assignments is also seen in the work of Kodagoda, Wong, and Kahan (2009), Kemeny, et al. (2013) and others. By pre-determining the search prompts, the researcher was able to observe patterns in site selection as well as patterns in keyword searches amongst the different groups of participants.

Finally, eye tracking was employed based on the research showing that it can be a key indicator of reading habits (as seen in Summers & Summers, 2009; Kemeny, et al., 2013, and Heard, Krawkow, & Foulsham, 2017). The limitations of eye tracking will be discussed next.

Eye tracking and the eye-mind Hypothesis

The first researchers to claim that the eyes will fixate on that which the participant is paying attention to were Just and Carpenter (1976) Since then many researchers have found similar connections in their research, but there have also been cautions offered in

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the field of eye tracking. Kok & Jarodzka (2017) wrote that eye movements are a key indicator of what the mind is engaged with, making eye tracking a useful tool for researchers. Goldberg & Helfman (2010) claimed that eye tracking can help researchers have a better understanding of user scanning strategies that "underlie more traditional high-level accuracy and task completion time results" (p. 71). However, eye tracking often entails challenges and possible inaccuracies that must be understood and controlled for (Goldberg & Helfman, 2010; Feng, 2011; Miller, 2015; Orquin, Ashby, & Clarke, 2016; Kok & Jarodzka, 2017; Orquin & Holmqvist, 2018).

Eye tracking data can show with some certainty what is not being attended to by the participant; however, the reverse is not equally true. Single words and design features can be skipped by the participant, but their meaning will be inferred by the context of the page's content and design (Miller, 2015). Feng (2011) also reported that a literate adult reader can have a "perceptual span [extending] approximately 15 letter spaces" and less experienced readers would have a much smaller span (p. 7). Further, the more difficult the reading the smaller that perceptual scan path will become for all readers.

One of the first sets of problems that Goldberg and Helfman (2010) talk about are setting up well defined measurements based on the eye tracking data: fixation definition, areas of interest, and other metrics. Most eye tracking systems have built-in algorithms that can be applied to define fixations. For the University of Baltimore (UB), the fixation algorithm is set to take a fixation that last for 100ms. Bojko (2013) indicates that it is best practice to set the algorithm for fixations between 70 and 100ms, which puts the UB lab

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at the higher end of fixations, limiting possible errors. It is imperative that once defined fixation rules do not change between tasks (Goldberg & Helfman, 2010).

Areas of Interest (AOIs) are considered a key first step in analyzing data; however, there has been no codification of best practices for creating AOIs to help researchers know how to set and define AOIs. In fact, researchers sometimes change the size and shape of their AOIs to better match the model they are trying to show (Orquin, Ashby, & Clarke, 2016). Goldberg and Helfman (2010) list three of the main questions researchers face when setting AOIs:

1. How to determine which features require being marked as an AOI,
2. How much padding does the AOI need for each intended feature or target, and
3. Should all features and targets have the same padding?

Goldberg and Helfman do offer a few guidelines to help overcome these questions:

- "Padding around a visual target should be consistent with questions and tasks[18]"
- AOIs should be reserved for objects and task features of key interest, not the whole page
- "The amount of padding around an object should depend on
    - (1) the importance of capturing every fixation on that object,
    - (2) the amount of white space surrounding the object, and
    - (3) expected variance in fixation positions across participants"

      (p. 72)

Goldberg and Helfman (2010) explain that reading tasks often have tighter scanpaths,

[18] Reading tends to have tighter scan paths than scan paths during general page browsing (Goldberg & Helfman, 2010)

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meaning that AOIs meant to capture reading behavior can have tighter padding than AOIs that cover navigational elements which need more padding.

Even with the best guidelines in place, dynamic content will cause problems for static AOIs. Given current technology and software, the most accurate approach to dynamic content is to go back to the video recording and count fixations by hand, as eye trackers will struggle with tracking on dynamic page elements (e.g., dropdown menus, animations, etc.). Manual fixation counting will not necessarily follow the same rules of fixation as set up by the system being used; therefore, data will not be comparable across tasks. During manual counts, a researcher will have to rely on the visual representation of fixation from the eye tracker. Fixations are shown as an increasing circle on the screen, some of which disappear as quickly as they appeared, meaning, a researcher could miss fixations that would have been counted by the algorithm.

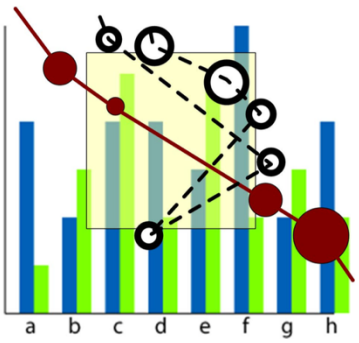

Figure 7. Example scan paths on a bar graph, with a single rectangular AOI (Goldberg & Helfman, 2010, p. 73)

Researchers must also recognize that even well-placed and well-defined AOIs can fail to portray the data accurately. Figure 7 shows two scan paths that cross through a particular AOI for a bar chart; notice that each path has only one fixation captured inside

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the AOI. Is one AOI per scan path really the best reflection of the data? Certainly not. The red scan path's fixation could be spurious, especially when it is compared to the other fixation points along this scan path. It was most likely a quick pause on the way to the next real fixation (Goldberg & Helfman, 2010). The dotted line scan path shows several fixations that land right on the edge of the AOI, so should these fixations be counted? These edge fixations could indicate that the user was studying the area inside the AOI, but the system picked up the fixation just outside the AOI (Goldberg & Helfman, 2010).

The data eye trackers supply may also report false fixations, where the participant was thinking but not seeing, or there could be an error in the calibration of the equipment or a natural offset of participant gaze with reported gaze (Miller, 2015). An error in gaze location reporting can be a large cause for concern. Goldberg and Helfman (2010) wrote that eye tracking manufacturers report a "gaze accuracy estimate of 0.5 arc degrees or less." In terms of centimeters this is equivalent to a range of 0.52–0.57 centimeters[19] (p. 73). Keep in mind this error rate is in best-case scenarios; normal use by practitioners will increase the likelihood that there will be a larger error than half a centimeter (Orquin & Holmqvist, 2018). Verbal feedback from the participants can help researchers understand why a participant was looking at a space but might not have seen it.

[19] This range is based on a viewing distance of 60-65 centimeters, which generally is the range we strive for in the University of Baltimore lab.

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Getting good data from eye tracking requires that the eye tracker be properly calibrated to each participant. The calibration process involves asking the participants to focus on various points on the screen so that the eye tracker can calculate gaze positions for the whole screen (Kok & Jarodska, 2017). Many things can impact the accuracy of the calibration, Kok and Jarodska (2017) list "droopy eyelids, hard contact lenses or narrow glasses. Or who are wearing mascara or are of Asian descent" as well as the experience of the researcher in calibrating the machine being used (p. 117). The Tobii eye tracking system tries to account for the problems listed by Kok & Jarodska (2017) by employing both a dark pupil and bright pupil tracking (Tobii Pro, 2015). During calibration most Tobii systems will test both a bright and dark pupil tracking[20] option to find the optimal method for tracking each participant. During the test, the eye tracker will swap between these two methods as needed to obtain the most accurate eye tracking data (Tobii Pro, 2015).

The well-documented limitations of eye tracking lead the researcher to take a larger look at the eye tracking data; individual fixations may be less insightful than taking in the entire scan path of the user. The bigger picture of the scan path helps show the full behavior and can lead to understanding the attention that drove the actions. Individual fixations may only show where eyes happened to rest long enough for the algorithm to catch them. Scan paths can show intention over time, which may be more accurate. Kok

[20] Dark and bright pupil tracking has to do with where the eye illumination comes from in relation to the eye. For bright pupils, the illumination source is placed close to the optical axis of the imaging device and for dark pupils it is placed away from that axis (Tobii Pro, 2015).

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and Jarodzka (2017) reported that like Yarbus found eye movements are not consistent when viewing the same image under different instructions, so it's imperative that researchers use well defined tasks that are consistently administered across participants.

Measuring Literacy in UX

Both the tests used by the NAAL and the PIAAC are time-consuming and require extensive training to use. In usability research, practitioners need a quick, easy, and accurate measure of literacy. Much research has been done linking oral fluency as an accurate predictor of literacy. This section will start with a discussion of oral fluency as an indicator of literacy, and then will look at the development of the Rapid Estimate of Adult Literacy in Medicine (REALM), as a tool that can be used for measuring literacy in usability studies. The REALM has been shown to give an accurate estimate of literacy in a matter of minutes, and with very little training needed for the administrator. Further, this section will look at a few other quick literacy measurement tools in comparison to the REALM.

Oral Fluency as Literacy Indicator. Oral reading has been deemed the 'most salient characteristic' of reading by Adams (1990) which is to say, that the ability to recognize text on the page and turn it into oral speech is a key indicator of literacy. Work by Fuchs, Fuchs, and Hosp (2001) went through over a decade of work and found there is still support that oral reading fluency is a key indicator of reading competence. They explained that the process of reading utilizes multiple cognitive functions that can be taxing, but a competent reader does these things in a "seemingly effortless manner" (p. 240). Fuchs et al. (2001) claim that one way to measure oral reading fluency is to have

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participants read through a list of words and then count how many words were correctly identified in a minute. This one-minute timeline creates a small interval that will be roughly equal across participants. This allows for the researcher to compare performance between individuals and retest the same individual to see incremental changes. However, they do point out that reading skills change over time; elementary-aged students will have a stronger correlation in their oral reading fluence and comprehension than may be present in high school-aged students or adults. As later reading skills continue to evolve into the ability to analyze literature and glean meaning from more complicated texts, word recognition no longer represents the full scope of a participants reading comprehension abilities but is rather one piece of that puzzle.

Similarly, Mellard, Anthony, & Woods (2012) found that the strongest predictor of literacy was word reading efficiency. Sabatini et al. (2010) also found that "word recognition and language comprehension are primary factors related to reading comprehension in low-literate adults" (pp. 131–132). However, Altin et al. (2014) have suggested that a simple reading test is not sufficient in truly understanding literacy and recommend a multi-modal approach to understanding literacy[21]. A multi-modal approach that does not just rely on word recognition and oral reading fluency would take substantially more time to administer then methods such as the REALM which depends on oral fluency to rate literacy. Usability studies do not have time built in to use tests like

[21] For understanding the nuance of literacy, the researcher does acknowledge that a multi-modal approach is the best method for testing; however, when one does not need an exact understanding a quick test method can be employed to understand the basics of literacy in users.

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the PIAAC as they are time intensive and expensive to administer; however, oral fluency tests are quick and inexpensive and can be administered quickly and efficiently.

Rapid Estimate of Adult Literacy in Medicine (REALM). The Rapid Estimate of Adult Literacy in Medicine; developed by Davis, et al. (1991) has been shown to give an accurate range for literacy amongst adults at lower literacy levels. Because low literate persons are aware of their struggles, they will often actively try to hide their reading problems, even when directly asked about them, so doctors and researchers need to be able to have a reliable test that can be administered quickly, so that they know how best to support the person. With this in mind, Davis, et al. (1991) developed the first iteration of the REALM with 125 words ordered from one syllable to multiple syllables. The test measures a person's ability to read and pronounce common medical terms but does not measure their ability to understand those words (Davis, et al. 1991). The REALM can be administered in less than five minutes and requires minimal training to administer. Once graded, the REALM supplies the administrator with a grade range that corresponds to "lower elementary, upper elementary, junior high, and senior high school (Davis, et al., 1991, p. 143).

During Davis et al.'s (1991) research, they also administered the Slosson Oral Reading Test (SORT) which is a standardized reading test that is similar in make up to the REALM. Participants are asked to read (correctly pronounce) words at various levels of difficulty, but unlike the REALM, the SORT has 200 words that are divided based on a corresponding grade level — pre-primer to ninth grade. The SORT can be administered and graded in about three minutes, with results tied directly to a reading grade level.

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"Test-retest reliability at a one-week interval is .99" and it has a high correlation with the Peabody Individual Achievement Test (PIAT) Reading Recognition (.94) and the Woodcock Johnson Letter Identification Subtest (.90) (Davis, et al., 1991, p. 434).

In addition to the SORT, Davis et al. (1991) administered the Peabody Individual Achievement Test-Revised (PIAT-R) to their participants. At the time, this test was commonly used in education to measure reading abilities, and included testing for reading, mathematics, spelling, and general information. The reading portion of this test can be converted into "specific grade levels (expressed in years and months)" (Davis, et al., 1991, p. 434). The reading recognition portion of this test has 100 questions that are broken down into a sixteen-question reading readiness section and eighty-four questions with single words for the participant to read aloud. The reading comprehension section is eighty-eight items that measures the participants ability to glean information and apply it from a presented text. Participants read a sentence, silently, and then choose a picture that best represents the sentence from a presented set of images. If the participant cannot answer the first eighteen questions in this section, the test is terminated (Davis, et al., 1991).

The wide acceptance, rigorous development, and national standardization made the PIAT-R an important tool for measuring the accuracy of the REALM. The PIAT-R has a "test-retest reliability based on a one-month interval" of ".96 for reading recognition and .90 for reading comprehension" (Davis, et al., 1991, p. 435). Unlike the REALM and the SORT, the PIAT-R takes 30-40 minutes to administer. The length of

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time it takes to administer this multi-modal exam makes it impractical for the medical or research settings.

The REALM was administered to 38 prisoners and 26 substance abuse halfway house residents over a one-week interval to determine test-retest reliability. Inter-rater reliability was found by using 20 university clinic patients, where one researcher administered the test and four others independently graded responses. Test-retest reliability for the REALM was found to be .98 (P <.0001) and inter-rater reliability was .99 (P <.0001) (Davis, et al., 1991, p. 435). As far as the REALM's correlation with the SORT and PIAT-R, there was a positive correlation with both, with the SORT having a .95 (P <.0001) correlation and the PIAT-R having a .94 (P <.0001) correlation for the recognition portion and a .81 (P <.0001) for the comprehension portion of the PIAT-R (Davis, et al., 1991, p. 435).

The grade level rankings of the REALM also fell in line with the SORT and PIAT-R exams, with minor deviations as the REALM was not meant to be accurate in grade and months like the SORT or PIAT-R. The mean reading level for the REALM was seventh to eighth grade, 7.4 for the SORT and 8.2 and 8.0 for the PIAT-R recognition and comprehension portions, respectively. Fifty-nine percent of participants fell below a ninth-grade reading level on the REALM, 57% on the SORT, and 51% and 55% on the PIAT-R recognition and comprehension subtests. On the low end of literacy,

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20% of participants scored as "lower elementary level (below fourth grade)[22]" on the REALM, but only 10% fell in that category on the SORT; for the PIAT-R subtests, 22% scored that low on the recognition subtest and 27% on the comprehension (Davis, et al., 1991, p. 435).

Davis, et al. (1991) concluded that the REALM "[appeared] to be a valid tool for estimating an individual patient's ability to read" common medical terminology (p. 435). Further, the REALM was designed to have a high concentration of words in the lower levels to increase its discriminatory power for people with lower reading ability, which increases its usefulness for low literacy screenings. (Davis, et al., 1991).

Today, the REALM is only sixty-six words long as it was shortened by Davis et al., (1993) after requests from researchers and clinicians (Murphy, et al., 1993). Items were kept based on psychometric estimates of difficulty and frequency of appearance in written material that patients could be given (Davis, et al, 1993). The format was maintained in the new version, with words being arranged in columns from short syllable counts to longer syllable counts and increased word difficulty. To obtain the grade estimates, Davis, et al. (1993) performed a linear regression analysis of REALM raw scores and predicted grade levels on the Slosson Oral Reading Test-Revised (SORT-R). They were then able to use the results from the SORT-R to verify that the predicted grade

[22] Davis, et al (1991) indicate that the REALM is designed to better delineate the lower levels of literacy than the SORT.

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levels were accurate. Davis, et al. (1993) had used a linear regression analysis to set the grade levels for the original REALM, as well.

Validity of the new, shortened REALM was established by correlation with the SORT-R, the PIAT-R recognition subtest, and Wide Range Achievement Test-Revised (WRAT-R). The REALM had positive correlations with each of these exams: a .96 (P <.0001) with the SORT-R; a .97 (P <.0001) with the PIAT-R recognition subtest; and a .99 (P <.0001) with the WRAT-R (Davis, et al., 1993, p. 395). Seventy-three percent of patients scored below high school reading levels (lower than 9th grade) on the REALM, 73% on the SORT-R, 75% on the PIAT-R recognition subtest, and 75% on the WRAT-R (p. 395).

As mentioned previously, a single-mode test is not necessarily as reliable a measure as a multi-modal approach (Altin et al., 2014). The Test of Functional Health Literacy in Adults (TOFHLA), is one multi-modal test in the medical research and practice field. Baker, et al. (1999) created a short version (S-TOFHLA) of this exam that had high correlation with the REALM, .80 (p. 38). One of the key differences between the two, was the S-TOFHLA has both a numeracy section and reading comprehension. The numeracy sections focus on a patient's ability to understand dosing on prescription bottles, appointment times, or even other health-related materials. The prose section used a modified cloze protocol[23] where every 5th to 7th word was deleted, and four options

[23] In typical cloze protocol, no possible answers are provided to the participant; they must rely on prior knowledge to fill in the gaps.

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were presented for filling in the blank. The S-TOFHLA takes up to 12 minutes to administer and is very much aligned with understanding medical literacy levels.

In 2012, Haun, et al. performed an analysis of the S-TOFHLA, REALM, and four-item test, the Brief Health Literacy Screening Tool (BRIEF)[24]. After testing 378 veterans using all three tests, the authors found that each test presented bias[25], but that results from all three correlated well, meaning that each test is an adequate measure of literacy. One key take-away of Haun, et al.'s work is to choose your tool wisely. The REALM and S-TOFHLA associated low health literacy with minority groups, but the BRIEF did not. The REALM did not associate low health literacy with age of participants, while the other two tests did. These findings should be weighed when considering which screener to use during a testing session. The authors do note that their findings may be a "function of sample size," but they have found correlation of their results with prior research (Haun, et al., 2012, p. 155). They conclude when time and personnel are limited, the REALM may be the most useful.

Though there has been no official correlation between the REALM and either the NAAL nor the PIAAC, prior work by Summers and Summers (2005) and Kemeny, et al. (2015) indicate that a score of 60 or below (below 8th grade reading level) is indicative of

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[24] The researcher chose not to delve into the BRIEF's development or history, comparing instead the two literacy rating methods of the S-TOFHLA and REALM. The BRIEF relies on self-report asking patients to identify how often they need help with reading materials; how difficult it is to understand written information about their condition; how they often struggle understanding their diagnosis; and how confident they are filling out medical forms.

[25] Both the REALM and the S-TOFHLA associated minority status with low health literacy, while the BRIEF did not. For the S-TIFHLA and BRIEF, age was associated with low heath literacy, but the REALM did not show this bias (Haun, et al., 2012).

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having a Below Basic reading level on the NAAL. For the purpose of this study, the researcher chose to go with the REALM. The University of Baltimore's User Research Lab has used the REALM for many years and has found it to be a useful estimate of literacy. As noted by Haun, et al., (2012) this study has limited personnel and time, making a test like the REALM an ideal candidate to supply an estimate of the literacy rate for the participants.

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Chapter 4: Methods

The research for this dissertation was conducted in two parts: a pilot study, and a main study. The pilot study was used to observe a few users to fine-tune and better understand the nature of the research needed for the main study. Findings from the pilot study will not be discussed in detail, as the pilot only served to help refine the structure of the main study. The study was designed to observe student search behaviors when using online tools for school assignments. The researcher observed students keyword searches, how those searches were refined or abandoned for new searches, what sites students chose, and their reading and scanning behaviors. Further details about the research will be provided in this chapter.

Pilot Study

Objective. The objective of the pilot study was to observe users as they completed simple search tasks to understand the how students approached information retrieval tasks. Questions and structure of the pilot study were less structured than in the main study, as it was more exploratory in nature.

Procedure. Seven (7) participants were selected from freshman courses at the University of Baltimore. During the selection process, participants were asked to complete the REALM to indicate their level of literacy. Testing occurred in one-hour sessions at the User Research Lab on the University of Baltimore campus. Sessions were recorded using the Tobii t60 eye tracker. Participants were instructed to use the task prompts (see below) as if they were assignments for a class, and they were left to complete the tasks without interference from the researcher. By observing without

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interference, the researcher was able to observe more natural behaviors from the students. After each task, the researcher asked the participants clarifying questions about their search behavior based on her observations. All participants were observed from a private observation room to ensure that they were not distracted by the researcher.

Recordings from the sessions were reviewed to understand and identify patterns of search behavior. Further, the researcher used these seven participants to refine the after-task questions to be more uniform in nature; though, variations still occurred based on observed behavior in the main study. The following task prompts were used during the pilot study:

- Describe, in detail, the history of Pluto from discovery to no longer being a planet.
- Explain, using diagrams, how the process of mitosis compares to meiosis.
- Submit a one-page outline of your biographical sketch of Johannes Kepler

Eye tracking was used to better understand the participants' search behavior — were the participants skimming pages, reading the full text, engaging with featured snippets, etc. These behaviors would have been unobservable without the aid of the eye tracker.

Participants. The seven participants were selected from freshman-level classes at the University of Baltimore. Participants had to be in their first year of school at the university. Of the seven participants, one was considered low literate, and the rest had normal to advanced literacy. Participants were all in their second semester of college and from a wide-range of majors at the university. Three participants self-identified as Asian,

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two as Black, and two as White. Four participants were female, and three male. Every participant used either a smartphone or their computer every day of the week.

Main Study

Objective. The objective of the main study was to build and understand the participants internet search behavior and to observe their reading and scanning habits based on prompts provided. Questioning was structured around understanding how they selected sites, and what sites they expected to find when completing the search prompts (questions provided below and in Appendix D); As well as, questions on habits for research projects and questioned based on observations. This framework mirrors work by prior researchers, in that specific prompts were used (Zhang, 2009; Kodagoda, Wong, & Kahan, 2009; Kemeny, et al., 2013), and the post-interview questions were modeled after work done by Zhang (2009) and Holman (2009).

Procedure. Twenty (20) participants were selected from freshman courses at the University of Baltimore and Baltimore City Community College; five (5) additional non-student participants were selected for low-literacy, and non-enrollment in a college or university setting. During the selection process, participants were asked to complete the REALM to indicate their level of literacy[26]. Testing occurred in one-hour sessions at the User Research Lab on the University of Baltimore campus. Sessions were recorded using the Tobii t60 eye tracker.

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[26] Students who scored less than 60 points on the REALM were placed into the "low literate" student group, while those who scored 60 or more were placed in the "medium to high literate" group; all non-student participants scored less than 60 on the REALM.

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Kemeny, et al. (2013) documented a few of the problems researchers can face when recruiting low literate participants. Namely, low literate participants are unlikely to have a consistent method of contact. When recruiting for this study, we tried to first reach out to only low literate non-students in a very narrow age window, but had difficulty finding enough through our database due to contact information changing. Thankfully, low literate participants are willing to help recruit through word of mouth, and we were able to use this network to help increase our pool of participants.

