

The Internet Search Strategies of Successful College Students

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Abstract

Finding credible information online is an important 21st century literacy skill, yet many young people struggle with online information-seeking. In this article, we analyze a transcript of a focus group conversation with college students in a Science Communication course at an elite university in the United States. We asked the students to discuss what they had been taught in secondary schools about searching the Internet for information as well as what they actually did when looking for information online. Using discourse analysis, we analyzed the transcript and identified six “rules” the students used for finding information online, rules that were quite different from the ones they had been taught formally in schools. We conclude with recommendations for teaching Internet searching in more nuanced ways in order to prepare all students for an information-dense future.

Keywords: Internet search; digital literacy; digital skills; discourse analysis

In the fall of 2013, we conducted a focus group in a Science Communication course at a highly selective university in the United States. Our goal was to understand how the students in this class—all of them extremely accomplished by school standards—thought about looking for and assessing information online, especially information about science. Most of these college students had grown up in the age of the Internet and had obviously learned to navigate the information-seeking requirements of school. We hoped our conversation with them could inform our work with secondary students and their teachers.

For several years prior to this focus group, we had been concerned by what we saw in the secondary classrooms where we worked as researchers and professional development providers. In some contexts, students had trouble getting access to the Internet during the school day: the number of computers was limited and/or so many websites were blocked that research was difficult. Even in schools where access was not a problem, both students and their teachers had difficulty talking about and finding credible information online. Many teachers and students fell back on simplistic rules to judge credibility: don't use Wikipedia, for example, or always go to dot edu websites (see Kohnen, in press). Stymied by these rules and without knowledge of other credible sources of information, we witnessed students struggling to satisfy their information-seeking needs.

Our goal in the focus group was to unearth the actual Internet search habits of these successful college students and to compare their online search strategies to what they had been taught in secondary school and to what we had observed in secondary classrooms. The disparities were striking.

Using discourse analysis (Gee, 2005), in this paper we will examine how the students and researcher co-constructed rules for searching the Internet that were more nuanced or in direct contrast to the rules they remembered being taught in school. We conclude with implications for teaching information-seeking as a complex and critical literacy skill.

Literature Review

As of 2015, the Pew Research Center reported that 84% of U.S. adults use the Internet; the rate is 95% for college graduates. The Internet has become society's collective memory (Sparrow, Liu, & Wegner, 2011), yet the advantage of having information available through nearly constant access to the Internet is negated if individuals cannot efficiently sift through and make use of that information. The sheer quantity of available information has led to a "division of cognitive labor" (Thomm & Bromme, 2012) "requiring everybody to rely on specialized experts and their expertise" (p. 207). However, seeking, accessing, and understanding credible sources of information online presents challenges; even young people, often considered "digital natives," are not uniformly skilled Internet users (Boyd, 2014; Eynon & Geniets, 2016; Stanford History Education Group, 2016). Individuals often access multiple, sometimes conflicting, sources of information online in an attempt to solve a problem or learn about a topic; those with limited prior knowledge may not even recognize the contradictions in the information they read (Braten, Stromso, & Salmeron, 2011), even though "multiple document comprehension" is considered a "prerequisite of digital literacy" (Goldman & Scardamalia, 2013, p. 255).

Therefore, it is no surprise that finding and evaluating information has been identified as a 21st Century work skill. As the Partnership for 21st Century Learning states:

Today we live in a technology and media-suffused environment with: 1) access to an abundance of information, 2) rapid changes in technology tools, and 3) the ability to collaborate and make individual contributions on an unprecedented scale. To be effective in the 21st century, citizens and workers must be able to create, evaluate, and effectively utilize information, media, and technology.

Despite this goal, students at all age levels have been shown to have particular difficulty navigating the Internet landscape (Brand-Gruwel, Wopereis, & Walraven, 2009; MaKinster, Beghetto, & Plucker, 2002; Walraven, Brand-Gruwel, & Boshuizen, 2008), even those who express confidence in their ability to do so. Students report using the Internet regularly as a source of information, including for academic assignments, because it is deemed “easy” to use (Barker & Julien, 2012). However, students struggle to assess the credibility and accuracy of online information (Brem, Russell, & Weems, 2001; Goldman & Scardamalia, 2013) and often make judgments about how relevant a source is based on how easy it is to access (Heinström, 2006) or how often a key word appears (Holman, 2011). Even college students, who tell researchers that credibility is an important factor in online research, privilege easy-to-find sources over credible ones (Rieh & Hilligoss, 2008). This is perhaps the most challenging for non-experts, including students, when they navigate rapidly changing Science, Technology, Engineering, and Mathematics (STEM) fields (Aikenhead, Orpowood, & Fensham, 2011; Bromme, 2005; Bromme, Kienhues, & Porsch, 2009; Seethaler, 2009).

When students are asked to judge the credibility of sources, they often engage in “source evaluation” rather than “text evaluation” (Thomm & Bromme, 2012), making credibility judgments based on such factors as domain name and web design rather than the content of the source or the relevance of the information to the task at hand (Barker and Julien, 2012;

Eysenbach, 2008; Holman, 2011; Warnick, 2004). Students show little awareness of the difference between