For student, low literate participants recruitment proved equally difficult. The researcher would join a freshman class and explain the test to all the students, students who were interested were brought out to the hall where the REALM was administered. It took the researcher three and half semesters to find ten low literate participants to complete the study. Medium to high literate students were easier to find and recruit.

Student participants were instructed to use the task prompts as if they were assignments for a class, while the non-student participants were asked to complete the tasks as if they were helping a relative with their school work. They were left to complete the tasks without interference from the researcher. The researcher chose to observe without interruption to help facilitate a more natural search behavior environment for the students. The researcher also observed the study from a separate room to help ensure minimal distractions for the student. After each task, the participants were asked clarifying questions about their search behavior, as well as a series of pre-defined questions (listed below) that were aimed at understanding the participants' level of familiarity and comfort with using the internet.

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Recordings from the sessions were reviewed to understand and identify patterns of search behavior. The following task prompts were used during the pilot study:

- Describe, in detail, the history of Pluto from discovery to no longer being a planet.
- Explain, using diagrams, how the process of mitosis compares to meiosis.
- Submit a one-page outline of your biographical sketch of Johannes Kepler

Eye tracking was used to better understand the participants' search behavior — were the participants skimming pages, reading the full text, engaging with featured snippets, etc. These behaviors would have been unobservable without the aid of the eye tracker.

In both the pilot and the main study, participants viewed the three tasks in the same order. There was no variation in the order the tasks were presented, and this may have impacted the results due to fatigue. This impact will be discussed as needed in Chapter 4. The fatigue effect was not seen in the pilot participants, so the main study did not randomize the order of task presentation.

Participants. Twenty participants (20) were selected from freshman-level classes at the University of Baltimore or Baltimore City Community College. Of the twenty participants, ten were considered low literate, and ten had average to advanced literacy. Participants were all in their first year of college (attending either the University of Baltimore or Baltimore City Community College). There were a few students who had completed college work through concurrent enrollment in high school or from the community college before transferring. Participants were selected from general classes to

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allow for a wide representation of majors. Two participants self-identified as Asian, fourteen as Black, two as Hispanic/Latino and two as White. Nine participants were female, and eleven males. Every participant used either a smartphone or their computer every day of the week. The average age of student participants was 19 years old.

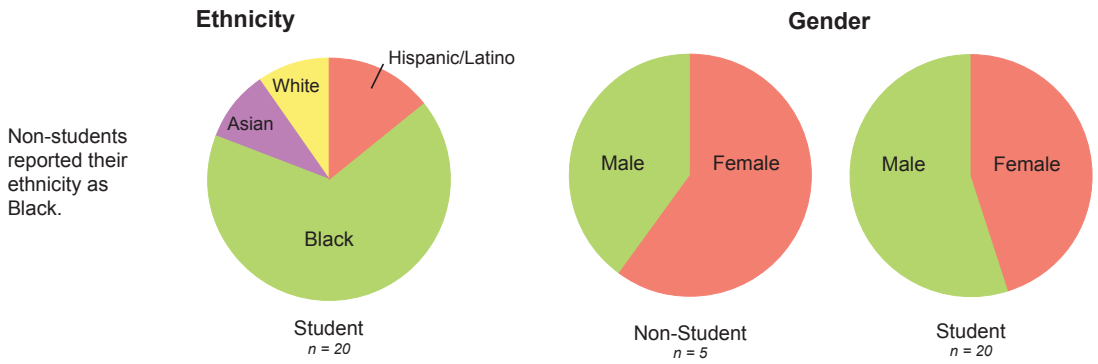

Figure 8. Ethnicity and Gender for Students and Non-Students

Five (5) participants were recruited through the University of Baltimore's adult participant database. These participants were recruited based on their REALM score (below 60), and for a lack of formal education beyond high school. One participant was older, but their general ages selected to be in-line with the student population (early twenties). All participants self-identified as Black and had some years of internet experience and used their computers or mobile device almost every day[27]. There were three female and two male participants in this group. The average age for non-students was a bit higher than the students, due to an outlier; their average age was 33 years old.

[27] Only one participant claimed to use their computer or mobile device less than every day. This was also the participant who was older than our student demographic.

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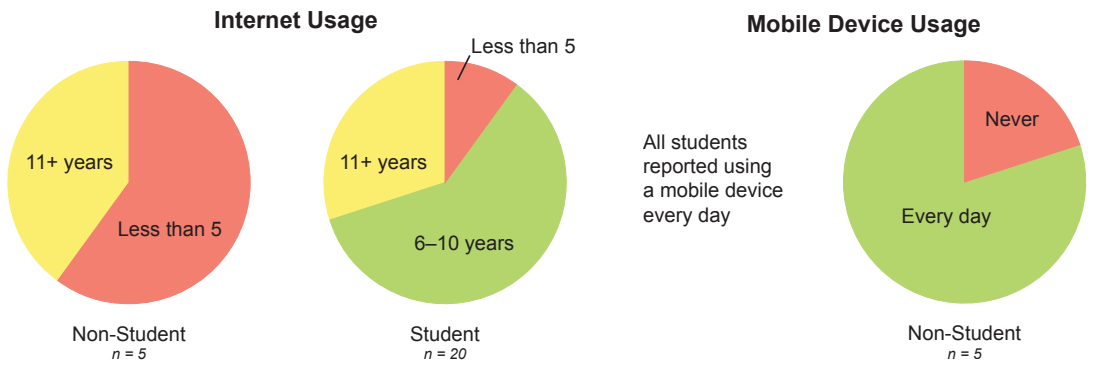

Figure 9. Internet usage and preferred device for Students and Non-Students

Questions. Participants were asked a series of post-task questions to gauge their level of task comprehension, view of the internet, perception of websites, and beliefs about search in education.

1. In your own words, what were you trying to find?
2. Where you able to find the information you needed?
3. What keywords or search items did you use?
4. What kind of sites did you expect to find?
5. Any other searches you may have done, if you were to have a few days to complete the task?
6. How do you choose a site that you want to use?
7. When doing research for school, is it more important to find as many sources as possible? Or fewer, that are more related to your topic?

After each task, the first five questions were asked to clarify and understand the participant's search behavior during task completion. These questions were designed to help the researcher understand what the participant *could* have done, if they had been

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completing the assignment for a course over several days. Questions six and seven were task-independent and were only asked after the first task. These two questions were designed to understand how participants assessed site validity and dependability and how participants approached source curation; did participants feel they needed to find several sources or was it better to find a few sources that corroborated findings.

Observations

The researcher met with each of the participants for about sixty minutes in the lab at the University of Baltimore. Participants were asked to fill out a demographic form, and then the study was briefly explained to them. After consent was obtained, they were taken to the study room and walked through a free association task and a diagraming task. The researcher explained how to perform each task, and then observed the participant as they completed each task. Participant questions were answered if they would not impact future search behaviors during that particular task or the rest of the session.

After the two tasks were complete, participants were set up on the Tobii t60 eye tracker and asked to perform each task presented to them as if they were completing a class assignment. The researcher observed the participants as they chose their search engine and searched for the required information to complete each presented task. She took notes on their behaviors for follow up after the task was completed. Participants were not asked to use a think aloud protocol, so that they could focus the attention on the tasks. Participants reading habits and search paths were captured with the Tobii t60 eye tracker.

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After each task, the researcher asked the participants to explain why they had chosen the sites they did, sometimes the researcher would ask about specific sites the participants had chosen, if they deviated from prior participant behavior[28]. After the clarifying questions were finished, the researcher asked each participant a series of seven questions (Appendix D). These questions ranged from what keywords participants used, how they choose a site, and their expectations. They were also asked to rate each task for the level of difficulty, mental effort used, and satisfaction with their performance. Questions were based on the work of Holman (2009) and Zhang (2009).

Data Coding and Analysis

The researcher reviewed each recording and captured search engine preference, all keyword searches performed, and a substantive list of the sites chosen by participants; time on task was also recorded for each task (Appendix E). From this review, the researcher was able to identify several areas for further analysis — number of unique searches per participant, type of searches performed (simple search, topic + focus search, phrase search, question search, and advanced search); search problems (misspellings, misunderstandings); and search refinements. She also documented behaviors on how sites were chosen from the list provided, e.g., while some participants relied on the SERP summaries, other participants would visit pages based on titles and do a quick scan before committing.

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[28] Most students had listed Wikipedia as a site they hardly ever used during their demographic questionnaire. If a student participant visited this site, the researcher would ask them to explain what drew them to Wikipedia and asked them what their general feeling about Wikipedia were for school assignments.

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Participant searches went through a modified affinity mapping session with several outside raters, recruited by the researcher from her peers and colleagues, to understand how participant searches were related and how they should best be grouped for understanding. Each search that a participant had completed was written on a card, and the raters were asked to group those cards into categories. The first two raters were allowed to create their own categories, but later raters were provided categories based on the work of Guinee, Eagleton, and Hall (2003). Affinity mapping is an efficient method for finding patterns in large data sets; the use of outside raters helped ensure that there was no researcher bias in the final groupings.

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Chapter 5: Findings

The twenty student participants performed 174 (102 unique) searches on 2 different search engines, and 13 internal web page searches. Of those searches 82 (47%) were performed on Google proper; 19 (11%) were performed using either the search box or URL search with results on Google; 14 (7%) were performed on Yahoo; 46 (26%) were performed through the URL search bar with results on Yahoo (Table 7). Only one participant attempted to use the library database to search for the topic, before changing to internet searches. Another student attempted searching GoogleScholar for information on Johannes Kepler, before abandoning the search engine for Google. A total of 99 unique sites were visited over the three tasks, but the sites were visited 213 times by the twenty student participants.

Table 7

Student Search Engine Results

Search Engine	**Number of Searches**	**Percent of Searches**
Google Site	82	47%
Google (URL Search)	19	11%
Yahoo Site	14	8%
Yahoo (URL Search)	46	26%
Specific Site	13	7%
Total	174	100%
Yahoo (‘google’)	12	

Student participants generally did not rely on the search dropdown suggestions for their searches, preferring instead to create their own search strings. However, 41 (24%) searches were performed using the dropdown search suggestions supplied by either Google or Yahoo when searching on their sites.

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When student participants used Google, they often encountered what are known as featured snippets; Yahoo presents a feature known as "Yahoo Answers" where a community member has answered a similar question through Yahoo Answers. Only two students were presented with Yahoo Answers and read these results; other students may have encountered Yahoo Answers, but they did not interact with them. SERP results—like featured snippets on Google—are designed to give the user a plain text answer at the top of the page, allowing the user to forgo the list of results for a quick answer to their query.

Not every search will produce a featured snippet for users; if a participant used a natural language query, featured snippet were less likely to appear. Simple searches were more likely to produce a featured snippet, such as "Pluto" over a search like "why isn't Pluto a planet?" There were no significant differences between the three groups when it came to reading or scanning a featured snippet; all groups read or scanned at similar rates. Anova results for reading were $F(2, 16)=2.629$, $p=.10$, and for scanning $F(2, 16)=.044$, $p=.95$. However, students were more likely to ignore the featured snippet over the non-student participants; the Anova results for ignoring were $F(2, 16)=3.91$, $p=.04$.

These findings are in contrast with prior work by Kemeny, et al. (2013)[29], which found that adult searchers tended to ignore the featured snippet provided by the search

[29] Kemeny, et al. (2013) tested thirty low literate adult participants during their study. At the time of that study featured snippets were a newer addition to the search results. It is possible that as featured snippets have become common place, they are becoming better utilized by all users of search results, but the small sample sizes in this study cannot say for certain that low literate adult users are using featured snippets more regularly.

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engine. Due to the small sample size of low literate, non-student participants in the current study, we cannot say for certain that featured snippets are being used more frequently with low literate adults than when Kemeny, et al.'s work was completed. The point of this study was not specifically to test featured snippet efficacy, which means the featured snippet did not supply the full answer for the tasks provided, unlike Kemeny, et al.'s work which was designed for the featured snippet to be sufficient information. In line with Kemeny, et al's (2013) work, low literate participants did not click through after reading the featured snippet. For this study, participants tended to move on to other sites rather than engage with the featured snippet site.

There were minor differences in the student participants across literacy rating, with low literate student participants engaging with the drop-down search suggestions more often (26 times (28% of searches) to 15 times (19% of searches) for medium to high literate students) than their medium to high literate contemporaries. Low literate students performed ninety-six (92) unique searches and medium to high literate students performed eighty (82) unique searches. Table 8 shows the search counts and percentages broken down by literacy groups. An Anova single factor test was conducted to compare search totals for low literate students and medium to high literate students; there was not a significant difference in scores for low literate students (M=9.6, SD=6.222) and medium to high literate students (M=8, SD=5.735); $F(1, 18)=.358$, $p=.557$. The results indicate that there is not a difference in how many searches each group performed, though we cannot say with certainty that both student groups perform similar amounts of

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searches[30]. Future research will be needed to substantiate the findings in this study. Note that low literate students tended to navigate directly to Google, while medium to high literate students used the search bar to search more often.

Table 8

Student Search Engine Results by Literacy Rating

Search Engine	**Low Literate Students**		**Medium to High Literate Students**	
	Total	Percent	Total	Percent
Google Site	51	55%	31	38%
Google (URL Search)	13	14%	6	7%
Yahoo Site	4	4%	10	12%
Yahoo (URL Search)	17	18%	29	35%
Specific Site	7	8%	6	7%
Total	92	100%	82	100%
Yahoo ('google')	6			

As for the five non-student participants, they conducted 26 searches with sixty-three percent (77%) of those being performed on Google. Three low literate, non-student participants used the search bar to search for Google (total of 6 times) before performing their content searches through Google's site. One non-student participant used the search bar for content searches, and one used Bing for a single search, after using Google for their first two searches. No non-student participants used the search functions within a site to search for more information. Four non-student participants relied on the Google drop down search suggestions for their searches, which was almost twice the rate of the

[30] There is a debate currently around the p-value and the 'arbitrary' nature of statistical significance being tied to a value of $p<.05$. (Dahiru, 2008; Aschwanden, 2016; Ge, 2016; Vidgen & Yasseri, 2016). A key component of this argument stems from a 'very low reproducibility' of research articles that are currently being published (Pritsker, 2012). This dissertation will maintain the statistical significance threshold of $p<.05$.

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student participants (42% to 24%). Three non-student participants read the featured snippet provided by Google. Only one non-student participant had featured snippet provided by Google but did not read them. Table 9 shows the search results of the non-student participants.

Table 9

Low Literate, non-student Search Engine Results

Search Engine	Number of Searches	Percent of Searches
Google Site	20	77%
Google (URL Search)	0	0%
Yahoo Site	1	4%
Yahoo (URL Search)	4	15%
Bing	1	4%
Total	26	100%
Yahoo ('google')	6	

Low literate, non-student participants showed signs of fatigue, as evidenced by decreased task time by Task 3 (Figure 10). On average, low literate non-students took 11 minutes and 19 seconds (SD=1.648) for Task 1, 10 minutes and 51 seconds (SD=1.88) for Task 2, and 9 minutes and 10 seconds (SD=2.146) for Task 3. For low literate non-students, less time was spent on average with each progressive task. This indicates that low literate non-student participants may have experienced fatigue as they went through the tasks. To try to remediate the effects of fatigue across tasks, the three tasks in this study should have been presented in random order for each participant.

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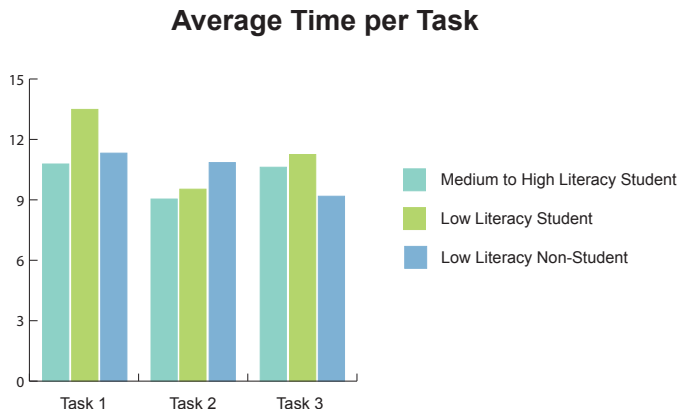

Figure 10. Average time in minutes for each of the three tasks by participant type.

Student participants did not exhibit this same downward trend in their average task completion times. Low literate students, on average, spent 13 minutes and 29 (SD=1.506) seconds on Task 1, 9 minutes and 32 seconds (SD=1.745) on Task 2, and 11 minutes and 15 seconds (SD=1.751) on Task 3. Medium to high literate students, on average, spent 10 minutes and 47 (SD=1.44) seconds on Task 1, 9 minutes and 2 seconds (SD=1.615) on Task 2, and 10 minutes and 37 seconds (SD=1.894) on Task 3. For students, there does not appear to be a fatigue-factor across the tasks in the same way that low literate non-students appeared to fatigue. Student participants spent the least amount of time on Task 2. Task 2 asked students to compare mitosis with meiosis; most students ended up searching for diagrams that explained the differences, which may account for the lower times for completion. A single factor ANOVA found no significant difference in task completion between the three groups for any task. For Task 1, $F(2, 22)=.803$, $p=.461$; for Task 2, $F(2, 22)=.141$, $p=.869$; and for Task 3, $F(2, 22)=.223$, $p=.802$.

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For Task 1, low literate non-students rated their performance satisfaction (M=4.4, SD=1.14) as higher than both the low literate students (M=4.18, SD=.9) and the medium to high literate students (M=3.9, SD=1.10). Low literate non-students also rated the difficulty (M=2.4, SD=1.52) as slightly higher than low literate students (M=2.17, SD=.72) and medium to high literate students (M=2, SD=.71). Low literate students ranked their mental effort (M=2.95, SD=1.36) as slightly higher than low literate non-students (M=2.8, SD=1.48) and medium to high literate students (M=2.4, SD=1.07). The averages for each category by participant type are presented in Figure 11.

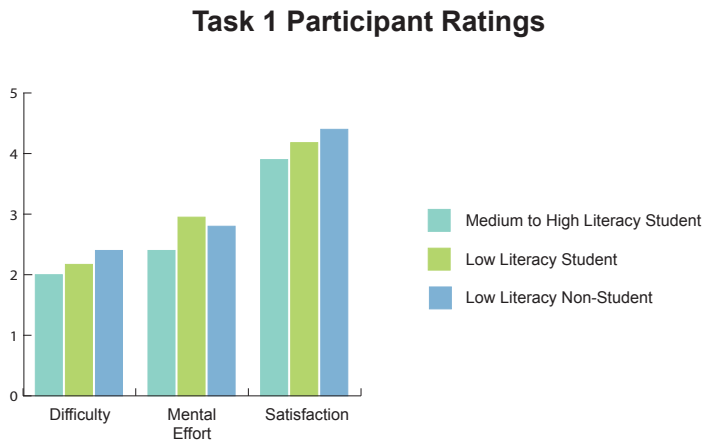

Figure 11. Task 1 participant ratings for difficulty, mental effort, and satisfaction

For Task 2, low literate non-students again rated their satisfaction (M=4.7, SD=.45) as higher than low literate (M=4.5, SD=.53) and medium to high literate (M=3.9, SD=.88) students. Low literate students (M=2.75, SD=.1.27) rated Task 2 as more difficult that the low literate non-students (M=2.6, SD=1.52) and medium to high literate students (M=2.4, SD=.84). Low literate non-students rated their mental effort (M=3.4, SD=1.14) as higher than low literate (M=2.75, SD=1.59) and medium to high

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literate (M=2.7, SD=.95) students. Figure 12 shows the averages for each category by participant type.

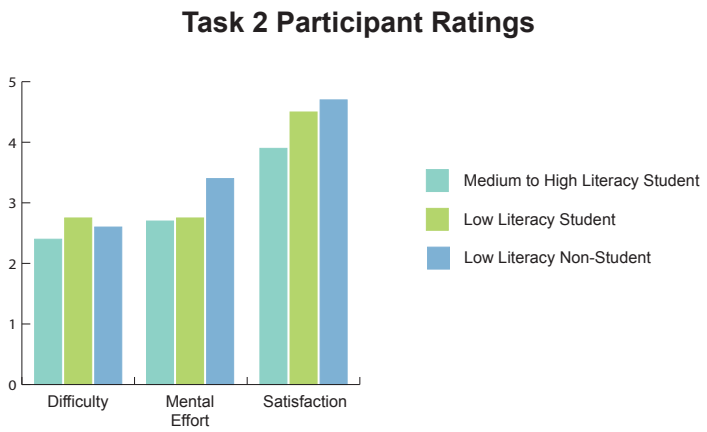

Figure 12. Task 2 participant ratings for difficulty, mental effort, and satisfaction

Finally, for Task 3, low literate non-student rated their satisfaction (M=4, SD=1.41) the same as low literate (M=4, SD=1) and medium to high literate (M=4, SD=1.05) students. Low literate non-students (M=2.4, SD=.89) rated the difficulty of Task 3 as lower than the low literate (M=3, SD=1.39) and medium to high literate (M=2.6, SD=1.71) students. Low literate non-students (M=3, SD=1.22) also rated their mental effort as lower than low literate (M=3.39, SD=1.45) and medium to high literate (M=3.2, SD=1.23) students. Figure13 shows the averages across categories by each participant type.

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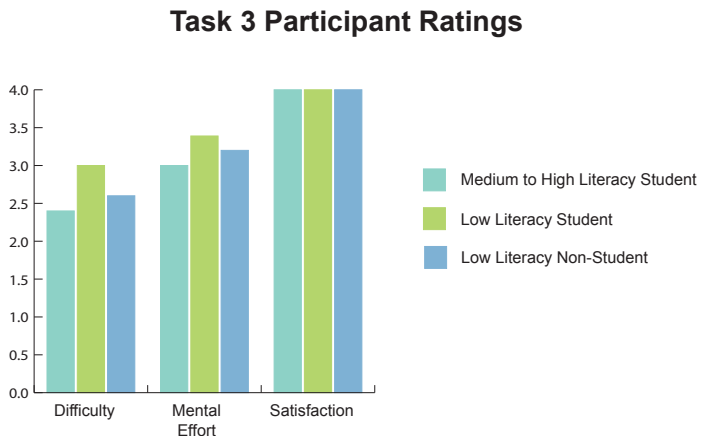

Figure 13. Task 3 participant ratings for difficulty, mental effort, and satisfaction

Across all three tasks, non-student low literate participants did tend to rate tasks as more difficult and to say that they required more mental effort, they also tended to rate their searches with higher satisfaction. Non-student participants were more satisfied with their performance than student participants across all three tasks. However, on Task 3 non-student participants rated that task as less difficult and requiring less mental effort than both groups of student participants. When talking with the low literate non-student participants after each task, not one addressed the difficulty of the tasks, they all stated they had been able to find what they were looking for and could think of no other searches that needed to be performed.

Overall student participants were also confident in their search results; however, a few students (both low and medium to high literate) participants expressed doubts that they had found all the relevant information needed:

- on Task 1, three expressed doubt in their findings;

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- on Task 2, two expressed doubt, and
- on Task 3, one expressed doubt.

Most students (across literacy levels) expressed beliefs that they could have done more research to better answer the prompt questions:

- on Task 1, twelve expressed there were more searches they could have done,
- on Task 2, eight expressed similar concerns, and
- on Task 3, thirteen suggested more searching was needed.

Low literate student participants tended to find each subsequent task to be more difficult and to require more mental effort. However, low literate student participants found Task 2 to require less mental effort (see Figure 14). There is a small level of correlation for difficulty of the task impacting the satisfaction that low literate students had with their task performance.

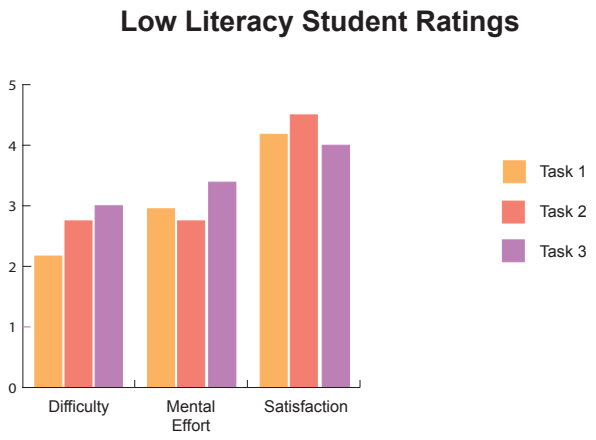

Figure 14. Difficulty, mental effort, and satisfaction ratings grouped by task for low literate students

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A correlation coefficient was computed to assess the relationship between task difficulty or mental effort and performance satisfaction. There was a slight correlation between task difficulty and performance satisfaction.

- Task 1: r= –.476, n=10, p=.164;
- Task 2: r= –.124, n=10, p=.733;
- Task 3: r= –.494, n=10, p=.147.

Though small, this correlation is larger than that for mental effort and performance satisfaction

- Task1: r=.198, n=10, p=.583;
- Task 2: r=.033, n=10, p=.928;
- Task 3: r= –.215, n=10, p=.551.

For low literate students, there is evidence that as their perception of task difficulty increased, their assessment of their performance decreased (as evidenced by the negative correlation between the two).

While low literate non-student participants found Task 2 to be the most difficult and required the most mental effort, it is also the task they rated with the highest satisfaction (see Figure 15). Task 2 asked participants to compare mitosis to meiosis, most student participants ended up looking at diagrams through the image search feature on Google, alleviating the need for in depth reading. It is possible that this played a part in low literate students finding this task to be less mental effort for them. For low literate

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non-student participants, it's not surprising that they found this task to be the most difficult. It required the most knowledge of science terms of the three tasks.

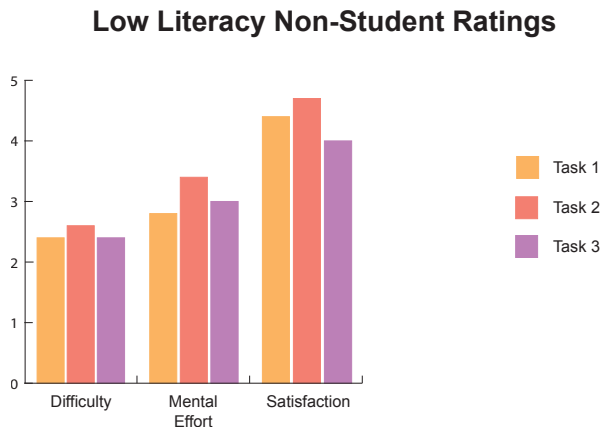

Figure 15. Difficulty, mental effort, and satisfaction ratings grouped by task for proficient to low literate non-students

For Tasks 2 and 3, low literate non-students show a small level of negative correlation between task difficulty and performance satisfaction; however, Task 1 does not have a correlation between task difficulty and performance satisfaction. As difficulty increased, there may have been a decrease in task performance satisfaction.

- Task 1: r=.034, n=5, p=.957
- Task 2: r= –.774, n=5, p=.125
- Task 3: r= –.791, n=5, p=.111

For perceived mental effort to performance satisfaction, there is a fairly strong positive correlation on Task 1, but not for Tasks 2 and 3.

- Task 1: r=.858, n=5, p=.063

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- Task 2: r= –.196, n=5, p=.752
- Task 3: r= –.144, n=5, p=.817

In this case, Task 1 shows that when perceived mental effort is high, the low literate non-students may be more satisfied with their performance. Given the small sample size of the low literate non-student participants, however, this could be an anomaly in the data.

For medium to high literate students, they rated each task as more difficult and requiring more mental effort as the tasks progressed (see Figure16). Despite their reported increase in difficulty and mental effort, they reported having increased satisfaction as the tasks progressed. As mentioned, thirteen students reported that they needed to do more searching for Task 3. Of those thirteen students, seven were in the medium to high literate group.

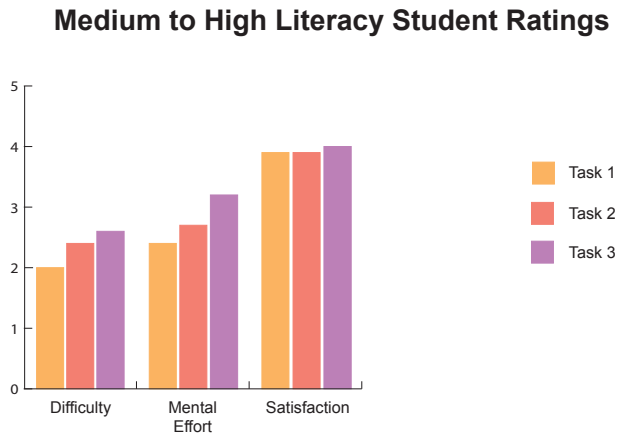

Figure 16. Difficulty, mental effort, and satisfaction ratings grouped by task for medium to high literate students

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Similarly, correlation coefficients were calculated for task difficulty or mental effort and performance satisfaction ratings, and no strong correlations were found for either in the medium to high literate student participants. For task difficulty to performance satisfaction, the following was found:

- Task 1: r= –.143, n=10, p=.694;
- Task 2: r= –.391, n=10, p=.264;
- Task 3: r=.062, n=10, p=.865.

For mental effort to perceived satisfaction, the following was found:

- Task 1: r=.052, n=10, p=.887;
- Task 2: r=.094, n=10, p=.796;
- Task 3: r=.086, n=10, p=.813.

The data seems to indicate that low literate students will be less satisfied when they perceive that the task has been more difficult. Students with medium to high literacy and low literate non-students do not seem to have the same relationship with their self-assessments. For students with low literacy, there could be a level of self-awareness of their limitations that leads to their self-assessments being more critical than their medium to high literate contemporaries. As for the low literate adults, Summers and Summers (2005) and Kodagoda, Wong, and Kahan (2009) found that low literate adults tend to be satisfied quickly and with partial answers. This seems to be supported by the self-assessment answers given by the five low literate adults in this study.

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Analysis was run on all three ratings (difficulty, mental effort, and satisfaction) against number of searches performed, drop-down used during search, number of sites visited, and time spent per task. There were no significant correlations found for any of these combinations for any of the participant groups. It seems that participant ratings were independent of their search behaviors; meaning participants search behaviors do not appear to have been influenced by the difficulty or mental effort required for the task.

Search Behavior

To understand the search terms that participants used, independent, outside raters were asked to group the participant searches along common themes. For the first two rounds of card sorting, the raters were allowed to define their own categories; however, after two rounds of free-association card sorting, it became apparent that the raters were grouping searches similarly to the work of Guinee, Eagleton, and Hall (2003). Therefore, participant searches were sorted by the following five categories

1. Simple search
2. Topic plus focus search
3. Phrase search
4. Question
5. Advanced search

Simple searches tend to be single subject, focused on the topic provided for the search. Topic plus Focus searches were searches that used the topic (example, 'Johannes Kepler') but added a focus (example, 'biography). Phrase searches were search strings that were simple phrases, but not formatted as a question; any question searches (e.g.,

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why isn't Pluto a planet?[31]) were categorized as questions. Finally, advanced searches employed multiple search types and/or one or more Boolean search operators.

Students tended to prefer simple searches and topic plus focus searches the most: 33% and 32% of search prompts, respectively (see Table 10). Phrase searches (14%) and questions (13%) were closely followed by advanced searches (9%). Examples of simple searches included "Pluto" "somatic cells," and "Kepler's laws." Questions included "how is Pluto not a planet?" or "what did Johannes Kepler discover?" or "what is meiosis?"

Table 10

Number of Student Keyword Searches by Category

	Simple Search	**Topic + Focus Search**	**Phrase Search**	**Question Search**	**Advanced Search**
Task 1	9	9	5	8	1
Task 2	17	15	7	3	6
Task 3	10	10	5	3	1
Total	36 (33%)	34 (31%)	17 (16%)	14 (13%)	8 (7%)

Note. There were 109 unique search prompts for the student participants.

The low literate, non-students, however, did more question searches (27% of search prompts), topic plus focus searches (27%), and phrase searches (27%). Simple searches (18%) followed closely, and advanced searches were not performed (see Table 11). A full listing of keyword searches performed by students and non-students can be found in Appendix E.

[31] Though the example uses a '?' there were search prompts that were categorized as questions that did not include a question mark.

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Table 11

Number of Non-student Keyword Searches by Category

	Simple Search	Topic + Focus Search	Phrase Search	Question Search	Advanced Search
Task 1	2	1	2	3	0
Task 2	1	2	2	2	0
Task 3	1	3	2	1	0
Total	4 (18%)	6 (27%)	6 (27%)	6 (27%)	0

Note. There were 22 unique search prompts for non-student participants.

Single factor ANOVA tests were run for all participant groups (low literate students, medium to high literate students, and non-students) to ascertain if there were statistically significant differences in the types of searches performed. There was no statistically significant differences in search types for all three groups except for phrase searches, $F(2,6)=8.375$, $p=.018$. Low literate students performed an average of 4.33 phrase searches (SD=1.155); medium to high literate students performed an average of 1.33 phrase searches (SD=1.155); and low literate, non-students performed an average of 2 phrase searches (SD=0) per task. Further analysis showed that each group had a statistically significant difference in their use of phrase searches. Low literate students used the most phrase searches (4.33 per task on average), while medium to high literate students used the least.

As noted, several student participants attempted advanced searches, but only one participant specifically recognized that they were performing a Boolean search. This participant stated that they liked using Boolean searches to help refine their search parameters. Another student engaged with Google's "advanced search option" to refine the type of sites that they would see in their search results. Most students did not

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knowingly and actively engage with advanced search options, choosing instead to use simple searches.

These findings are in line with what Holman (2009) found in her research on student library search habits. Student participants tended to either use phrases or simple searches. They also did not tend to refine their original search prompts, instead opting to try a different, but related search. (Student participant 32 started with "pluto" followed by "history of pluto"). Participant 13 did refine their searches, but only by taking their initial search ('Pluto,' 'mitosis vs. meiosis,' and 'Johannes Kepler' for each task respectively), and adding words to the end ('Pluto' became 'Pluto planet' then 'Pluto planet facts;' 'mitosis vs. meiosis' became 'mitosis vs. meiosis diagram;' and 'Johannes Kepler' became 'Johannes Kepler achievements'). Participant 13 was the only student participant to attempt such narrowing searches.

The low literate non-student participants similarly had only one participant (A01) attempt to refine their searches; however, participant A01 was also the only non-student participant who consistently visited more than one site. This unwillingness to refine searches is in line with work done previously by Kodagoda, Wong, and Kahan (2009) who found that ten low literate adults could not recover from bad searches and would abandon a search instead of trying something new.

Nine student participants (4 medium to high literate, 5 low literate) had at least one spelling error during their task searches, compared to all of the non-student participants having at least one spelling error during their task searches. The most common spelling error involved the name "Johannes Kepler" with variants ranging from

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"John Kepler" (Student Participant 32) to "Johannes Kelpler" (Non-student Participant 05) to "Yohan Kepler (Student Participant 33). Table 12 lists spelling errors by participant ID and literacy rating. Several participants were able to correct their spelling errors by using the drop-down search suggestions provided by Yahoo and Google. Those four searches are marked with an asterisk in Table 12.

Table 12

List of Spelling Errors During Search by Participant ID and Literacy Rating

Participant ID	Literacy Level	Spelling Error
SP10	Medium-High	Joannes Kepler
SP13	Medium-High	Johannes Kepler acheivements
SP16	Low	What is a dwaft planet?
		Johnanes Kepler
SP18	Low	Ploto (as planet)
		Mesios*
		Johnan Keler*
SP19	Medium-High	Johannes Keplar achievements
SP28	Low	Explain using diagrams how process of motosis compares to meiosis
SP30	Low	Why isnt Pluto a planet?
SP32	Low	John Kepler
		Whay is a biographical sketch?
SP33	Medium-High	Ubslt.langsdalelibrary
		Yohan Kepler
		Johan Kepler
AP01	Low	Biographical sketch of Johanne Kepler
AP02	Low	Why is pu lu…*
AP03	Low	Why is puto not a panet no more you tube
		Why is puto not a panet any more you tube
		Whats the comparisson of mitosis to meiosis you tube
		A bio. of Johannes kepler you tube
AP05	Low	The diference … *
		Biographic sketch of Johannes Kelpler
AP06	Low	goggle.com
		The defference between mitosis and meiosis

Student participants and non-student participants tended to rely solely on Internet search engines when performing their searches. However, one student participant (SP33) attempted to search using the University of Baltimore's library. He attempted multiple

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searches, starting with “history of Pluto” and adding Boolean searches through the library’s interface that included

- AND how it is no longer a planet
- NOT planet
- AND lost planet status

None of these searches pulled up articles that the student found helpful, as he didn’t engage in any of them, so he ended up searching through Google for more information. SP33 was also the only student to attempt a search on Google Scholar for Johannes Kepler. He explained that he prefers to use the school’s database whenever possible, and when searching for a person, he likes to start on Google Scholar to see what the person may have written.

On average, low literate non-students performed less than two (1.8 for Task 1 and 1.6 for Task 2 and 3) searches per task (see Figure 17). For low literate student participants, the average number of searches varied by task, with a low of 2.8 (Task 3) and a high of 3.7 (Task 1). Average literate student participants were in the middle of the other two groups with a low of 2.4 (Task 3) and a high of 2.9 (Task 1).

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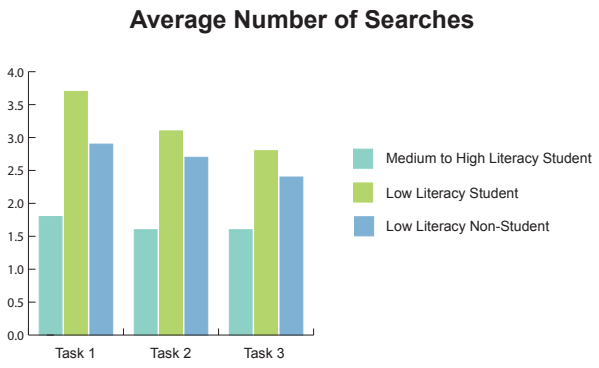

Figure 17. Average number of searches on each task by participant type

A single factor Anova test was run on the search totals for all student participants and non-student participants. There was no significant difference in total searches for low literate students (M=9.6, SD=6.222) and medium to high literate students (M=8, SD=5.735); $F(1,18)=.358$, $p=.55$. A second Anova was conducted to compare total number of searches for low literate non-students and all students. There was a significant difference in total searches for low literate non-students (M=5, SD=3.391) and all students (M=8.8, SD=5.881); $F(1,13)=10.293$, $p=.007$. These differences show that low literate students do not differ significantly in the number of searches performed when compared to their medium to high literate contemporaries; however, low literate non-students do perform significantly fewer searches than the students.

There is a downward trend in number of searches across tasks, which could be due to fatigue, but could also be explained by the search type. Task three asked participants to find information about one person's life. A simple search of 'Johannes Kepler' would have given the participants ample sites to choose from to learn about his

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life; while Task 1 asked participants to describe the full history of Pluto from its discovery until its downgrade to dwarf planet. This task could require more search refinement, thus needing a higher count of searches. As noted above (see Figure 10), task time did not diminish across tasks for students, so it's less likely that the lower search numbers in Task 3 are based on fatigue for the student participants.

Low literate non-students saw an upward trend in the number of sites visited across the three tasks. For Task 1 and 2, they visited an average of about two sites each, but by Task 3 they visited 2.6 sites on average. Non-student participant 3 visited two sites instead of one, as the video on Johannes Kepler required reading, so he opted for Wikipedia. This was in part due to the timed nature of reading on the video, he said he felt more comfortable reading without the pressure. Non-student participant 2 visited both Wikipedia and Britannica, because they liked Britannica better than Wikipedia.

Student participants searched for definitions of biographical sketch seven times across three students; two of whom were in the medium to high literate student population and one in the low literate student population. No non-student participants searched for a definition of a biographical sketch. Two non-student participants (2 and 6) performed simple name searches, while the other three included some version of "biography of" in their search prompt. See Figure 18 for more information.

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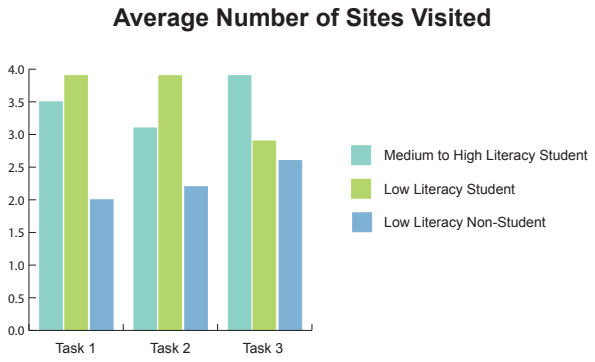

Figure 18. Average number of searches by task for each participant type

A single factor Anova test was run on the total sites visited for all student participants and non-student participants. There was no significant difference in total searches for low literate students (M=10.5, SD=5.276) and medium to high literate students (M=10.7, SD=3.743); $F(1,18)=.009$, p=.92. A second Anova was conducted to compare total sites visited for low literate non-students and all students. There was a significant difference in total searches for low literate non-students (M=7, SD=7.314) and all students (M=21.2, SD=6.391); $F(1,13)=15.024$, p=.002. These differences show that low literate students do not differ in the number of sites they will visit when compared to their medium to high literate contemporaries; however, low literate non-students do visit significantly fewer sites than the students.

Qualitative Search Behaviors

As discussed, student participants tended to use searches that were simple or had a topic plus focus approach. Non-students used more natural language searches (phrases

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and questions) than the students did. The next question to look at asks if the groups modified their searches in anyway, and if so, how did they modify those searches.

Searches were analyzed to understand if the participant used subsequent searches to narrow their results, redefine their search, repeated the prior search prompt (with maybe a small tweak in the wording), or simply repeated the prompt. It was also noted if there was no attempt to modify their original search prompt. For all student participants, they were most likely to employ the topic plus focus technique on subsequent searches to help narrow (M=8.7, SD=2.082) their results, non-students were statistically speaking less likely to attempt to narrow (M=1.5, SD=.707) their results; $F(1,3)=10.171$, $p=.02$. The narrowing technique was the most frequently employed modification technique for students.

Conversely, non-students were most likely to perform a single search and not attempt any modification of that original search prompt. Non-students performed an average of 3.33 single searches (SD=1.155) per task compared to students who performed an average of 8.33 single searches (SD=1.155) per task, $F(1,4)=28.125$, $p=.006$. This is in line with prior work that shows low literate adult internet users tend to be satisfied with their results quickly, and do not tend to modify their search results if they don't find all the information they need.

To further understand the digital literacy of students and non-students, it's important to look at the quality of sites visited by students. For the purpose of this research, sites were graded for reliability and credibility. Each site was rated as 'low,'

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'medium,' or 'high' by the researcher. The following guidelines were used when rating sites:

- Low: user-created content, open-source content, source of content is unknown. Site design is minimal or dated.
- Medium: content appears to be sourced reliably, but verification of sources is hard to find or non-existent. Site design is updated and feels professional.
- High: content is sourced reliably, citations are provided, or credentials for page authors is clearly marked. Site design is current and professional.

Examples of low rated sites include Wikipedia, answers.com, or Pinterest. Medium rated sites included Britannica, Reference.com, or Dummies.com. High rated sites included Nasa, Meriam-Webster, or McGraw Hill Higher Ed. Sites that were geared towards children were rated in the medium category, even if they had valid, science-backed information, as the participants were searching for college-level course work.

Across all three tasks, there was no statistical difference between the quality of sites used by all participants, $F(2, 6)=.405$, $p=.684$. Across all three participant groups, there was no statistical difference in the use of low and medium quality sites. For low quality sites, low literate students used an average of 4.7 (SD=1.528); medium to high literate students used an average of 6.7 (SD=2.887); and non-students used an average of 3 (SD=0), $F(2,6)=2.844$, $p=.24$. For medium quality sites, low literate students used an average of 6.3 (SD=4.04); medium to high literate students used an average of 6.3 (SD=.577); and non-students used an average of 3 (SD=2), $F(2, 6)=1.613$, $p=.28$

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However, when it came to high quality sites, there was a statistically significant difference in which group visited the high quality sites most frequently.

For all three groups, the low literate students visited an average of 6 (SD=2.65), medium to high literate students visited an average of 9.3 (SD=.577), and low literate, non-students visited an average of 2.3 (SD=.577) high quality sites. This gives a statistically significant Anova factor of $F(2, 6)=14.391$, p=.005. To figure out which groups had the statistically significant difference, further Anova analysis was run comparing each group to one other in turn. It was found that there was no statistically significant difference — $F(1, 4)=4.55$, p=.099 — between low literate students (M=6, SD=2.65) and medium to high literate students (M=9.3, SD=.577). Nor was there a statistically significant difference — $F(1, 4)=5.5$, p=.08 — between low literate students (M=6, SD=2.65) and non-students (M=2.3, SD=.577). However, there was a stasticially significant difference — $F(1, 4)=220.5$, p=.0001 — for the medium to high literate students (M=9.3, SD=.577) and non-students (M=2.3, SD=.577).

These results suggest that though search habits of low literate students follow closely with their medium to high literate contemporaries, the low literate students may still lack some of the digital literacy skills of their medium to high literate contemporaries. More research will be needed to understand these differences.

Reading Behavior

Student participants showed no preference for reading as compared to scanning. For all student participants, reading behavior was exhibited on fifty-two percent (52%) of sites visited, while forty-eight percent (48%) of sites were scanned for information. When

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literacy is selected for, low literate students read fifty-one percent (51%) of the sites they encountered. and scanned forty-nine percent (49%); medium to high literate students read fifty-three percent (53%) of the sites visited and scanned forty-seven percent (47%). Non-student participants, however, did tend to read every word with a high level of frequency (reading seventy-six percent (76%) of the sites to twenty-four percent (24%) scanning). Thanks to the Tobii t60 eye tracker, the researcher was able to observe the scan paths of all participants as they interacted with the websites. Figure 19 shows a screen shot of a scan path for reading versus a scan path for scanning a page.

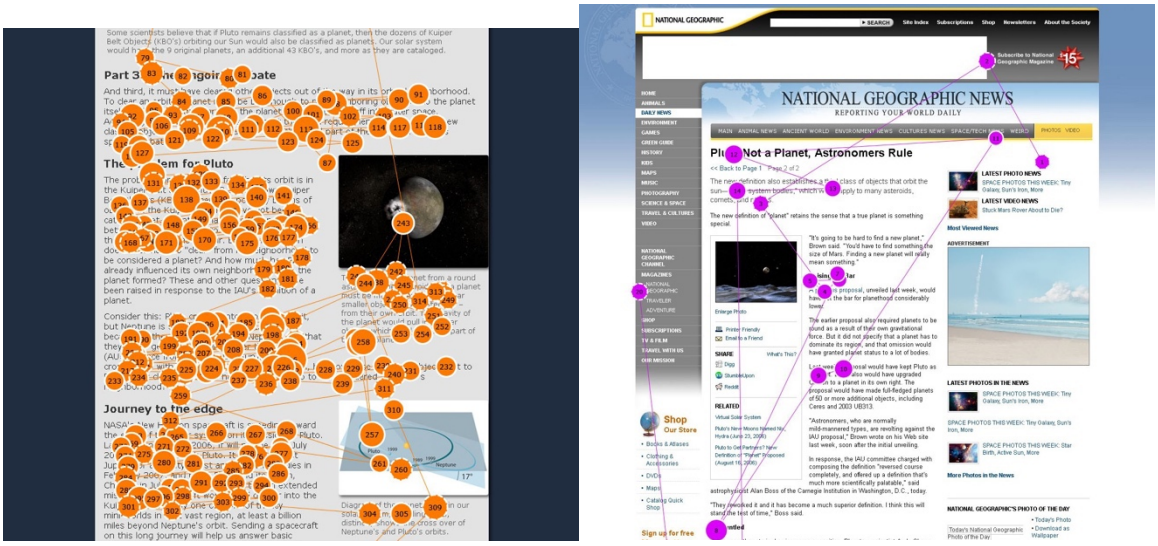

Figure 19. Sample of student (P28 & P15 respectively) reading and scanning behavior

When non-student participants read, their reading habit tended to start at the top of the page and read every word, which is in line with the findings of Summers and Summers (2005). (See Figure 20). One non-student participant did not even attempt reading for the first two tasks, opting instead to find videos on YouTube to watch; when he was unable to find videos for Johannes Kepler, he did read Wikipedia. The researcher

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also noted that non-student participants were more likely to use their mouse to help them read the words, similar to using one's finger to point to each word as it's being read.

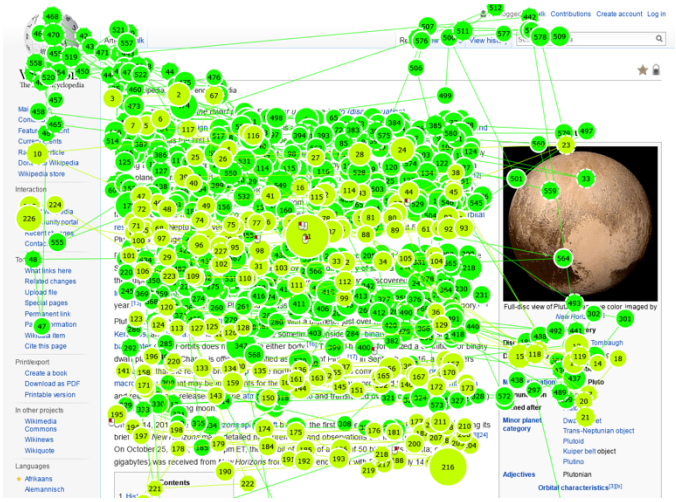

Figure 20. Example of two non-student participants (A01 and A02) reading behavior.

While student participants were likely to spend time reading content for understanding, they also would scan the pages looking for relevant information. None of the low literate non-student participants participated in this scanning behavior. This difference in behavior for low literate student participants compared to low literate non-student participants indicates that the students have learned skills that the non-student participants have not. Namely, low literate students seem to have learned how to search a page of content for the information that is relevant to their search, while skipping over less important information. Both groups of students (low and medium to high literate students) would read small portions of the text before moving on to the next section looking for pertinent information. This behavior was never observed with the low literate non-student participants.

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Post-Task Questions

All participants were asked a series of post-task questions that were designed to gain insights into their digital literacy. Student participants generally felt that finding 'well designed' and 'trustworthy' sites was important when searching for school assignments. Many students reported that they tried to only use .org, .edu, or .gov sites when they were looking for credible sources. Several students commented that they try to avoid using Wikipedia as it can be edited by anyone, though Wikipedia was visited 14 times by 10 students[32]. Two of the students scrolled down to the references at the bottom of the Wikipedia page, never engaging in the content, but using the reference section to find sources. Further, all students talked about the need to fact check their information with multiple sites, instead of relying on a single source for their information.

The low literate non-student participants did not share these reasons for site selection. Most non-students talked about looking for sites that "seemed to have what they were looking for" and only one non-student mentioned fact checking on multiple sites. These answers point to the low literate non-student participants having less digital literacy than the student participants. Students all reported having had access to the internet for a good portion of their lives and using the internet every day for their personal and educational needs. The low literate non-student participants did not report the same level of access or usage, despite the fact that the ages of both groups were

[32] Of the student participants who visited Wikipedia, five were low literate (17, 18, 26, 28, and 32) and five were medium to high literate (10, 11, 20, 27, and 33).

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roughly the same. As shown in Figure 9, one student reported less than five years of internet use, the rest reporting six or more years; on the other hand, half of the low literate non-students reported that they had used the internet for less than five years.

Summary of Findings

Low literate students tended to perform search tasks similarly to their medium to high literate contemporaries. Low literate students performed an average of 9.3 searches per student participant, compared to an average of 8 searches for the medium to high literate student participants. Low literate non-students performed an average of 4.8 searches per participant, nearly half as many as both student groups. Low literate non-students were also more likely to have spelling errors than both student groups, with all non-students having at least one error, compared to spelling errors from 5 low literate students and 4 medium to high literate students. There were no significant differences in task time between the three groups, though low literate non-students show a decrease in task time over the three tasks, possibly from fatigue. Neither student group showed the same decrease across the three tasks.

Low literate non-students and medium to high literate students showed a statistically significant higher likelihood to ignore featured snippets than the non-students. Though students in each group did engage with featured snippets, the non-student group was more likely to engage. Low literate non-students and medium to high literate students showed no correlations between task difficulty or mental effort ratings and their perceived satisfaction with task performance. Low literate students, however, did have a slight negative correlation between task difficulty and performance

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satisfaction. In other words, low literate non-students and medium to high literate students seemed to rate task performance satisfaction independent of difficulty and mental effort, while low literate students rated their performance satisfaction lower as the task difficulty increased.

These findings seem to suggest that low literate students are almost as digitally literate as the medium to high literate students. These results seem to support hypothesis 1b that stated low, medium, and high literate students would search with similar techniques that are more developed than low literate non-students. Hypothesis 1a seems to have been found to be false, as students with low literacy ratings do not seem to have learned adaptive techniques that are unique to their literacy rating.

Appendix E includes a table with all key demographic information covered in Chapter 4 and key findings of Chapter 5.

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Chapter 6: Conclusion

This study set out to examine the similarities and differences in search habits of low literate college freshman and medium to high literate college freshman. It was hypothesized that low literate students might have developed search techniques that had helped them to be successful in their education that were different than those of their medium to high literate contemporaries. This hypothesis was based on prior research in low literate search habits conducted by Kodagoda, Wong, and Kahan (2009) and Kemeny, et al. (2013); both of these studies found that low literate users often missed information outside of their focus and abandoned searches early having believed they found the right information. Generally, this study found these search behaviors to be true of adult, non-student searchers, but not true of low literate students.

Prior to this study, the researcher conducted a pilot experiment that tested seven college freshman's search behaviors for three tasks. These student participants were tested on an eye tracking machine so that the researcher was able to better understand the reading habits of the students during their search tasks. Fixations as well as saccades were noted by the researcher to understand where the students' attention seemed to be (accepting the eye-mind hypothesis) during the testing session. Further, these data were used to understand the reading behavior versus scanning behaviors of the students. The findings from this study showed limited differences in student search habits but served to help the researcher refine the testing process both before and after the tasks were finished.

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Participants in the main study were asked to perform the same tasks as the pilot study, but they also were probed more carefully to understand their digital literacy. Digital literacy was a main component of the current study. All participants were tested prior to completing the search tasks so that the researcher understood their general literacy level, but their digital literacy was tested during the search tasks. It was expected that there would be a correlation between their traditional literacy and their digital literacy skills, as found by Van Deursen & Van Dijk (2016). But unlike Van Deursen & Van Dijk (2016) this study showed that low literate students did not necessarily have lower digital literacy skills than their medium to high literate student contemporaries; however, the low literate adult, non-student participants did exhibit lower digital literacy skills as predicted by Van Deursen & Van Dijk (2016).

This study found that low literate students tended to use the internet for searching in the same manner as their medium to high literate student contemporaries. All student participants tended to use multiple search queries to ensure they found accurate information; additionally, they visited multiple sites to fact check their findings on prior sites and searches. This indicates that low literate students have received the same level of training in digital literacy as their medium to high literate student contemporaries, unlike the low literate non-student participants who showed very few similarities with the students. Low literate non-student participants tended to do single searches and only visited single sites before declaring themselves finished with the search task. This is an indication that the student participants (both low and medium to high literate) may have developed digital literacy skills independently of their traditional literacy skills.

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Sutherland-Smith (2002) wrote that "if people cannot undertake [reading] they are disadvantaged, and the education system has failed" them, and further claimed that just like traditional literacy, 'Web literacy' must be attained so that "students…become proficient in accessing and analyzing information, so that a level of understanding can be reached" (p. 662). Sutherland-Smith included the ability to find, scan, and digest the information found on the web in her definition of literacy. Like Sutherland-Smith (2002), this study has found that web literacy (or digital literacy) is critical in the matriculation process for high school students.

This study did find support that Generation Z students are digital natives, well equipped to use the internet to serve their needs. Students in this study seemed to have an understanding of how the internet worked and what was generally reliable and not reliable on the internet. However, this study did not look into their understanding of the internet beyond search, nor did it investigate other digital skills.

Limitations. There are several limitations to this study that need to be addressed in future iterations of search behavior research. First, this study was conducted with a relatively small sample size; largely due to difficulty recruiting low literate participants who were university students, as mentioned previously. However, ten low literate and ten medium to high literate students can give us a foundation upon which to build future research projects on student digital literacy. While we gained valuable insights into the current college student search behavior, future research conducted with larger sample sizes would help validate the findings of this study.

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Second, this was a snapshot study, conducted in single sessions with participants. This gives us a baseline understanding of student search behavior but does not allow us to make any claims about continued student success in school. A longitudinal study that followed students through their entire college careers would give us a better understanding of how student literacy and digital literacy impact their educational success. A longitudinal study should also be able to show whether student search behaviors evolve, whether the students (in both groups) graduate at similar or different rates, and whether there are differences in job placement and economic future post-graduation. This study shows that students with digital literacy are able to be successful enough to get into college but says nothing about their potential for long term success.

Third, all the students in this study came from one of two colleges, both of which were in the same city. Adult, non-student participants were also from the same general area as the students. Future studies would benefit from expanding the pool of students to several colleges across the country (including rural communities) that would better represent the cultural and economic diversity of the student population in the United States. Similarly, students (and non-students) tended to be from the same minority group, with only a handful of participants from other ethnic groups. Expanding the pool beyond the geographic confines of this study would help expand the ethnic representation.

Fourth, participants were asked to perform searches for hypothetical school assignments. Though findings were similar to work by Holman (2009), this study was limited by its artificiality. A less artificial study would examine what searches students would perform in an actual class assignment setting. This study focused on hypothetical

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tasks so that there would be more comparability in the potential search habits, as all participants were searching for the same information. Future research should combine both approaches: the focused search paradigm of this study, and the paradigm of observing students perform searches for their school assignments. Participants in future work could be selected from similar classes to help ensure similar search needs.

Fifth, students were simply asked to complete the search for information, they were not asked to complete the task and submit their findings. Evidence of successful searching was based on observation and on the notes students took. Future work could ask students to submit the completed task for review by the researcher, or students could be asked to complete a post-task quiz to gauge how much they had learned from their search.

Finally, this research does not speak to the intelligence levels of any of the participants included. As mentioned in Chapter 1, there is no correlation between reading skills and intelligence, but there is correlation between reading skills and specific learning disabilities. While this research did not ask about, nor test for, learning disabilities, it would be advisable for future studies to administer a quick intelligence test to participants.

Contributions. The main contribution of this research is to add to the body of work being done on search behaviors in both low literate and medium to high literate populations. To the researcher's knowledge this is the first study to investigate search habits of college students where literacy rates were a key variable in the research. The findings of this study show that digital literacy is not necessarily tied to traditional

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literacy, and that persons with low literacy skills can be taught to use the internet well enough to get them into college.

This study also contributes to the growing body of eye tracking research and continues to show how eye tracking is an important part of user research. Gaze data is a useful data point that researchers can use to understand how the user is interacting with the digital environment. Without eye tracking data, it would be hard for researchers to see if participants are reading or scanning a page. Similarly, interactions with featured snippets would only be available through click data, which as we saw had low correlations, while reading featured snippets was done frequently when featured snippets were present.

The importance of this research is that it examined search behaviors of college students through observation, and through oral feedback from current students; it contributes to the larger body of work through eye tracking and analysis; it called into question our current understanding of the connection between low literacy and digital literacy; and it identifies future research goals for this area.

Future Work. As noted, future work should focus on expanding the pool of student participants beyond a single university and community college. This research was conducted as a snapshot study to help researchers have a starting point for future iterations. Future iterations should include students performing searches for class assignments in a laboratory setting, over multiple sessions — if necessary — for their coursework. Similarly, future work would have students come back over their entire college career. Repeat sessions across the years would show how students continue to

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develop their skills, or should they eventually drop out, may give insights into why they were unsuccessful in completing college. Research should also include tracking students beyond graduation by recording job placement rates and the types of jobs participants accept.

Future iterations could also explore how the students learned their digital literacy skills, through in-depth interviews about past education experiences and details about their home life or through field studies. Both interviews and field studies could be used to understand why some students are learning digital literacy skills and why some students are not learning these skills. Is there a difference in home life that accounts for the differences? Is the difference related to what schools the students attended? Or are there other differences independent of the schools attended? Such research is essential if the benefits of our information economy are to be equitably shared.

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Appendix A: Participant Informed Consent

CONSENT FORM FOR PARTICIPATION IN RESEARCH ACTIVITIES

Search Habits of College Freshmen

Noël T. Alton, M.A., noel.alton@ubalt.edu, 208.850.7780

I. PURPOSE OF THE STUDY:

I am being asked to be part of a research study. This study is designed to learn about search habits of college freshmen. My part in this study will last about thirty minutes.

II. PROCESS:

In this study, I will be asked to use an online search engine to find answers to specific questions. No personal information will be collected. There will be a screen recording taken, as well as, video of the participant's face and audio. This video will never be linked to any personal information. Participants may decline video recording of their face and still participate in this research.

III. RISKS AND BENEFITS:

I understand that being part of this study is not harmful, and there is no cost to be in this study.

I also know that being part of this study will not benefit me. But I will be compensated $20 for my time This study will benefit all future online form users by helping to make sure that forms are accessible. I know that I can stop being a part of this study at any time.

IV. PRIVACY:

I agree that the information collected from me may be used by current and future researchers as long as my personal identity will be protected. This includes sharing anonymous information with other researchers so that they can check the accuracy of the study results. It also includes sharing anonymous information for future approved research that has the potential to improve human knowledge.

I understand that the information published from this study will not include my name. If there is any information that might identify me, such as my image, that information will only be used if I give permission. All information gathered in this study will be stored in a locked file cabinet in a locked room. Only the research team will have access to this information.

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If needed, I give permission for Noël T. Alton to share the information from this study with the University of Baltimore Institutional Review Board (IRB) and regulatory agencies as required by law.

☐ Yes, I give permission to use my image in scientific publications or presentations.

☐ No, I do not give permission to use my image in scientific publications or presentations

☐ Yes, I give permission to use my voice in scientific publications or presentations.

☐ No, I do not give permission to use my voice in scientific publications or presentations

V. QUESTIONS:

Noël T. Alton has answered all my questions about being in this study. If I have any more questions, I can contact Noël T. Alton at 208.850.7780 or noel.alton@ubalt.edu.

For questions about my rights as a participant in this research study, I can contact the UB IRB Chair: Eric Easton, Chair, University of Baltimore Institutional Review Board, 410-837-4874, eeaston@ubalt.edu.

I will be given a copy of this consent form to keep.

VI. <u>SIGNATURE FOR CONSENT</u>

Noël Alton has answered my questions. I agree to be part of this study. And I am 18 years old or older.

Participant's Name: _____

Participant's Signature: _____ Date: _____

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Appendix B: Email for Student Involvement

Subject: Request for time with students

[Professor's Name]

My name is Noël Alton, and I am a doctoral candidate in Information and Interaction Design in the Yale Gordon College of Arts and Sciences. I am conducting research on the internet search habits of college freshmen. I'm reaching out to you, as your class, [title], has a high number of freshmen students. If you would be willing to let me take some time during one of your classes to work with students, that would be appreciated.

I would need to have students spend about 5 minutes with my research assistants on a one-on-one basis. Students who wanted to participate would need to fill out demographic information, and then take a short test that would be administered one-on-one.

Students who qualify for the study would be compensated for their time. The study would take place outside of class time, so we can minimize impact on their time with you.

Thanks,

Noël T. Alton
Doctoral Candidate

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Appendix C: Demographic Questionnaire

1. How old are you? _____
2. Are you:

   ____ Female

   ____ Male
3. How many semesters have you been in college? _____

   (at University of Baltimore AND any other schools)
4. What is your planned major? _____
5. Which of these best describes your race or ethnicity:

   _____ American Indian or Alaska Native

   _____ Asian

   _____ Black or African-American

   _____ Hispanic/Latino

   _____ Native Hawaiian or other Pacific Islander

   _____ White

   _____ Other
6. How many years (roughly) have you been an internet user? _____
7. How often do you use a computer each **week**?

   never once a week 2-3 times a week every day
8. How often do you use a smartphone (e.g., iPhone, Galaxy, HTC) to access the internet?

   never once a week 2-3 times a week every day
9. When doing school research, do you access information primarily on your mobile device (cell or tablet) or a computer?

   mobile computer

   10. How often do you use the following when looking for information for school assignments?

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General web search engines (e.g., Google, Yahoo, AOL, etc)?

never daily weekly monthly yearly

Wikipedia

never daily weekly monthly yearly

Encyclopedia - Britannica Online Encyclopedia

never daily weekly monthly yearly

Infoplease

never daily weekly monthly yearly

MSN Encarta

never daily weekly monthly yearly

World Book

never daily weekly monthly yearly

HowStuffWorks

never daily weekly monthly yearly

YouTube

never daily weekly monthly yearly

Scholarpedia

never daily weekly monthly yearly

National Geographic

never daily weekly monthly yearly

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Family and Friends

never daily weekly monthly yearly

Books (for class or from the library)

never daily weekly monthly yearly

UB Library

never daily weekly monthly yearly

Other: _____

never daily weekly monthly yearly

Other: _____

never daily weekly monthly yearly

Other: _____

never daily weekly monthly yearly

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Appendix D: Post Task Questions

Participant: _____ Date: _____

1. In your own words, what was it that you were trying to find today?

2. What key words did you use during your search?

3. What kinds of sites did you expect to find for this task?

4. Are there other searches you may have performed, if you had more time?

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5. What makes you choose one site over another site?

6. When it comes to school assignments, is it more important to find a lot of sources, or fewer sources that are closely related to your search?

7. On a scale of 1-5, rate the difficulty of this task (one being very easy, and five being very hard)

   1 2 3 4 5

8. On a scale of 1-5, rate how much mental effort you used to complete the task (one being very little, and five being a lot)

   1 2 3 4 5

9. On a scale of 1-5, rate the difficulty of this task (one being completely unsatisfied and five being completely satisfied)

   1 2 3 4 5

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Appendix E: Demographics and Key Findings

Student Participant 10					**Age:** 21
Realm	**Gender**	**Ethnicity**	**Internet Usage**	**Computer Usage**	**Mobile Usage**
66	Female	Hispanic/Latino	15 years	Every day	Every day

Task 1 Difficulty	**Task 1 Mental Effort**	**Task 1 Satisfaction**	**Task 1 Number of Searches**	**Task 1 Number of Sites Visited**	**Task 1 Time on Task**
2	2	2	2	3	5.37

Task 2 Difficulty	**Task 2 Mental Effort**	**Task 2 Satisfaction**	**Task 2 Number of Searches**	**Task 2 Number of Sites Visited**	**Task 2 Time on Task**
3	3	3	2	3	7.33

Task 3 Difficulty	**Task 3 Mental Effort**	**Task 3 Satisfaction**	**Task 3 Number of Searches**	**Task 3 Number of Sites Visited**	**Task 3 Time on Task**
4	4	5	1	2	7.18

Student Participant 11					**Age:** 18
Realm	**Gender**	**Ethnicity**	**Internet Usage**	**Computer Usage**	**Mobile Usage**
63	Male	Black	14 years	Every day	Every day

Task 1 Difficulty	**Task 1 Mental Effort**	**Task 1 Satisfaction**	**Task 1 Number of Searches**	**Task 1 Number of Sites Visited**	**Task 1 Time on Task**
2	1	4	1	3	9.98

Task 2 Difficulty	**Task 2 Mental Effort**	**Task 2 Satisfaction**	**Task 2 Number of Searches**	**Task 2 Number of Sites Visited**	**Task 2 Time on Task**
4	3	4	1	2	6.07

Task 3 Difficulty	**Task 3 Mental Effort**	**Task 3 Satisfaction**	**Task 3 Number of Searches**	**Task 3 Number of Sites Visited**	**Task 3 Time on Task**
5	4	3	1	4	17.60

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Student Participant 12					**Age:** 18
Realm	**Gender**	**Ethnicity**	**Internet Usage**	**Computer Usage**	**Mobile Usage**
65	Female	Asian	13 years	Every day	Every day

Task 1 Difficulty	**Task 1 Mental Effort**	**Task 1 Satisfaction**	**Task 1 Number of Searches**	**Task 1 Number of Sites Visited**	**Task 1 Time on Task**
2	2	5	3	4	11.35

Task 2 Difficulty	**Task 2 Mental Effort**	**Task 2 Satisfaction**	**Task 2 Number of Searches**	**Task 2 Number of Sites Visited**	**Task 2 Time on Task**
3	3	4	1	2	5.27

Task 3 Difficulty	**Task 3 Mental Effort**	**Task 3 Satisfaction**	**Task 3 Number of Searches**	**Task 3 Number of Sites Visited**	**Task 3 Time on Task**
1	2	4	2	3	4.30

Student Participant 13					**Age:** 18
Realm	**Gender**	**Ethnicity**	**Internet Usage**	**Computer Usage**	**Mobile Usage**
63	Male	White	10 years	Every day	Every day

Task 1 Difficulty	**Task 1 Mental Effort**	**Task 1 Satisfaction**	**Task 1 Number of Searches**	**Task 1 Number of Sites Visited**	**Task 1 Time on Task**
1	2	3	2	4	12.25

Task 2 Difficulty	**Task 2 Mental Effort**	**Task 2 Satisfaction**	**Task 2 Number of Searches**	**Task 2 Number of Sites Visited**	**Task 2 Time on Task**
2	2	3	2	2	12.40

Task 3 Difficulty	**Task 3 Mental Effort**	**Task 3 Satisfaction**	**Task 3 Number of Searches**	**Task 3 Number of Sites Visited**	**Task 3 Time on Task**
1	2	4	3	6	17.78

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Student Participant 14					**Age:** 18
Realm	**Gender**	**Ethnicity**	**Internet Usage**	**Computer Usage**	**Mobile Usage**
58	Female	Black	10 years	Every day	Every day

Task 1 Difficulty	**Task 1 Mental Effort**	**Task 1 Satisfaction**	**Task 1 Number of Searches**	**Task 1 Number of Sites Visited**	**Task 1 Time on Task**
2	5	5	6	2	20.23

Task 2 Difficulty	**Task 2 Mental Effort**	**Task 2 Satisfaction**	**Task 2 Number of Searches**	**Task 2 Number of Sites Visited**	**Task 2 Time on Task**
2	2	5	1	1	9.07

Task 3 Difficulty	**Task 3 Mental Effort**	**Task 3 Satisfaction**	**Task 3 Number of Searches**	**Task 3 Number of Sites Visited**	**Task 3 Time on Task**
3.5	5	4	3	3	12.70

Student Participant 15					**Age:** 18
Realm	**Gender**	**Ethnicity**	**Internet Usage**	**Computer Usage**	**Mobile Usage**
66	Female	White	12 years	Every day	Every day

Task 1 Difficulty	**Task 1 Mental Effort**	**Task 1 Satisfaction**	**Task 1 Number of Searches**	**Task 1 Number of Sites Visited**	**Task 1 Time on Task**
1	2	5	2	2	9.68

Task 2 Difficulty	**Task 2 Mental Effort**	**Task 2 Satisfaction**	**Task 2 Number of Searches**	**Task 2 Number of Sites Visited**	**Task 2 Time on Task**
2	3	4	2	10	13.08

Task 3 Difficulty	**Task 3 Mental Effort**	**Task 3 Satisfaction**	**Task 3 Number of Searches**	**Task 3 Number of Sites Visited**	**Task 3 Time on Task**
1	2	5	2	2	14.93

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Student Participant 16					**Age:** 18
Realm	**Gender**	**Ethnicity**	**Internet Usage**	**Computer Usage**	**Mobile Usage**
32	Male	Black	8 years	Every day	Every day

Task 1 Difficulty	**Task 1 Mental Effort**	**Task 1 Satisfaction**	**Task 1 Number of Searches**	**Task 1 Number of Sites Visited**	**Task 1 Time on Task**
2.5	4	4	11	4	15.97

Task 2 Difficulty	**Task 2 Mental Effort**	**Task 2 Satisfaction**	**Task 2 Number of Searches**	**Task 2 Number of Sites Visited**	**Task 2 Time on Task**
3.5	4	4	9	4	9.92

Task 3 Difficulty	**Task 3 Mental Effort**	**Task 3 Satisfaction**	**Task 3 Number of Searches**	**Task 3 Number of Sites Visited**	**Task 3 Time on Task**
5	5	4	3	4	11.30

Student Participant 17					**Age:** 18
Realm	**Gender**	**Ethnicity**	**Internet Usage**	**Computer Usage**	**Mobile Usage**
60	Female	Black	12 years	2-3 times/week	Every day

Task 1 Difficulty	**Task 1 Mental Effort**	**Task 1 Satisfaction**	**Task 1 Number of Searches**	**Task 1 Number of Sites Visited**	**Task 1 Time on Task**
2.5	2	4	3	3	10.88

Task 2 Difficulty	**Task 2 Mental Effort**	**Task 2 Satisfaction**	**Task 2 Number of Searches**	**Task 2 Number of Sites Visited**	**Task 2 Time on Task**
4	5	5	1	1	5.80

Task 3 Difficulty	**Task 3 Mental Effort**	**Task 3 Satisfaction**	**Task 3 Number of Searches**	**Task 3 Number of Sites Visited**	**Task 3 Time on Task**
			1	1	12.73

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Student Participant 18					**Age:** 18
Realm	**Gender**	**Ethnicity**	**Internet Usage**	**Computer Usage**	**Mobile Usage**
45	Female	Asian	10 years	2-3 times/week	Every day

Task 1 Difficulty	**Task 1 Mental Effort**	**Task 1 Satisfaction**	**Task 1 Number of Searches**	**Task 1 Number of Sites Visited**	**Task 1 Time on Task**
3	3	2	3	9	13.33

Task 2 Difficulty	**Task 2 Mental Effort**	**Task 2 Satisfaction**	**Task 2 Number of Searches**	**Task 2 Number of Sites Visited**	**Task 2 Time on Task**
4	3	4	1	4	6.37

Task 3 Difficulty	**Task 3 Mental Effort**	**Task 3 Satisfaction**	**Task 3 Number of Searches**	**Task 3 Number of Sites Visited**	**Task 3 Time on Task**
3	2	2	1	4	3.48

Student Participant 19					**Age:** 20
Realm	**Gender**	**Ethnicity**	**Internet Usage**	**Computer Usage**	**Mobile Usage**
63	Male	Black	6 years	Once a week	Every day

Task 1 Difficulty	**Task 1 Mental Effort**	**Task 1 Satisfaction**	**Task 1 Number of Searches**	**Task 1 Number of Sites Visited**	**Task 1 Time on Task**
2	2	4	7	8	14.30

Task 2 Difficulty	**Task 2 Mental Effort**	**Task 2 Satisfaction**	**Task 2 Number of Searches**	**Task 2 Number of Sites Visited**	**Task 2 Time on Task**
3	4	3	6	4	13.27

Task 3 Difficulty	**Task 3 Mental Effort**	**Task 3 Satisfaction**	**Task 3 Number of Searches**	**Task 3 Number of Sites Visited**	**Task 3 Time on Task**
2	3	4	7	11	15.50

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Student Participant 20					**Age:** 18
Realm	**Gender**	**Ethnicity**	**Internet Usage**	**Computer Usage**	**Mobile Usage**
64	Female	Black/Hispanic	10 years	2-3 times/week	Every day

Task 1 Difficulty	**Task 1 Mental Effort**	**Task 1 Satisfaction**	**Task 1 Number of Searches**	**Task 1 Number of Sites Visited**	**Task 1 Time on Task**
2	3	5	6	3	19.48

Task 2 Difficulty	**Task 2 Mental Effort**	**Task 2 Satisfaction**	**Task 2 Number of Searches**	**Task 2 Number of Sites Visited**	**Task 2 Time on Task**
1	2	5	7	4	16.47

Task 3 Difficulty	**Task 3 Mental Effort**	**Task 3 Satisfaction**	**Task 3 Number of Searches**	**Task 3 Number of Sites Visited**	**Task 3 Time on Task**
2	3	5	3	5	12.17

Student Participant 26					**Age:** 23
Realm	**Gender**	**Ethnicity**	**Internet Usage**	**Computer Usage**	**Mobile Usage**
47	Female	Black	7 years	2-3 times/week	Every day

Task 1 Difficulty	**Task 1 Mental Effort**	**Task 1 Satisfaction**	**Task 1 Number of Searches**	**Task 1 Number of Sites Visited**	**Task 1 Time on Task**
2	4.5	5	1	4	5.90

Task 2 Difficulty	**Task 2 Mental Effort**	**Task 2 Satisfaction**	**Task 2 Number of Searches**	**Task 2 Number of Sites Visited**	**Task 2 Time on Task**
4	3.5	4	1	3	4.78

Task 3 Difficulty	**Task 3 Mental Effort**	**Task 3 Satisfaction**	**Task 3 Number of Searches**	**Task 3 Number of Sites Visited**	**Task 3 Time on Task**
1.5	2.5	5	2	2	4.35

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Student Participant 27					**Age:** 18
Realm	**Gender**	**Ethnicity**	**Internet Usage**	**Computer Usage**	**Mobile Usage**
65	Male	Black	11 years	2-3 times/week	Every day

Task 1 Difficulty	**Task 1 Mental Effort**	**Task 1 Satisfaction**	**Task 1 Number of Searches**	**Task 1 Number of Sites Visited**	**Task 1 Time on Task**
2.5	4	5	1	5	10.15

Task 2 Difficulty	**Task 2 Mental Effort**	**Task 2 Satisfaction**	**Task 2 Number of Searches**	**Task 2 Number of Sites Visited**	**Task 2 Time on Task**
2	4	5	1	1	4.02

Task 3 Difficulty	**Task 3 Mental Effort**	**Task 3 Satisfaction**	**Task 3 Number of Searches**	**Task 3 Number of Sites Visited**	**Task 3 Time on Task**
5	5	5	1	2	8.33

Student Participant 28					**Age:** 32
Realm	**Gender**	**Ethnicity**	**Internet Usage**	**Computer Usage**	**Mobile Usage**
54	Male	Black	4 years	Every day	Every day

Task 1 Difficulty	**Task 1 Mental Effort**	**Task 1 Satisfaction**	**Task 1 Number of Searches**	**Task 1 Number of Sites Visited**	**Task 1 Time on Task**
3	4	4	2	2	22.55

Task 2 Difficulty	**Task 2 Mental Effort**	**Task 2 Satisfaction**	**Task 2 Number of Searches**	**Task 2 Number of Sites Visited**	**Task 2 Time on Task**
4	5	5	5	5	29.75

Task 3 Difficulty	**Task 3 Mental Effort**	**Task 3 Satisfaction**	**Task 3 Number of Searches**	**Task 3 Number of Sites Visited**	**Task 3 Time on Task**
5	5	3	6	3	15.80

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Student Participant 29					**Age:** 18
Realm	**Gender**	**Ethnicity**	**Internet Usage**	**Computer Usage**	**Mobile Usage**
56	Male	Black	10 years	Every day	Every day

Task 1 Difficulty	**Task 1 Mental Effort**	**Task 1 Satisfaction**	**Task 1 Number of Searches**	**Task 1 Number of Sites Visited**	**Task 1 Time on Task**
1	1.5	5	3	6	15.00

Task 2 Difficulty	**Task 2 Mental Effort**	**Task 2 Satisfaction**	**Task 2 Number of Searches**	**Task 2 Number of Sites Visited**	**Task 2 Time on Task**
2	1	5	5	5	7.67

Task 3 Difficulty	**Task 3 Mental Effort**	**Task 3 Satisfaction**	**Task 3 Number of Searches**	**Task 3 Number of Sites Visited**	**Task 3 Time on Task**
1	1	5	2	2	8.78

Student Participant 30					**Age:** 18
Realm	**Gender**	**Ethnicity**	**Internet Usage**	**Computer Usage**	**Mobile Usage**
57	Female	Hispanic/Latino	8 years	Every day	Every day

Task 1 Difficulty	**Task 1 Mental Effort**	**Task 1 Satisfaction**	**Task 1 Number of Searches**	**Task 1 Number of Sites Visited**	**Task 1 Time on Task**
1	2	4	2	3	9.08

Task 2 Difficulty	**Task 2 Mental Effort**	**Task 2 Satisfaction**	**Task 2 Number of Searches**	**Task 2 Number of Sites Visited**	**Task 2 Time on Task**
1	1	5	2	3	4.07

Task 3 Difficulty	**Task 3 Mental Effort**	**Task 3 Satisfaction**	**Task 3 Number of Searches**	**Task 3 Number of Sites Visited**	**Task 3 Time on Task**
3	3	5	1	3	9.43

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Student Participant 31					**Age:** 17
Realm	**Gender**	**Ethnicity**	**Internet Usage**	**Computer Usage**	**Mobile Usage**
56	Male	Black	8 years	Every day	Every day

Task 1 Difficulty	**Task 1 Mental Effort**	**Task 1 Satisfaction**	**Task 1 Number of Searches**	**Task 1 Number of Sites Visited**	**Task 1 Time on Task**
2	2.5	4	2	1	8.57

Task 2 Difficulty	**Task 2 Mental Effort**	**Task 2 Satisfaction**	**Task 2 Number of Searches**	**Task 2 Number of Sites Visited**	**Task 2 Time on Task**
2	2	4	2	7	6.90

Task 3 Difficulty	**Task 3 Mental Effort**	**Task 3 Satisfaction**	**Task 3 Number of Searches**	**Task 3 Number of Sites Visited**	**Task 3 Time on Task**
3	4	4	1	3	22.20

Student Participant 32					**Age:** 18
Realm	**Gender**	**Ethnicity**	**Internet Usage**	**Computer Usage**	**Mobile Usage**
59	Male	Black	10 years	Every day	Every day

Task 1 Difficulty	**Task 1 Mental Effort**	**Task 1 Satisfaction**	**Task 1 Number of Searches**	**Task 1 Number of Sites Visited**	**Task 1 Time on Task**
2.651	1	4.8	4	5	13.33

Task 2 Difficulty	**Task 2 Mental Effort**	**Task 2 Satisfaction**	**Task 2 Number of Searches**	**Task 2 Number of Sites Visited**	**Task 2 Time on Task**
1	1	4	4	6	10.97

Task 3 Difficulty	**Task 3 Mental Effort**	**Task 3 Satisfaction**	**Task 3 Number of Searches**	**Task 3 Number of Sites Visited**	**Task 3 Time on Task**
2	3	4	8	4	11.70

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Student Participant 33					**Age:** 18
Realm	**Gender**	**Ethnicity**	**Internet Usage**	**Computer Usage**	**Mobile Usage**
64	Male	Black	3 years	2-3 times/week	Every day

Task 1 Difficulty	**Task 1 Mental Effort**	**Task 1 Satisfaction**	**Task 1 Number of Searches**	**Task 1 Number of Sites Visited**	**Task 1 Time on Task**
3.5	4	3	4	1	8.45

Task 2 Difficulty	**Task 2 Mental Effort**	**Task 2 Satisfaction**	**Task 2 Number of Searches**	**Task 2 Number of Sites Visited**	**Task 2 Time on Task**
2	2	5	3	1	6.50

Task 3 Difficulty	**Task 3 Mental Effort**	**Task 3 Satisfaction**	**Task 3 Number of Searches**	**Task 3 Number of Sites Visited**	**Task 3 Time on Task**
4	5	3	3	3	5.43

Student Participant 34					**Age:** 19
Realm	**Gender**	**Ethnicity**	**Internet Usage**	**Computer Usage**	**Mobile Usage**
64	Male	Black	9 years	Every day	Every day

Task 1 Difficulty	**Task 1 Mental Effort**	**Task 1 Satisfaction**	**Task 1 Number of Searches**	**Task 1 Number of Sites Visited**	**Task 1 Time on Task**
2	3	3	1	2	6.78

Task 2 Difficulty	**Task 2 Mental Effort**	**Task 2 Satisfaction**	**Task 2 Number of Searches**	**Task 2 Number of Sites Visited**	**Task 2 Time on Task**
2	1	3	2	2	6.00

Task 3 Difficulty	**Task 3 Mental Effort**	**Task 3 Satisfaction**	**Task 3 Number of Searches**	**Task 3 Number of Sites Visited**	**Task 3 Time on Task**
1	2	2	1	1	2.93

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Non-Student Participant 01					**Age:** 28
Realm	**Gender**	**Ethnicity**	**Internet Usage**	**Computer Usage**	**Mobile Usage**
56	Female	Black	20+ years	2-3 times/week	Every day

Task 1 Difficulty	**Task 1 Mental Effort**	**Task 1 Satisfaction**	**Task 1 Number of Searches**	**Task 1 Number of Sites Visited**	**Task 1 Time on Task**
1	1	1	3	5	11.83

Task 2 Difficulty	**Task 2 Mental Effort**	**Task 2 Satisfaction**	**Task 2 Number of Searches**	**Task 2 Number of Sites Visited**	**Task 2 Time on Task**
2	3	4.5	4	7	7.38

Task 3 Difficulty	**Task 3 Mental Effort**	**Task 3 Satisfaction**	**Task 3 Number of Searches**	**Task 3 Number of Sites Visited**	**Task 3 Time on Task**
2	2	5	4	8	17.47

Non-Student Participant 02					**Age:** 33
Realm	**Gender**	**Ethnicity**	**Internet Usage**	**Computer Usage**	**Mobile Usage**
46	Female	Black	1 year	Once a week	Every day

Task 1 Difficulty	**Task 1 Mental Effort**	**Task 1 Satisfaction**	**Task 1 Number of Searches**	**Task 1 Number of Sites Visited**	**Task 1 Time on Task**
4	2	4	2	2	10.50

Task 2 Difficulty	**Task 2 Mental Effort**	**Task 2 Satisfaction**	**Task 2 Number of Searches**	**Task 2 Number of Sites Visited**	**Task 2 Time on Task**
3	2	5	1	1	6.87

Task 3 Difficulty	**Task 3 Mental Effort**	**Task 3 Satisfaction**	**Task 3 Number of Searches**	**Task 3 Number of Sites Visited**	**Task 3 Time on Task**
4	2	2	1	1	3.00

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Non-Student Participant 03					**Age:** 52
Realm	**Gender**	**Ethnicity**	**Internet Usage**	**Computer Usage**	**Mobile Usage**
43	Male	Black	3 years	3-Feb	Never

Task 1 Difficulty	**Task 1 Mental Effort**	**Task 1 Satisfaction**	**Task 1 Number of Searches**	**Task 1 Number of Sites Visited**	**Task 1 Time on Task**
4	3	3	2	1	6.17

Task 2 Difficulty	**Task 2 Mental Effort**	**Task 2 Satisfaction**	**Task 2 Number of Searches**	**Task 2 Number of Sites Visited**	**Task 2 Time on Task**
5	4	4	1	1	14.50

Task 3 Difficulty	**Task 3 Mental Effort**	**Task 3 Satisfaction**	**Task 3 Number of Searches**	**Task 3 Number of Sites Visited**	**Task 3 Time on Task**
2	3	5	1	2	8.38

Non-Student Participant 05					**Age:** 24
Realm	**Gender**	**Ethnicity**	**Internet Usage**	**Computer Usage**	**Mobile Usage**
53	Male	Black	12 years	Every day	Every day

Task 1 Difficulty	**Task 1 Mental Effort**	**Task 1 Satisfaction**	**Task 1 Number of Searches**	**Task 1 Number of Sites Visited**	**Task 1 Time on Task**
1	3	5	1	1	6.72

Task 2 Difficulty	**Task 2 Mental Effort**	**Task 2 Satisfaction**	**Task 2 Number of Searches**	**Task 2 Number of Sites Visited**	**Task 2 Time on Task**
1	3	5	1	1	4.35

Task 3 Difficulty	**Task 3 Mental Effort**	**Task 3 Satisfaction**	**Task 3 Number of Searches**	**Task 3 Number of Sites Visited**	**Task 3 Time on Task**
2	3	5	1	1	3.85

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Non-Student Participant 06					**Age:** 19
Realm	**Gender**	**Ethnicity**	**Internet Usage**	**Computer Usage**	**Mobile Usage**
56	Female	Black	5 years	Never	Every day

Task 1 Difficulty	**Task 1 Mental Effort**	**Task 1 Satisfaction**	**Task 1 Number of Searches**	**Task 1 Number of Sites Visited**	**Task 1 Time on Task**
2	5	6	1	1	21.38

Task 2 Difficulty	**Task 2 Mental Effort**	**Task 2 Satisfaction**	**Task 2 Number of Searches**	**Task 2 Number of Sites Visited**	**Task 2 Time on Task**
2	5	5	1	1	21.13

Task 3 Difficulty	**Task 3 Mental Effort**	**Task 3 Satisfaction**	**Task 3 Number of Searches**	**Task 3 Number of Sites Visited**	**Task 3 Time on Task**
2	5	3	1	1	13.22

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Appendix F: Participant Code Sheets

Student Participant 10 – Medium to High Literacy		
Task 1	**Keyword Searches**	birth and death of pluto
		is pluto still a plant?
	Site List	Wikipedia
		Nasa. Gov
		Universe Today
	Task Time	5 minutes, 22 seconds
	What were you trying to find?	
	Were you able to find the information you needed?	Yes
	What keywords or search items did you use?	
	What kind of sites did you expect to find?	
	Any other searches you may have done?	
	Is there anything that makes you choose one site over another?	Whatever is most closely correlated with what I'm looking for If it doesn't look like it's a good a site, like it's official, if it doesn't look like that, that raises a flag, errors in the writing would raise a flag.
	Do you like to find as many sources as possible, or fewer sources that are closely related to your topic?	
	Difficulty Rating	2
	Mental Effort Rating	1
	Performance Satisfaction	2
Task 2	**Keyword Searches**	process of meiosis
		stages of mitosis
	Site List	nature.com
		Wikipedia
		yahoo images
	Task Time	7 minutes, 20 seconds
	What were you trying to find?	
	Were you able to find the information you needed?	Yep
	What keywords or search items did you use?	
	What kind of sites did you expect to find?	Finding images was easier than trying to read what it was I needed to find
	Any other searches you may have done?	
	Difficulty Rating	3
	Mental Effort Rating	3
	Performance Satisfaction	3
Task 3	**Keyword Searches**	joannes kepler
	Site List	Wikipedia
		Britannica Online
	Task Time	7 minutes, 11 seconds
	What were you trying to find?	
	Were you able to find the information you needed?	Yes
	What keywords or search items did you use?	
	What kind of sites did you expect to find?	
	Any other searches you may have done?	
	Difficulty Rating	4
	Mental Effort Rating	4
	Performance Satisfaction	5

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Student Participant 11 – Medium to High Literacy		
Task 1	**Keyword Searches**	Pluto history
	Site List	Nasa.gov
		Johns Hopkins
		time.com
	Task Time	9 minutes, 59 seconds
	What were you trying to find?	Basically, trying to find when pluto was discovered anything we knew about in the middle of it being a planet and then watch eventually led to it being classified as a dwarf planet
	Were you able to find the information you needed?	Yeah
	What keywords or search items did you use?	Bascially, just typed in 'pluto history' and found everything I wanted
	What kind of sites did you expect to find?	I expected to see Wikipedia first, any universities that had astronomical like articles and stuff put up, but ended up finding a Nasa page, didn't expect to find that. I did find a Johns Hopkins page.
	Any other searches you may have done?	Maybe as I found information about, I would have dug deeper into what makes it a planet a dwarf planet and not just when it was discovered but how
	Is there anything that makes you choose one site over another?	Trust .org and .edu sites more than .com site, I feel like since Nasa is a .gov site I feel like it can be trusted. "I'm pretty sure that all Nasa finds, is owned by the governement…so for this prompt it's the best way to go" I was looking for sites that talked about "history" judging by what the question was asking me.
	Do you like to find as many sources as possible, or fewer sources that are closely related to your topic?	Depends on the nature of the sources, it's always best to have multiple, to see if what you have is consistent
	Difficulty Rating	2
	Mental Effort Rating	1
	Performance Satisfaction	4
Task 2	**Keyword Searches**	mitosis vs meiosis
	Site List	PBS.org (NOVA)
		yourgenome.org
	Task Time	6 minutes, 4 seconds
	What were you trying to find?	The similarities and differences between meisosis and mitosis
	Were you able to find the information you needed?	Yeah
	What keywords or search items did you use?	"mitosis vs. meisosis"
	What kind of sites did you expect to find?	
	Any other searches you may have done?	Searching for each one individually instead of the comparison right off the bat.
	Difficulty Rating	4
	Mental Effort Rating	3
	Performance Satisfaction	4
Task 3	**Keyword Searches**	johannes kepler (chosen from drop down)
	Site List	kepler.nasa.gov (untrusted sign came up)
		famousscientists.org
		wikipedia
		Galileo Project
	Task Time	17 minutes, 36 seconds
	What were you trying to find?	The biography of Julienne Kelper
	Were you able to find the information you needed?	Yes
	What keywords or search items did you use?	Basically just typed in his name
	What kind of sites did you expect to find?	Biography page, and what other biographical websites that give information like this
	Any other searches you may have done?	I think I should have added the "biography" part of the search. Every page that would have appeared would have contained biographical information. And it would have been more organized to find what I had used.
	Difficulty Rating	5
	Mental Effort Rating	4
	Performance Satisfaction	3

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Student Participant 12 – Medium to High Literacy		
Task 1	**Keyword Searches**	Pluto
		(on yahoo) Why is pluto not a planet anymore
		how was pluto discovered
	Site List	Nasa.gov
		universe today
		national geographic
		about.com (education)
	Task Time	11 minutes, 22 seconds
	What were you trying to find?	I was trying to find…um…like some history on the planet Pluto.
	Were you able to find the information you needed?	Yes
	What keywords or search items did you use?	how was pluto discovered // why is pluto not considered as a planet // straight up Pluto
	What kind of sites did you expect to find?	I did expect to find NASA and that's what I use. And then found National Geographic as well, which is sort of surprising, but not really. And then of course, Wikipedia is always everywhere and yahoo answers is usually everywhere.
	Any other searches you may have done?	I could have put in "history of pluto"
	Is there anything that makes you choose one site over another?	If it looks official. Looks like a credible source. I saw that wikipedia is there, but right beneath it is Nasa.gov and I decided to go there instead, because it has more details and stuff. It's probably going to be more accurate.
	Do you like to find as many sources as possible, or fewer sources that are closely related to your topic?	Match what I'm looking for?
	Difficulty Rating	2
	Mental Effort Rating	2
	Performance Satisfaction	5
Task 2	**Keyword Searches**	mitosis vs. meiosis (used drop down, went to image results)
		Changed to video results
	Site List	YouTube image
		Watched Khan Academy Video
	Task Time	5 minutes, 16 seconds
	What were you trying to find?	A comparison between mitosis and meiosis…how the process of those two compare
	Were you able to find the information you needed?	Yes
	What keywords or search items did you use?	Mitosis vs. meiosis.
	What kind of sites did you expect to find?	
	Any other searches you may have done?	
	Difficulty Rating	3
	Mental Effort Rating	3
	Performance Satisfaction	4
Task 3	**Keyword Searches**	google "biographical sketch" (AH! Duh)
		Johannes Kepler
	Site List	Britannica Online
		Galileo Project
		Famous Scientists
	Task Time	4 mionutes, 18 seconds
	What were you trying to find?	Information about Johannes Kepler (mispronounced)
	Were you able to find the information you needed?	Yes
	What keywords or search items did you use?	Johannes Kepler
	What kind of sites did you expect to find?	Historical Sites
	Any other searches you may have done?	Maybe just put in "biography of" before his name
	Difficulty Rating	1
	Mental Effort Rating	2
	Performance Satisfaction	4

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Student Participant 13 – Medium to High Literacy		
Task 1	**Keyword Searches**	Pluto
		pluto planet
		pluto planet facts
	Site List	Nasa.gov
		nineplanets.org
		bbc.com (new horizons report)
		planetfacts.org
	Task Time	12 minutes, 15 seconds
	What were you trying to find?	Tried to find the history of pluto and what lead up to it no longer being classified as a planet
	Were you able to find the information you needed?	Yes, I got a pretty good idea
	What keywords or search items did you use?	Pluto / pluto planet / pluto planet facts
	What kind of sites did you expect to find?	
	Any other searches you may have done?	I would probably look up the guy who discovered the planet, and then the association that deemed pluto not a planet anymore
	Is there anything that makes you choose one site over another?	I look at the ending, if it's .org, .edu, .gove then it's probably more reputable than a site that is .com
	Do you like to find as many sources as possible, or fewer sources that are closely related to your topic?	I would try to find the more reputable ones, but if they say "this many sources, I would find that many sources." He's looking at the quality of the site.
	Difficulty Rating	1
	Mental Effort Rating	2
	Performance Satisfaction	3
Task 2	**Keyword Searches**	mitosis vs. meiosis (from dropdown)
		mitosis vs. meiosis diagram
	Site List	pbs.org
		(image search)
		tutorvista.com
	Task Time	12 minutes, 24 seconds
	What were you trying to find?	I was trying to find the process of mitosis compared to the process of meiosis, and I was trying to make a diagram to explain the differences and similarities between the two.
	Were you able to find the information you needed?	Yes
	What keywords or search items did you use?	I used the word diagram and the term meisos and mitosis
	What kind of sites did you expect to find?	Pbs, I know they're very reputable. And then I used [tutuorvista] and the diagram was from Pearson which makes text books, which I know is reputable so I trusted it a bit more.
	Any other searches you may have done?	Maybe, similarities or differences between the two.
	Difficulty Rating	2
	Mental Effort Rating	2
	Performance Satisfaction	3
Task 3	**Keyword Searches**	johannes kepler
		johannes kepler achievements (mispelled)
	Site List	Britannica
		johanneskepler.info
		parallelogram.org
		kepler.nasa.gov (untrusted notice)
		thefamouspeople.com (page 2 of results)
		nmspacemuseum.org
	Task Time	17 minutes, 47 seconds
	What were you trying to find?	I was trying to create a one-page outline of the biographical sketch of johannes kepler
	Were you able to find the information you needed?	yeah
	What keywords or search items did you use?	johannes kepler biography and johannes kepler achievements, and just his name
	What kind of sites did you expect to find?	
	Any other searches you may have done?	elaborated on more of who he worked with and gone deeper into his theories

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	Difficulty Rating	1
	Mental Effort Rating	2
	Performance Satisfaction	4

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Student Participant 14 – Low Literacy		
Task 1	**Keyword Searches**	history of pluto
		Why is pluto no longer a planet?
	Site List	nineplanets.org
		universe today (searched on site "why is pluto no longer a planet?")
	Task Time	20 minutes, 14 seconds
	What were you trying to find?	The history of pluto in detail, and basically it was a planet (how it was made to be a planet)
	Were you able to find the information you needed?	Most of it, except I couldn't find why it's no longer a planet
	What keywords or search items did you use?	history of pluto, discovery of pluto, pluto's gone, and pluto's orbits. And also I did "The atmosphere of pluto"
	What kind of sites did you expect to find?	I was looking to find sites like "the universe today" something that had to do with "NSA (Nasa, sic) and new horizons aircrafts. I was looking for ones that would be more credible.
	Any other searches you may have done?	I don't know
	Is there anything that makes you choose one site over another?	Not saying "wikipedia" have actual dates and sources and comments on it.
	Do you like to find as many sources as possible, or fewer sources that are closely related to your topic?	As many as I can. Some of the ones I can find may not be credible, but would tell her what she needed. So she would find as many as she could for credibel sources.
	Difficulty Rating	2
	Mental Effort Rating	5
	Performance Satisfaction	5
Task 2	**Keyword Searches**	mitosis and meiosis
	Site List	diffen.com
	Task Time	9 minutes, 4 seconds
	What were you trying to find?	Um, the differences and the compairisons of mitosis and meiosis
	Were you able to find the information you needed?	yes
	What keywords or search items did you use?	mitosis and meiosis comparison
	What kind of sites did you expect to find?	Diffen.com was something that I thought was what I was looking for because it had the stages and stuff about them
	Any other searches you may have done?	the process of how it's made and stuff
	Difficulty Rating	2
	Mental Effort Rating	5
	Performance Satisfaction	5
Task 3	**Keyword Searches**	biographcial sketch of johannes kepler
	Site List	kepler.nasa.gov (untrusted notice)
		space.com
		britannica
	Task Time	12 minutes, 42 seconds
	What were you trying to find?	I was looking at Johannes Kepler, basically about his life and everything. And the history of what he did and what schools he went to
	Were you able to find the information you needed?	Yes
	What keywords or search items did you use?	His name, and biographical sketch of johannes kepler
	What kind of sites did you expect to find?	Biography pages and stuff like that
	Any other searches you may have done?	Maybe like using "astronomy" or something like that with his name
	Difficulty Rating	3.5
	Mental Effort Rating	5
	Performance Satisfaction	4

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Student Participant 15 – Medium to High Literacy		
Task 1	**Keyword Searches**	history of pluto
		why did pluto get demoted
	Site List	time.com
		universe today
	Task Time	9 minutes, 41 seconds
	What were you trying to find?	I was trying to find the basic history of pluto, and then I was trying to find why it became a dwarf planet, specifically
	Were you able to find the information you needed?	Yes, it was pretty easy
	What keywords or search items did you use?	"history of pluto" and then "why is pluto no longer a planet"
	What kind of sites did you expect to find?	…to find things like scientifically based, or science-specific magazines.
	Any other searches you may have done?	Um, I don't think so
	Is there anything that makes you choose one site over another?	Typically, I try to look at the link that it gives me. See if it's something I recognize. Knowing it's agood source, or something like .gove that may be more reliable.
	Do you like to find as many sources as possible, or fewer sources that are closely related to your topic?	I say it depends on the assignment. If I'm doing a research paper, I'm going to want to have a lot of them that closely match, but a broad amount of statistics to back up my claim. But if I'm doing a historical analysis, I might not need as many, but I would need specifics.
	Difficulty Rating	1
	Mental Effort Rating	2
	Performance Satisfaction	5
Task 2	**Keyword Searches**	diagram of mitosis
		diagram of mitosis and meiosis
	Site List	(link that tried to download word doc)
		genome.gov
		(images)mitosis for kids)
		ivyroses.com
		khanacademy.org
		owlcation.com
		(images) accessexcellence.org; nbu.bg, imgarcade.com
		University of Leicester
		Biology 1510 (Georgia Tech)
	Task Time	13 minutes, 5 seconds
	What were you trying to find?	The differences between mitosis and meisosis in a diagram form
	Were you able to find the information you needed?	Um, yeah
	What keywords or search items did you use?	"diagram of mitosis and meiosis"
	What kind of sites did you expect to find?	Anything from like probably university level biology to just any google, wikipeida, or anything.
	Any other searches you may have done?	
	Difficulty Rating	2
	Mental Effort Rating	3
	Performance Satisfaction	4
Task 3	**Keyword Searches**	Johannes kepler
		(Google) johannes kepler
	Site List	kepler.nasa.gov (warning/closed)
		Galileo project
	Task Time	14 minutes, 56 secodns
	What were you trying to find?	I was trying to find basically of a biography of (I don't know how to say his name) Johannes Kepler
	Were you able to find the information you needed?	Yeah
	What keywords or search items did you use?	I just used his name
	What kind of sites did you expect to find?	I expected to find like simpel things like wikipedia, and also sites that had to do with astrology..astronomy.
	Any other searches you may have done?	
	Difficulty Rating	1

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	Mental Effort Rating	2
	Performance Satisfaction	5

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Student Participant 16 – Low Literacy		
Task 1	**Keyword Searches**	pluto (x2)
		nasa
		why is pluto no longer a planet
		hitory behind pluto (yahoo x2)
		percival lowell (found in article, and looked up)
		clyde tobaugh (found in article, and looked up)
		definition of a planet
		What is a (dwaft) dwarf planet?
	Site List	nasa (from nasa search, and pluto)
		wonderopolis (why is pluto…)
		history.com (history behind...)
		space.com (percival lowell)
		starchild.gsf.nasa.gov
		space.com (definition…)
		solarsystem.nasa.gov (what is…)
	Task Time	15 minutes, 58 seconds
	What were you trying to find?	I was trying information on the history of pluto
	Were you able to find the information you needed?	yeah
	What keywords or search items did you use?	I used prior knowledge and looked up "dwarf planet" then I looked the "definition of a planet." Then I looked up the names of the guys that found pluto, their names. And then I looked up the definiton of a dwarf planet. Then I looked up why is pluto not a planet, and I looked up the history behind pluto history behind dwarf planets
	What kind of sites did you expect to find?	I tried to find sites that were really credible, like science and scientific articles
	Any other searches you may have done?	
	Is there anything that makes you choose one site over another?	I tried to look for sites that I know are credible, so like I'm not going to go a site like Wikipedia, because their not credible. But I'm going to go to a site that I know has been peer reviewed, stuff like that. Answered above.
	Do you like to find as many sources as possible, or fewer sources that are closely related to your topic?	I try to find as much sites as possible and then like try to compare the information I get from each site to like one site that I know has all the information I need.
	Difficulty Rating	2.5
	Mental Effort Rating	4
	Performance Satisfaction	4
Task 2	**Keyword Searches**	mitosis
		meiosis
		what is crossing over (didn't fiinish the search, used RSR)
		homoolgous (used RSR)
		steps of mitosis
		haploid definition (RSR)
		diploid and haploid definition
		What is meiosis? (yahoo answers)
	Site List	yourgenome.org (mitosis)
		diffen.com (meiosis)
		carolina.com/life science (steps..)
		diffen.com (diploid…)
	Task Time	9 minutes, 55 seconds
	What were you trying to find?	I was looking up the process of mitosis and meiosis and then doing a comparison.
	Were you able to find the information you needed?	Yeah
	What keywords or search items did you use?	I just looked up the basic what is both of them and what is different between the two. And if there were any words I didn't know, I justlooked those up too
	What kind of sites did you expect to find?	Some scientific sites.
	Any other searches you may have done?	
	Difficulty Rating	3.5
	Mental Effort Rating	4

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	Performance Satisfaction	4
Task 3	**Keyword Searches**	johannes kepler
		johannes kepler impact (yahoo)
		laws of planetary motion
	Site List	Nasa (untrusted)
		Britannica
		answers.com (impact) (visited multiple times)
		Britannica (laws…)
	Task Time	11 minutes, 18 seconds
	What were you trying to find?	I was trying to learn as much information on this guy as much as possible
	Were you able to find the information you needed?	yeah
	What keywords or search items did you use?	I looked up what did he do and his impact on society and then like what job he had and basic information like wehre is he from and when he was born.
	What kind of sites did you expect to find?	After I found out what he did, scientific websites
	Any other searches you may have done?	
	Difficulty Rating	5
	Mental Effort Rating	5
	Performance Satisfaction	4

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Student Participant 17 – Low Literacy		
Task 1	**Keyword Searches**	history of pluto
		pluto no longer a plant (drop down) (RSR)
	Site List	nineplanets.org
		space.com
		International Astronomical Union (linked from space.com)
	Task Time	10 minutes, 53 seconds
	What were you trying to find?	Why pluto was no longer a planet
	Were you able to find the information you needed?	yeah, basically pluto was too small
	What keywords or search items did you use?	Um, pluto, history of pluto, and planet
	What kind of sites did you expect to find?	Scientific sites, I guess
	Any other searches you may have done?	
	Is there anything that makes you choose one site over another?	I don't really have a thought process, as long as I'm using google, I feel it's more beneficial to me.
	Do you like to find as many sources as possible, or fewer sources that are closely related to your topic?	No it's more important to find what you're looking for, it doesn't matter how many sites it is as long as you're getting the information you need.
	Difficulty Rating	2.5
	Mental Effort Rating	2
	Performance Satisfaction	4
Task 2	**Keyword Searches**	proces of mitosis and meiosis (RSR McGraw Hill Higher Ed)
	Site List	University of Leicester
	Task Time	5 minutes, 45 seconds
	What were you trying to find?	The differences between the process of mitosis and meiosis
	Were you able to find the information you needed?	Uh, I think so…<laughs>
	What keywords or search items did you use?	I just typed in "meiosis and mitosis"
	What kind of sites did you expect to find?	Sites about germs and stuff like that, genes and what not.
	Any other searches you may have done?	Wikipedia might have helped better, (Actually, no I don't trust it)
	Difficulty Rating	4
	Mental Effort Rating	5
	Performance Satisfaction	5
Task 3	**Keyword Searches**	johannes kepler (drop down)
	Site List	wikipedia
	Task Time	12 minutes, 44 seconds
	What were you trying to find?	Basically, just like his life story, his background, how he became so legendary, and what he did
	Were you able to find the information you needed?	Yeah. I was
	What keywords or search items did you use?	I just typed up his name in google.
	What kind of sites did you expect to find?	Wikipedia (no, but I figured it would pop up, because it usually pops up when you type someone's name)
	Any other searches you may have done?	Not that I know of , no.
	Difficulty Rating	
	Mental Effort Rating	
	Performance Satisfaction	

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Student Participant 18 – Low Literacy		
Task 1	**Keyword Searches**	ploto (mispelled)
		Pluto as a planet
	Site List	nasa (x2)
		solarsystem.nasa.gov
		Geek.com
		plutoisaplanet.com
		Earthsky.org
		Inquisitor.com
		Science Mag (watched video)
		Independent (UK)
	Task Time	13 minutes, 20 seconds
	What were you trying to find?	Is pluto considered a planet or not?
	Were you able to find the information you needed?	Kind of, not exactly because it's not determined if it's a planet or not.
	What keywords or search items did you use?	I just used "pluto" and then "planet"
	What kind of sites did you expect to find?	I know the N-A-N one, I forgot what webstie it is, [the NASA] but I knew that one was a science thing. So I knew I would go to that site, but the others I didn't really want to look at the news and stuff.
	Any other searches you may have done?	
	Is there anything that makes you choose one site over another?	I kind of look for the title because if the title doesn't seem right I don't want to click on it and waste my time
	Do you like to find as many sources as possible, or fewer sources that are closely related to your topic?	The one that match the most
	Difficulty Rating	3
	Mental Effort Rating	3
	Performance Satisfaction	2
Task 2	**Keyword Searches**	mesios compared to mitosis (drop down, after autocorrect on meiosis) (RSR - mcGraw hill higher ed)
	Site List	McGraw Hill Higher Ed
		Diffen.com
		Boundless.com
		Image results (briefly)
		Udemy
	Task Time	6 minutes, 22 seconds
	What were you trying to find?	I was looking for the different between the two
	Were you able to find the information you needed?	Yeah, like on the second one I found some good research.
	What keywords or search items did you use?	
	What kind of sites did you expect to find?	Mostly, I looked for the definiton first and then go deeper into it. Like, if I had to find the two differences in them I would go to the dictionary, but because it had this [RSR] I ddin't have to
	Any other searches you may have done?	No.
	Difficulty Rating	4
	Mental Effort Rating	3
	Performance Satisfaction	4
Task 3	**Keyword Searches**	johhan kepler (autocorrect fixed)
	Site List	wikipedia
		Nasa (untrusted)
		Britannica
		Space.com
	Task Time	3 minutes, 29 seconds
	What were you trying to find?	His background information
	Were you able to find the information you needed?	I guess a little bit; I kind of only remembered his name and not the whole prompt
	What keywords or search items did you use?	
	What kind of sites did you expect to find?	
	Any other searches you may have done?	
	Difficulty Rating	3
	Mental Effort Rating	2

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	Performance Satisfaction	2

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Student Participant 19 – Medium to High Literacy		
Task 1	**Keyword Searches**	pluto
		pluto 2016 plante?
		pluto research
		how is pluto not a planet
		paul rincon
		planet definition
		kuiper belt
	Site List	nasa (pluto, ...planet?)
		the conversation (…research)
		bbc.com (how is….)
		LinkedIn (paul)
		journal listed (paul)
		press ruch (paul)
		nasa, mission science (definition)
		space.com (kuiper belt)
	Task Time	14 minutes, 18 seconds
	What were you trying to find?	I was trying to find the history of why pluto is not considered a planet.
	Were you able to find the information you needed?	Yeah, I think so
	What keywords or search items did you use?	Pluto, planet, kuiper belt,
	What kind of sites did you expect to find?	I expected to find a lot of different sites but I ended up most of the sites I clicked ended up being Nasa
	Any other searches you may have done?	
	Is there anything that makes you choose one site over another?	I basically look at the sources and the links, so Nasa just seemd like a more credible -- known -- source.
	Do you like to find as many sources as possible, or fewer sources that are closely related to your topic?	I prefer a variety, but the ones that most match are more important.
	Difficulty Rating	2
	Mental Effort Rating	2
	Performance Satisfaction	4
Task 2	**Keyword Searches**	mitosis
		somatic cells
		Mitosis process
		mitosis diagram
		meiotic division
		meiosis diagram
	Site List	about education (mitosis)
		Ivy Rose Holistic (mitosis process, diagram)
		Scitable by Nature (meiotic division)
		Owlcation (meosis diagram)
	Task Time	13 minutes, 16 seconds
	What were you trying to find?	First I was just finding out what mitosis and meisos is, and what I found out what they were, and I got all the terms defined, I searched out what the process was and I just like read through it And then I findally went to just diagrams.
	Were you able to find the information you needed?	Yeah I think so. For the most part.
	What keywords or search items did you use?	Miosis. Mitosis. Well, I know I put diagram, and I searched what somatic cells were.
	What kind of sites did you expect to find?	I expected to find sites from like an institute or something like that?
	Any other searches you may have done?	
	Difficulty Rating	3 - I didn't know what the proces s was
	Mental Effort Rating	4
	Performance Satisfaction	3
Task 3	**Keyword Searches**	biographical sketch
		bio sketch
		johannes keplar (fixed typo)
		johannes keplar achievements

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		johannes keplar biography
		johannes keplar timeline
	Site List	reference (biographical…)
		Dictionary.com (for biography)
		Biosketch.net (bio sketch
		Nasa (untrusted site)
		Keplar's discovery (name)
		Virginia.edu Galileo (name)
		Johanneskepler.info (…achievements)
		Iac.net
		Britannica (timeline)
		Physics.edu
		famous scientists.org
	Task Time	15 minutes, 30 seconds
	What were you trying to find?	First, I had to look up what a biographical sketch is, then biographies and acheivements for Johannes.
	Were you able to find the information you needed?	Yeah, I think so.
	What keywords or search items did you use?	Name, timeline, biographies, biographical sketch.
	What kind of sites did you expect to find?	History sites, ones that focused on history.
	Any other searches you may have done?	
	Difficulty Rating	2
	Mental Effort Rating	3
	Performance Satisfaction	4

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Student Participant 20 – Medium to High Literacy		
Task 1	**Keyword Searches**	history of pluto (only read RSR)
		pluto not a planet (from drop down; reading RSR)
		youtube: pluto no longer a planet
	Site List	National Geographic (Pluto not…; RSR)
		Universe today (pluto not…)
		wonderopolis (pluto not)
		Why isn't pluto a planet anymore? (ask an astronomer)
		Why is Pluto not a planet? (scishow space)
	Task Time	19 minutes, 29 seconds
	What were you trying to find?	The main reason why pluto wasn't a planet anymore.
	Were you able to find the information you needed?	Yeah.
	What keywords or search items did you use?	Um, why pluto, … I think I put "pluto not a planet, and then I did "pluto is no longer a planet?"
	What kind of sites did you expect to find?	National geoprahic, Universe Today, BBC, but they didn't really give me anything. And then I went to Youtube, not really to dumb it down, but to give me the concise version. (She told me what she *did* find, not what she expected to find)
	Any other searches you may have done?	If I was writing a paper, I would try to get an article from a database so I would know it was reliable.
	Is there anything that makes you choose one site over another?	Well, I try not to … if I'm reading it and I feel it's opinion and not facts, then I'll like try another website. And if I find something that seems like an fact on an actual website, I'll compare it to another webstie to see if it's similar things about the particular thing I"m searching. And if it is then I know it's like a fact
	Do you like to find as many sources as possible, or fewer sources that are closely related to your topic?	More specific, I would rather have a good quality paper than a paper with a bunch of sources that are all over the place. Because then my paper may be all over the place.
	Difficulty Rating	2
	Mental Effort Rating	3
	Performance Satisfaction	5
Task 2	**Keyword Searches**	mitosis (only looked at the RSR)
		mitosis stages
		meiosis phases (very briefly)
		meiosis definition (very briefly)
		meiosis
		meiosis vs. mitosis
	Site List	(images) easy mnemoic to remember…remembering.com
		khan academy (...stages; RSR)
		back to remembering.com's diagram in images
		meiosis (RSR)
		(images) what is meiosis … yourgenome.org (briefly)
		HigherEd (RSR vs.)
	Task Time	16 minutes, 28 seconds
	What were you trying to find?	To find the difference between the two [mitosis and meiosis]
	Were you able to find the information you needed?	Yes
	What keywords or search items did you use?	
	What kind of sites did you expect to find?	I found a textbook site, and then khan academy.
	Any other searches you may have done?	
	Difficulty Rating	1
	Mental Effort Rating	2
	Performance Satisfaction	5
Task 3	**Keyword Searches**	johannes kepler
		johannes kepler theory (from bottom of first search page)
	Site List	wikipedia (name)
		nasa.gov (untrusted site)
		Britannica (name)
		The Galigleo Project (hopped on and off)
		Space.com

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		RSR (…theory, wikipedia)
	Task Time	12 minutes, 10 seconds
	What were you trying to find?	Who he was and what was so special about what he did.
	Were you able to find the information you needed?	Yeah
	What keywords or search items did you use?	First, I typed in his name, and then I typed in "his theory" once I figured out who he was and what he did.
	What kind of sites did you expect to find?	I started on wikipeida, just to give me a general idea of who he was. I went on to some other sites, kepler.nasa and then another biograpy site, space.com
	Any other searches you may have done?	I would try to go more in depth about his theories and how they effected Isaac Newton's theories. And then mabye go into some databases about him and his life and theories to get more trusted information (library)
	Difficulty Rating	2
	Mental Effort Rating	3
	Performance Satisfaction	5

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Student Participant 26 – Low Literacy		
Task 1	**Keyword Searches**	all about the history of pluto
	Site List	Nine Planets
		Wikipedia
		Nasa
		History.com
	Task Time	5 minutes, 54 seconds
	What were you trying to find?	I was um looking for um what is pluto and basically I discovered it was a planet. It was discovered in the 1930s. …
	Were you able to find the information you needed?	Yeah
	What keywords or search items did you use?	Only one search
	What kind of sites did you expect to find?	Sometimes, I access a familiar site (like wikipedia). Normally, ask will stand out, but that wasn't here.
	Any other searches you may have done?	I could have just put "history of pluto" I went to three different websites to compare, to see what they were saying. To see if one site said anything different than the next.
	Is there anything that makes you choose one site over another?	She chooses sites based on familiarity.
	Do you like to find as many sources as possible, or fewer sources that are closely related to your topic?	Multiple websites to make sure she's getting the right information or the key points that she needs.
	Difficulty Rating	2
	Mental Effort Rating	4.5
	Performance Satisfaction	5
Task 2	**Keyword Searches**	using a diagrm comapre and contrast mitosis and meiosis
	Site List	quizlet.com
		diffen.com
		boundless.com
	Task Time	4 minutes, 47 seconds
	What were you trying to find?	I wanted to compare and contrast the differences of mitosis and meiosis (mispronounced)
	Were you able to find the information you needed?	Yeah
	What keywords or search items did you use?	She only did a single search
	What kind of sites did you expect to find?	She thought it had more to do with health, so science and health.
	Any other searches you may have done?	Besides google, ask, and wikipedia there isn't anything else you need. She trusts wikipedia because theres like more of it. She can't explain it, but views it as the dictionary and the general basics of things. Even though others can edit it.
	Difficulty Rating	4
	Mental Effort Rating	3.5
	Performance Satisfaction	4
Task 3	**Keyword Searches**	biographical on johannes kepler
	Site List	wikipedia
		groups.dcs.st-and.ac.uk/history/biogrpahies/kepler.html
	Task Time	4 minutes, 21 seconds
	What were you trying to find?	I think it's called an autobiography, basically all about Johannes Kepler. Basically sum up him.
	Were you able to find the information you needed?	Yeah
	What keywords or search items did you use?	single search
	What kind of sites did you expect to find?	
	Any other searches you may have done?	I probably could have just typed in his name or all about him. I probably would have got the same information if I just did his name. Wikipedia came up first…but it probably would have given me more details in general.
	Difficulty Rating	1.5
	Mental Effort Rating	2.5
	Performance Satisfaction	5

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Student Participant 27 – Medium to High Literacy		
Task 1	**Keyword Searches**	why isn't pluto a planet anymore
	Site List	wiseGEEK
		USCB ScienceLine
		Wonderopolis
		seekers
		planets for kids
	Task Time	10 minutes, 9 seconds
	What were you trying to find?	Why do people think pluto isn't a planet anymore
	Were you able to find the information you needed?	yes, I did
	What keywords or search items did you use?	Um, planet and pluto basically
	What kind of sites did you expect to find?	I expected wikipedia and astrology type sites. And that is what I found
	Any other searches you may have done?	When was pluto not considered a planet
	Is there anything that makes you choose one site over another?	I guess I look at the top searches
	Do you like to find as many sources as possible, or fewer sources that are closely related to your topic?	A few sites, because the sites have different information. And that's better for the paper
	Difficulty Rating	2.5
	Mental Effort Rating	4
	Performance Satisfaction	5
Task 2	**Keyword Searches**	mitosis and meiosis venn diagram comparing
	Site List	Pinterest
	Task Time	4 minutes, 1 second
	What were you trying to find?	Trying to find out how mitosis and meiosis are the same
	Were you able to find the information you needed?	yes, I did
	What keywords or search items did you use?	Mitosis and meisos venn diagram comparisons
	What kind of sites did you expect to find?	Science or biology type site, but I went on to pinterest and they had a a lot of charts on it.
	Any other searches you may have done?	comparing and contrasting mitosis and meiosis
	Difficulty Rating	2
	Mental Effort Rating	4
	Performance Satisfaction	5
Task 3	**Keyword Searches**	johannes kepler biological sketch
	Site List	wikipedia
		groups.dcs.st-and.ac.uk/history/biographies/kepler.html
	Task Time	8 minutes, 20 seconds
	What were you trying to find?	I wanted to a backgraound of johannes kepler, just background facts about what he did back in the 1600s
	Were you able to find the information you needed?	I found some interesting stuff that I didn't know
	What keywords or search items did you use?	I looked up Johannes Kepler biographical sketch
	What kind of sites did you expect to find?	I knew it was going to be wikipedia, but I probably thought it was going to be one of those history sites
	Any other searches you may have done?	I probably would have just typed in his name and see what pops up
	Difficulty Rating	5
	Mental Effort Rating	5
	Performance Satisfaction	5

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Student Participant 28 – Low Literacy		
Task 1	**Keyword Searches**	planet pluto
	Site List	space.com
		wikipedia
	Task Time	22 minutes, 33 seconds
	What were you trying to find?	Who discovered Pluto, and the history of pluto
	Were you able to find the information you needed?	Yes, I did
	What keywords or search items did you use?	planet pluto. He used google and…wigga…wigga…I used google, right?
	What kind of sites did you expect to find?	I think it's the wikipledia, I used two websites. Google and wikipledia. I was expecting to find discovery, discovery site. I didn't see it because I went through google, and it was too many information. // He didn't like the first site (he kept calling it google) because it didn't have enough information, so he went to wikipedia and it had all the information he needed.
	Any other searches you may have done?	Like, what the surface in pluto and uh, what's the origins constellation to be the ninth planet from the sun
	Is there anything that makes you choose one site over another?	I always look for the main point.
	Do you like to find as many sources as possible, or fewer sources that are closely related to your topic?	I like different sites, but for me, I just want to focus on the point…on my…assignment. I always go to google and it gives me the right answer, but wikipedia gives me all the information I need. So I like those two sites.
	Difficulty Rating	3
	Mental Effort Rating	4
	Performance Satisfaction	4
Task 2	**Keyword Searches**	explain using diagrams how process of motosis compares to meiosis
		diagram how the porcess of mitosis compares to meiosis
		doctor web
		using diagrams how the process of mitosis compares to meiosis
	Site List	Khan Academy
		MHEducation - Science
		IvyRose.com
		University of Leicester
		Pinterest
	Task Time	29 minutes, 45 seconds
	What were you trying to find?	On this search I was trying to find the difference between meiosis and mitosis. And what's the similarities. And what's in there for the chromosones from the male and the female
	Were you able to find the information you needed?	Yeah, I did. I actually went on yahoo.com because they have nice videos from doctors and stuff. Doctors put their stuff on yahoo. Then I went to google, because google has universities that put stuff there.
	What keywords or search items did you use?	I used the one you gave me, using diagrams how the process of mitosis and meiosis. That was a good thing I just needed to put on the computer and all stuff popped up.
	What kind of sites did you expect to find?	he thought lookany was helpful, but they wanted him to download stuff so he kept moving on.
	Any other searches you may have done?	
	Difficulty Rating	4
	Mental Effort Rating	5
	Performance Satisfaction	5
Task 3	**Keyword Searches**	wekop (wikipedia from drop down)
		geoprah (yahoo)
		johannes kepler
	Site List	wikipedia
		geograph.com
		encyclopedia britannica
	Task Time	15 mintes, 48 seconds

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	What were you trying to find?	I mean I was…I just put his name, because I knew he had a very popular name, so I knew things were going to come up.
	Were you able to find the information you needed?	Yeah
	What keywords or search items did you use?	what he discovered. His name. Where he was born. How many things he discovered and what he discovered.
	What kind of sites did you expect to find?	I went to geography, which disappointed me because it showed me buildings and stuff. So I went to wikipedia and encyclopedia because I know they're good sites that will tell me stuff.
	Any other searches you may have done?	No, those were the ones I used….used more about him and Isaac Newton. Like why they become customary about each other…and uh…he worked on the universe. He said God designed for the universe, and I wanted to know more about that.
	Difficulty Rating	5
	Mental Effort Rating	5
	Performance Satisfaction	3

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Student Participant 29 – Low Literacy		
Task 1	**Keyword Searches**	this history of pluto
		this history of pluto as a planet
		why is pluto not a planet?
	Site List	Nine Planets
		History.com
		space.com (…as a planet)
		BBC.com (why is pluto….)
		nasa.gov (why is pluto…)
		solarsystem.nasa.gov
	Task Time	15 minutes
	What were you trying to find?	Basically, just look up articles about what pluto is and stuff
	Were you able to find the information you needed?	yeah
	What keywords or search items did you use?	First, I was looking for history of pluto. And second, I wanted ot know the reason pluto wasn't a planet anymore.
	What kind of sites did you expect to find?	Space and astronomy sites, because they would explain more why it wasn't a planet anymore. I saw wikipedia but I kinda don't trust that because people can change that so it's a big no. // I also go on news sites, too sometimes.
	Any other searches you may have done?	Compared pluto to planets, I would compare the planet that was found right after pluto…eres, I would compare those two planets. Searched stuff on the history of the solar system, too.
	Is there anything that makes you choose one site over another?	I've been using google for a long time. I have been on bing and yahoo before. I hardly go on those, as I don't have an account. // I thought nasa would have more information than other sites.
	Do you like to find as many sources as possible, or fewer sources that are closely related to your topic?	Personal opinion, a few sites. Most sites, if I keep going on, I might find the wrong site. I can't take that chance.
	Difficulty Rating	1
	Mental Effort Rating	1.5
	Performance Satisfaction	5
Task 2	**Keyword Searches**	mitosis vs. meisos
		the difference between mitosis and meiosis
		meaning of mitosis
		meaning of meisos
		similarities between mitosis and meiosis
	Site List	McGraw Hill Science
		biologyexams4u.com (the difference…)
		RSR - dictionary.com (meaning…)
		biology-online.org (meaning…both)
		RSR - education.seattlepi.com
	Task Time	7 mintes, 40 seconds
	What were you trying to find?	Looking at what is mitosis and meiosis, what they basically mean. Then I searched stuff like what differences they both have. So I could tell them apart. Then last thing was what was the same about them.
	Were you able to find the information you needed?	Yeah
	What keywords or search items did you use?	
	What kind of sites did you expect to find?	Educational. Mostly biology and science sites.
	Any other searches you may have done?	Like the process of how they divide. Yeah, that's what I'm curious about.
	Difficulty Rating	2
	Mental Effort Rating	1
	Performance Satisfaction	5
Task 3	**Keyword Searches**	history of johannes kepler
		what did johannes kepler discover
	Site List	Britannica
		space.com (…discover)
	Task Time	8 minutes, 47 seconds
	What were you trying to find?	Mostly, like a biography of him. Like learn the history of him

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	Were you able to find the information you needed?	Yep
	What keywords or search items did you use?	Bascially, I searched the history of him and what he discovered during his research phase
	What kind of sites did you expect to find?	Mostly like um, biography sites, I didn't expect to find a space website
	Any other searches you may have done?	Mostly, like the stuff that he researched. Like the laws that he found for the planets
	Difficulty Rating	1
	Mental Effort Rating	1
	Performance Satisfaction	5

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Student Participant 30 – Low Literacy		
Task 1	**Keyword Searches**	history of pluto
		why isn't pluto a planet
	Site List	nine planets (RSR)
		loc.gov (couldn't be displayed)
		Nasa (solar systems)
		nasa.gov
	Task Time	9 minutes, 5 seconds
	What were you trying to find?	I was trying to find when was pluto discovered at first and why it was considered a planet at the time, how long it was considered a planet, and find out when it wasn't considered a planet anymore and why
	Were you able to find the information you needed?	yeah
	What keywords or search items did you use?	history of pluto and why isn't pluto a planet
	What kind of sites did you expect to find?	I already knew I was going to look at nasa, that's where you go to find space stuff.
	Any other searches you may have done?	maybe like search for like, there are always people who will believe pluto is planet. So look at the other side, the counter argument for why pluto would still be a planet.
	Is there anything that makes you choose one site over another?	I mostly like to use that have .gov because they're usually more reliable. The government is putting that information out to the public and they're usually like a reliable source. Specifically, NASA because they're the ones going out into space.
	Do you like to find as many sources as possible, or fewer sources that are closely related to your topic?	To match what I'm looking for. There's no point if you have 10 sources, if they don't help you support your claim.
	Difficulty Rating	1
	Mental Effort Rating	2
	Performance Satisfaction	4
Task 2	**Keyword Searches**	mitosis vs. meiosis (used dropdown)
		mitosis vs. meiosis diagram
	Site List	khan academy
		young genome
		university of leicester
	Task Time	4 minutes, 4 seconds
	What were you trying to find?	I was trying to look for pictures of mitosis and meiosis and kind of compare them
	Were you able to find the information you needed?	yes
	What keywords or search items did you use?	Um. First I used mitosis vs. meiosis, but because I was looking specifically for a picture, a diagram, I searched for mitosis vs. meiosis diagram
	What kind of sites did you expect to find?	Um, mostly like school sites. Um yeah.
	Any other searches you may have done?	I could have search pictures of mitosis and meiosis.
	Difficulty Rating	1
	Mental Effort Rating	1
	Performance Satisfaction	5
Task 3	**Keyword Searches**	johannes kepler biography
	Site List	Nasa (RSR)
		space.com
		local histories
	Task Time	9 minutes, 26 seconds
	What were you trying to find?	I was trying to find … um … sort of like a summary of the life of johannes kepler
	Were you able to find the information you needed?	yes
	What keywords or search items did you use?	I think I just searched…I'm trying to go back… johannes kepler biography
	What kind of sites did you expect to find?	I wasn't too sure, mainly because I didn't know who he was
	Any other searches you may have done?	the story of johannes kepler, timeline of his life
	Difficulty Rating	3

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	Mental Effort Rating	3
	Performance Satisfaction	5

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Student Participant 31 – Low Literacy		
Task 1	**Keyword Searches**	history of pluto
	Site List	history.com
	Task Time	8 minutes, 34 seconds
	What were you trying to find?	I was pretty much trying to figure out the history of Pluto..
	Were you able to find the information you needed?	Yes
	What keywords or search items did you use?	history of pluto
	What kind of sites did you expect to find?	I was thinking like space.com or NASA, but I ended up finding everything on history.com
	Any other searches you may have done?	It depends on how big the assignment is, because a 10 page paper I would have to do more research, if it's 1 page or like a paragraph or something, I think I could use just this one site.
	Is there anything that makes you choose one site over another?	I will usually go through and look at the title of it first, to see if it's on that specific topic. Then I will read the small description under the link to see if it has any information that could be relavant.
	Do you like to find as many sources as possible, or fewer sources that are closely related to your topic?	Um. I think it would be better to have a lot of websites to go through, as long as they stay around the same topic.
	Difficulty Rating	2
	Mental Effort Rating	2 or 3
	Performance Satisfaction	4
Task 2	**Keyword Searches**	mitosis compared to meiosis
	Site List	missed one image he looked at.
		shutterstock image
		bioninja image (kirbies!)
		YouTube still frame.
		Biology Stack exchange image
		Socratic. Org (answers questions posed by users)
		MyTutor.com
		Biology Exams 4 u (took too long to load)
	Task Time	6 minutes, 54 seconds
	What were you trying to find?	the difference between meiosis and mitosis.
	Were you able to find the information you needed?	yeah
	What keywords or search items did you use?	Mitosis compared to meiosis
	What kind of sites did you expect to find?	Um. Like biology sites, like um….(looks all over screen)
	Any other searches you may have done?	Um, I did uh main difference between meiosis and mitosis
	Difficulty Rating	2
	Mental Effort Rating	2
	Performance Satisfaction	4
Task 3	**Keyword Searches**	johannes kepler
	Site List	Brittanica
		NASA
		Famous Scientists
	Task Time	22 minutes, 12 seconds
	What were you trying to find?	Key points about Kepler's life
	Were you able to find the information you needed?	Yes
	What keywords or search items did you use?	I think I just used his anem
	What kind of sites did you expect to find?	I expected like, um, I didn't know who he was, but I kinda expected like history.com and like um…nasa
	Any other searches you may have done?	I could have search, uh, who is johannes kepler, or johannes kepler's life, or uh his achievements orsomething
	Difficulty Rating	3
	Mental Effort Rating	4
	Performance Satisfaction	4

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Student Participant 32 – Low Literacy		
Task 1	**Keyword Searches**	pluto (didn't engage any sites)
		history of pluto
		When was pluto no longer considered a planet
		history of pluto (second time)
	Site List	Nine planets
		RSR results were read for third rpompt.
		How stuff works (when…)
		Wikipedia
		Universe Today
		Space.com (history…second)
	Task Time	13 mintes, 20 seconds
	What were you trying to find?	Pretty much facts bout Pluto. Like when it was discovered and then when it was classified as no longer being a planet.
	Were you able to find the information you needed?	Yeah
	What keywords or search items did you use?	Uh…history of pluto, then on the pages I used things like "number of" because I knew it would help me find the number of moons, or "2006" because I knew it was no longer a planet in 2006.
	What kind of sites did you expect to find?	Sites that end in .org
	Any other searches you may have done?	No.
	Is there anything that makes you choose one site over another?	If it doesn't say "wikipedia" I'll click on it. Or if it says history or something related to the genre I'ms earching for. Since I'm looking at pulto, if it has something to do with space.
	Do you like to find as many sources as possible, or fewer sources that are closely related to your topic?	It depends on the assignemtn, so a history project like pluto, I would try to get a few sources, around the same information. But if it's an assignment where you argue something, I would get more so I could seem to have perspective.
	Difficulty Rating	2.651
	Mental Effort Rating	1
	Performance Satisfaction	4.8
Task 2	**Keyword Searches**	definition of mitosis
		difference between mitosis and meiosis
		Meiosis sexual reproduction
		similarities between mitosis and meiosis.
	Site List	merriam-webster.com (definition)
		Microbiologyinfo.com
		quizlet.com (similiarities)
		SeattlePI (similarities)
		biologydiscussion.com (similarities)
		sciencing.org
	Task Time	10 minutes, 58 seconds
	What were you trying to find?	The similiarities that mitosis and meiosis share, and also differences
	Were you able to find the information you needed?	Yeah
	What keywords or search items did you use?	Um. Similiarities between mitosis and meiosis, and then idfferences between them.
	What kind of sites did you expect to find?	Um. Sites that looked like biology and science.
	Any other searches you may have done?	I know I searched the definition of mitosis and meiosis.
	Difficulty Rating	1
	Mental Effort Rating	1
	Performance Satisfaction	4
Task 3	**Keyword Searches**	john kepler
		biographical sketch template
		Keplers law
		what is a biogrpahical sketch (what is spelled whay)
		biographical sketch for dummies
		what is a biographical sketch for students
		john kepler (2nd time)
		John kepler biographical sketch

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	Site List	Nasa (back on john kepler search)
		RSR for what is biographical sketch
		Ended up on dummies.com (was about a site, not how to)
		University of St Andrews
		Space.com
	Task Time	11 mintes, 24 seconds
	What were you trying to find?	Pretty much um information about the career…um..of johannes kepler. Like a biography on him.
	Were you able to find the information you needed?	Yes
	What keywords or search items did you use?	Um. Well, I know he had a lot of science, so I looked up keplers law so I could learn about the law he made. Just pretty much (I had to look up biographical sketch) and then I look up john kepler.
	What kind of sites did you expect to find?	Um. Anything relating to space and science. I knew John Kepler is a scientist.
	Any other searches you may have done?	Um. Probably just a more indepth search of his career and stuff…and who he was
	Difficulty Rating	2
	Mental Effort Rating	3
	Performance Satisfaction	4

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Student Participant 33 – Medium to High Literacy		
Task 1	**Keyword Searches**	ub login portal
		myub login
		UB Library: History of Pluto
	Site List	(once on google: Wikipedia)
	Task Time	8 minutes, 27 seconds
	What were you trying to find?	Pretty much pluto and I was asked to find pluto and pretty much it came to be part of the solar system
	Were you able to find the information you needed?	partially, not a 100%
	What keywords or search items did you use?	history of pluto, to be truth I just typed in history of pluto.
	What kind of sites did you expect to find?	I'd usually find probably links to other websites, but it's like it has wikipedia as the first thing I see, usually I wouldn't expect google to have it's very own answer. So I would scroll down to see it has links to other websites.
	Any other searches you may have done?	Um, yes. I probably would have tried back at the library again, I mean if I failed, I would probably stuck with google or bing.
	Is there anything that makes you choose one site over another?	For starters, I look at the heading of what the link may have and if I find anythign most convincing than I will visit that one first. The content is what makes me decide which will help me the most.
	Do you like to find as many sources as possible, or fewer sources that are closely related to your topic?	Honestly, I would find a few good, most relates to the topic.
	Difficulty Rating	3.5
	Mental Effort Rating	4
	Performance Satisfaction	3
Task 2	**Keyword Searches**	internet explorer
		firefox
		the process of mitosis and meiosis
	Site List	sparknotes.com
	Task Time	6 mintes, 30 seconds
	What were you trying to find?	Um, pretty much the processes of mitosis and meiosis and how they were alike and different.
	Were you able to find the information you needed?	Yes.
	What keywords or search items did you use?	I used the process of mitosis and meiosis, and suprisingly so the link I clicked on gave me both
	What kind of sites did you expect to find?	Um, pretty much some websites related to science.
	Any other searches you may have done?	I am pretty much satisified with what I found.
	Difficulty Rating	2
	Mental Effort Rating	2
	Performance Satisfaction	5
Task 3	**Keyword Searches**	johan kepler > yohan kepler
		johann kepler
		johannes kepler achievements earch.
	Site List	wikipedia
		University of St Andrews
		leonardo-newtonic.com (achievements)
	Task Time	5 minutes, 26 seconds
	What were you trying to find?	I was trying to find johanens kepler's achievements and what he was thorughout his life
	Were you able to find the information you needed?	yes
	What keywords or search items did you use?	First I just typed up his name, and then after I typed up his name, I decided to add in his achievements
	What kind of sites did you expect to find?	Honestly, I thought I was going to find modern or up-to-date, but acutally it was pretty historical.
	Any other searches you may have done?	I was going to do contributions too
	Difficulty Rating	4
	Mental Effort Rating	5
	Performance Satisfaction	3

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Student Participant 34 – Medium to High Literacy		
Task 1	**Keyword Searches**	how is pluto not classified as a planet AND planets
	Site List	Encyclopedia Britannica
		National Geographic
	Task Time	6 minutes, 47 seconds
	What were you trying to find?	I was trying to find out why pluto was not considered a planet
	Were you able to find the information you needed?	yes, I was
	What keywords or search items did you use?	Specifically, I used a boolean terms, such as "and" in this to search for how is pluto not classified as a planet and planets. It's a technique that I learned to allow to include or exclude search items that you want.
	What kind of sites did you expect to find?	Um, I really expected to find Wikipedia as one of the top sources there, a lot of sources that get a lot of clicks.
	Any other searches you may have done?	Yes, I probalby would have changed up my search statement a little bit more and see if I could find more concrete evidence of why pluto isn't a planet.
	Is there anything that makes you choose one site over another?	Depending on the reliability of the website, such as wikipedia can be reliable and in others it wouldn't. I would think in this instance wikipedia would not be reliable. But a science or encyclopedia would be more reliable.
	Do you like to find as many sources as possible, or fewer sources that are closely related to your topic?	A few resources that are closely related to the topic, having a lot of resources means you found sources that doesn't necessarily pertain to what you're looking for. You'll look up something and just go for the first couple of sites, instead of narrowing down to sources that answer the quetion and provide evidence.
	Difficulty Rating	2
	Mental Effort Rating	3
	Performance Satisfaction	3
Task 2	**Keyword Searches**	how mitosis compares to meiosis AND diagrams
		how does mitoses and meios differ AND diagrams
	Site List	Lancaster K12 (compare)
		Nature (differ)
		Biology wise (differ)
	Task Time	6 minutes
	What were you trying to find?	I was trying to find the difference between mitosis and meiosis.
	Were you able to find the information you needed?	Yes, I was able to find what I was looking for
	What keywords or search items did you use?	Similar to the previous search, I sort of did the same thing, and booleaned for diagrams.
	What kind of sites did you expect to find?	Um, either biology, scientific, or educational websites.
	Any other searches you may have done?	Uh, no I don't think so.
	Difficulty Rating	2
	Mental Effort Rating	1
	Performance Satisfaction	3
Task 3	**Keyword Searches**	johannes kepler AND biography
	Site List	Encyclopedia.com
	Task Time	2 minutes, 56 seconds
	What were you trying to find?	Biographical outline for Johannes Kepler
	Were you able to find the information you needed?	Yes, I was
	What keywords or search items did you use?	Particularly, for this search, I search Johannes Kepler and Biography
	What kind of sites did you expect to find?	Most of the websites I expected to find were, I actually didn't expect to find anything, as I didn't know anything about him.
	Any other searches you may have done?	Yes, I would have done more
	Difficulty Rating	1
	Mental Effort Rating	2
	Performance Satisfaction	2

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Non-Student Participant 01		
Task 1	**Keyword Searches**	pluto
		pluto moons
		The names of pluto's 5 moons
	Site List	wikipedia
		nasa.gov
		space facts
		wikipedia (moons)
		space.com (names…5 moons)
	Task Time	11 minutes, 50 seconds
	What were you trying to find?	The major facts about pluto: How the distance from sun, how many moons it has, their names, who found pluto. The year it was found. What year the moons were found. Just the basic general facts.
	Were you able to find the information you needed?	Yes
	What kind of sites did you expect to find?	Nasa, a lot of wikipedia (it always pops up)
	Is there anything that makes you choose one site over another?	When I can read what is going to be on the site, I will skim through to see…because most likely that is going to be the topic I see when I pull up the site. So I read that to know if it's going to be the right information without going to deep.
	Difficulty Rating	1
	Mental Effort Rating	1
	Performance Satisfaction	4
Task 2	**Keyword Searches**	mitosis
		mitosis vs. meiosis
		mitosis and meiosis similarities
		similarities and differences between mitosis and meiosis
	Site List	Biology.Arizona.edu (RSR read it.)
		People who also ask (yourgenome.com; wikipedia)
		yourgenome (RSR)
		People who also ask (boundless.com; highered.mheducation; shmoop.com)
		pbs.org (nova vs)
	Task Time	7 minutes, 23 seconds
	What were you trying to find?	I was trying to find their similarities and their differences and how they operate together. Or do they even operate together. Or could they. Since I didn't know what they were, I was trying to figure out what they were first. That was my goal
	Were you able to find the information you needed?	Yes, I was.
	What kind of sites did you expect to find?	Um, more help stuff. Diagrams, pictures. Because pictures and cells, you can't really picture the cell without the picture
	Difficulty Rating	2
	Mental Effort Rating	3
	Performance Satisfaction	4.5
Task 3	**Keyword Searches**	biography sketch of johannes kepler
		biographical sketch of johannes kepler
		johannes kepler inventions
		what did johannes kepler invent
	Site List	wikipedia
		People Also ask (who is…famouspeoplecom; what did kepler study, britannica; …have to do with astronomy, calstatela.edu; born…education, famousscientists.org)
		Local Histories (timed out before ever loading)
		People also aske (…keplarsdiscovery; famous people)
		people also ask (discover about the universe,
		visionlaunch.com (…invent)
	Task Time	17 minutes, 28 seconds
	What were you trying to find?	Find out who he was. Once I found out who he was, I found out a little information like he invented the telescope. Towards the end I found out htat he did a lot of things, so I went back and looked up more of those. I found out his siblings, his parents, what college he went to. Where he was born and when he died.

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	Were you able to find the information you needed?	Yes
	Difficulty Rating	2
	Mental Effort Rating	2
	Performance Satisfaction	5

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Non-Student Participant 02		
Task 1	**Keyword Searches**	pluto
		why is pluto not a planet
	Site List	(RSR) Nasa
		wonderopolis (why is…)
	Task Time	10 minutes, 30 seconds
	What were you trying to find?	I was looking for, I wanted to know why pluto wasn't consi…a planet anymore. She then told me what she found.
	Were you able to find the information you needed?	
	What kind of sites did you expect to find?	I just thought it would pop up "pluto as a planet"
	Is there anything that makes you choose one site over another?	
	Difficulty Rating	4
	Mental Effort Rating	2
	Performance Satisfaction	4
Task 2	**Keyword Searches**	what the diagrams process of mitosis and meiosis
	Site List	University of Leicester
	Task Time	6 minutes, 52 seconds
	What were you trying to find?	I was trying to see the difference between the cells, and that…
	Were you able to find the information you needed?	Yes
	What kind of sites did you expect to find?	
	Difficulty Rating	3
	Mental Effort Rating	2
	Performance Satisfaction	5
Task 3	**Keyword Searches**	johannes kepler
	Site List	wikipedia
		britannica
	Task Time	3 minutes
	What were you trying to find?	I was trying to find out who he was first of all and then I was trying to find out what he discovered. His three major discovery from the 16th century.
	Were you able to find the information you needed?	I googled his name and I was just reading on him.
	What kind of sites did you expect to find?	
	Difficulty Rating	4
	Mental Effort Rating	2
	Performance Satisfaction	2

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Non-Student Participant 03		
Task 1	**Keyword Searches**	why is puto not a panet no more you tube (failed search)
		why is puto not a panet any more you tube
	Site List	Ask and astronomer: why isn't pluto a planet anymore?
	Task Time	6 minutes, 10 seconds
	What were you trying to find?	Discover why Pluto is not a planet anymore.
	Were you able to find the information you needed?	Discovered as a planet in 1930, before that there were other planets and they decided to name the author planets asteroids. Then those asteroids became dwarf planets. …. They named [pluto] an asteroid or a dwarf planet.
	What kind of sites did you expect to find?	youtube
	Is there anything that makes you choose one site over another?	He chooses youtube over other sites because his reading is not so good, so he likes to listen to them explain things to them.
	Difficulty Rating	4
	Mental Effort Rating	3
	Performance Satisfaction	3
Task 2	**Keyword Searches**	whats the comparesson of mitosis to meiosis you tube
	Site List	Difference between mitosis and meiosis
		What's the Difference Between mitosis and meiosis
		Difference between mitosis and meiosis (shomu's biology)
	Task Time	14 minutes, 30 seconds
	What were you trying to find?	I was seeing the difference between mitosis and meiosis. Mitosis is a asexual organ, it's a mother cell and a daughter cell. Yeah, there is a mother cell and a daughter…no it's two daughter cells. It's tissue, organ, and it forms more cell organs. It forms...the mother cells forms, adn the two daughter cells form new organ cells. And then meiosis it's just a four cells, but it is sexual and it produces offspring and coming from sperms and eggs....sperm and egg cells...and then it come form from animals, plants, and it uh it can break down from dividing two division cells to make up 4 cells which two germ cells and can create 4 gametes.
	Were you able to find the information you needed?	Yeah.
	What kind of sites did you expect to find?	youtube
	Difficulty Rating	5
	Mental Effort Rating	4
	Performance Satisfaction	4
Task 3	**Keyword Searches**	a boi.of johannes kepler you tube
	Site List	johannes kepler biography (cloud biography)
		wikipedia (prompt -you tube)
	Task Time	8 minutes, 23 seconds
	What were you trying to find?	His biography, like his bio, who was he, what was he famous for
	Were you able to find the information you needed?	Yeah, the basis of his fame, I guess you could say
	What kind of sites did you expect to find?	
	Difficulty Rating	2
	Mental Effort Rating	3
	Performance Satisfaction	5

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Non-Student Participant 05		
Task 1	**Keyword Searches**	history on pluto the planet (used drop down for "the planet)
	Site List	wikipedia
	Task Time	6 minutes, 43 seconds
	What were you trying to find?	I was looking for when it was discovered and why did they question why it was a planet, because they found other several objects of similar size in kuiper belt, and in 2005 they named it a dwarf planet.
	Were you able to find the information you needed?	yes
	What kind of sites did you expect to find?	I use google and it came right up. It sent me to wikipedia. (He expected wikipedia)
	Is there anything that makes you choose one site over another?	Chooses where "google sends him"
	Difficulty Rating	1
	Mental Effort Rating	3
	Performance Satisfaction	5
Task 2	**Keyword Searches**	the difference between mitosis and meisos (used drop down to fix spelling error and select his final search)
	Site List	diffen.com
	Task Time	4 minutes, 21 seconds
	What were you trying to find?	The difference between the two mitosis and meisos (mitos and mios) … he then explains them to me.
	Were you able to find the information you needed?	No, I was expecting something else
	What kind of sites did you expect to find?	I thought this was something on atoms.
	Difficulty Rating	1
	Mental Effort Rating	3
	Performance Satisfaction	5
Task 3	**Keyword Searches**	biographic sketch of johannes kepler
	Site List	space.com
	Task Time	3 minutes, 51 seconds
	What were you trying to find?	Some of the things about him, like he was born in the 1600s and he was doing a study on how the um planets orbit the sun.
	Were you able to find the information you needed?	No, I thought it was just going to be a picture.
	What kind of sites did you expect to find?	I wasn't expecting a word, just four or five pictures to choose from
	Difficulty Rating	2
	Mental Effort Rating	3
	Performance Satisfaction	5

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Non-Student Participant 06		
Task 1	**Keyword Searches**	history of pluto as a planet
	Site List	space.com
	Task Time	21 minutes, 23 seconds
	What were you trying to find?	I was trying to find, well, I found the brief history of Pluto being a planet to, um, its supposedly not being a planet. But, um, I was finished with finding the situation with finding it. … I actually learned a lot.
	Were you able to find the information you needed?	Yeah, I actually learned a lot.
	What kind of sites did you expect to find?	Um, I went to, um, the brief history of pluto viewing: from its discovery
	Is there anything that makes you choose one site over another?	Um, I just know what I'm looking for. And whatever I'm looking for is, whichever bold letters give me the thing I'm looking for is basically what I go off of. Sometimes, it's wrong, sometimes it don't. And if it is wrong, I'll go back and search for something different. It if isn't wrong, I'll just do my research on that one.
	Difficulty Rating	2
	Mental Effort Rating	5
	Performance Satisfaction	6
Task 2	**Keyword Searches**	the difference between mitosis to meiosis
	Site List	diffen.com
	Task Time	21 minutes, 8 seconds
	What were you trying to find?	The difference between meiosis and mitosis.
	Were you able to find the information you needed?	Yes
	What kind of sites did you expect to find?	
	Difficulty Rating	2
	Mental Effort Rating	5
	Performance Satisfaction	5
Task 3	**Keyword Searches**	johannes kepler (used drop down)
	Site List	Notable Biographies (Encylcopedia of World Biography)
	Task Time	13 minutes, 13 seconds
	What were you trying to find?	A biography on Johannes Kepler. So far I found where he was born where he died….etc, etc, etc
	Were you able to find the information you needed?	Yeah
	What kind of sites did you expect to find?	
	Difficulty Rating	2
	Mental Effort Rating	5
	Performance Satisfaction	3

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Participant Searches by Site

Participant ID	Literacy Rating	Google Site Search	Google URL Search	Yahoo Site Search	Yahoo URL Search	Onsite Search	Bing Search	Yahoo URL to Find Google	Total Searches
SP 10	M-H	3			2				5
SP 11	M-H	3							3
SP 12	M-H	2		1	3				6
SP 13	M-H	5		1	1			2	9
SP 14	L	1			5	3		1	10
SP 15	M-H	1		2	3			1	7
SP 16	L	14		2	7	1			24
SP 17	L	4						1	5
SP 18	L	4						1	5
SP 19	M-H			2	18				20
SP 20	M-H	10			2	1		3	16
SP 26	L	2		1	2				5
SP 27	M-H			4					4
SP 28	L	3		1	3	1		3	11
SP 29	L	10							10
SP 30	L	5							5
SP 31	L	1	4						5
SP 32	L	7	9			2			18
SP 33	M-H	7	2			5			14
SP 34	M-H		4						4
Student Totals		**82**	**19**	**14**	**46**	**13**	**0**	**12**	**186**
A01	L	11						3	14
A02	L	4						2	6
A03	L			1	4				5
A05	L	2					1	1	4
A06	L	3							3
Adult Totals		**20**	**0**	**1**	**4**	**0**	**1**	**6**	**32**

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Participant Search Habits

Participant ID	Literacy Rating	Used Dropdown Suggestion	Read Featured Snippet	Clicked Featured Snippet	Read Yahoo Answer	Read Content	Scanned Content
10	M-H		1	1		5	3
11	M-H	3	1			6	4
12	M-H	1	1		1	4	4
13	M-H	2	1			6	4
14	L			1		3	2
15	M-H	1				6	5
16	L	5			1	6	8
17	L	3	1			3	2
18	L	2	1	1		6	6
19	M-H					8	9
20	M-H	3	1	1		5	3
26	L		1			5	5
27	M-H	2				5	2
28	L	2				8	4
29	L	10	1			5	6
30	L	2	1	1		6	5
31	L		1	1		6	4
32	L	2	1			7	10
33	M-H	3	1			5	8
34	M-H					2	5
Student Totals		**41**	**13**	**6**	**2**	**107**	**99**
A01	L	4	1			7	2
A02	L	2	1			2	2
A03	L					1	0
A05	L	2	1	1		3	1
A06	L	2				3	0
Adult Totals		**10**	**3**	**1**	**0**	**16**	**5**

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Appendix G: Card Sort Results

The following tables represent the categorization of 4 outside raters on search types.

Student Task 1 Search Prompts

Search Prompt	Simple Search	Topic + Focus Search	Phrase Searches	Advanced (Boolean) Searches	Questions
all about the history of pluto			4		
birth and death of pluto		3	1		
clyde tobaugh	4				
definition of a planet		2	1		1
history behind pluto		4			
history of pluto		1	3		
how is pluto not a planet?					4
How is pluto not classified as a planet AND planet				3	1
how was pluto discovered?					4
is pluto still a planet					4
Kuiper belt	4				
nasa	4				
paul rincon	4				
percival lowell	4				
planet definition	1	3			
planet pluto	4				
pluto	4				
pluto 2016 planet?	1	2	1		
pluto as a planet		4			
pluto history		4			
pluto no longer a planet			3	1	
pluto not a planet		4			
pluto planet	4				
pluto planet facts		4			
pluto research	3	1			
the history of pluto as a planet?			4		
what is a dwarf planet					4
when was pluto no longer considered a planet					4
why did pluto get demoted					4
Why is pluto not a planet anymore?					4

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Student Task 2 Search Prompts

Search Prompt	Simple Search	Topic + Focus Search	Phrase Searches	Advanced (Boolean) Searches	Questions
definition of mitosis	1		2		1
diagram how the process of mitosis compares to meiosis			1	3	
diagram of mitosis		2	2		
diagram of mitosis and meiosis		2		2	
diploid and haploid definition		3		1	
doctor web	4				
explain using diagrams how process of mitosis compares to meisos			1	3	
firefox	3	1			
haploid definition	3	1			
homologous	4				
how does mitoses and meiosis differ AND diagrams				2	2
how mitosis compares to meiosis AND diagrams				4	
internet explorer	3	1			
meaning of meiosis	1		2		1
meaning of mitosis	1		2		1
meiosis	4				
meiosis compared to mitosis		4			
meiosis definition	3		1		
meiosis diagram	3		1		
meiosis sexual reproduction		4			
meiotic division	3		1		
meosis vs. mitosis		4			
mitosis	4				
mitosis and meiosis		3		1	
mitosis and meiosis venn diagram comparing			1	3	
mitosis compared to meiosis		4			
mitosis diagram	2	1	1		
mitosis phasees	2	1	1		
mitosis process	2	1	1		
mitosis stages	2	1	1		
mitosis vs meiosis		4			
mitosis vs. meiosis diagram		3		1	
process of meiosis	1		3		
process of mitosis and meiosis		3		1	
similarities between mitosis and meiosis		1	3		
somatic cells	4				
stages of mitosis		1	3		
steps of mitosis		1	3		
the difference between mitosis and meiosis		3		1	
using a diagram compare and contrast mitosis and meiosis				4	
using diagrams how the process of mitosis compares to meiosis			1	3	
what is crrossing over?					4
what is meiosis?					4

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Student Task 3 Search Prompts

Search Prompt	Simple Search	Topic + Focus Search	Phrase Searches	Advanced (Boolean) Searches	Questions
bio sketch	4				
biographical on johannes kepler		1	3		
biographical sketch	4				
biographical sketch for dummies		1	3		
biographical sketch of johannes kepler		3	1		
biographical sketch template		4			
biography of johannes kepler		1	3		
geograph	4				
history of johannes kepler		1	3		
johan kepler	4				
johann kepler	4				
johannes kepler	4				
johannes kepler achievement search		4			
johannes kepler achievements		4			
johannes kepler AND biography		1		3	
johannes kepler biographical sketch		4			
johannes kepler biography		4			
johannes kepler impact		4			
johannes kepler theory		4			
johannes kepler timeline		4			
john kepler	4				
john kepler biographical sketch		4			
keplers law	4				
laws of planetary motion		1	3		
what did johannes kepler discover					4
what is a biographical sketch					4
what is a biographical sketch for students					4
wikipedia	4				

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Non-Student Search Prompts

Search Prompt	Simple Search	Topic + Focus Search	Phrase Searches	Advanced (Boolean) Searches	Questions
pluto	4				
pluto moons	3	1			
The names of pluto's 5 moons			3		1
Why is pluto not a planet					4
why is puto not a panet no more you tube				1	3
why is puto not a panet any more you tube					4
history on pluto the planet		2	2		
history of pluto as a planet		1	3		
mitosis	4				
mitosis vs. meiosis	1	3			
mitosis and meiosis similarities		3		1	
similarities and differences between mitosis and meiosis				4	
what the diagrams process of mitosis and meiosis				1	3
whats the comparesson of mitosis to meiosis you tube					4
the difference between mitosis to meiosis			1	3	
biography sketch of johannes kepler		2	2		
biographical sketch of johannes kepler		1	3		
johannes kepler inventions		4			
what did johannes kepler invent					4
johannes kepler	4				
a boi.of johannes kepler you tube		1	3		
biographic sketch of johannes kepler		2	2		

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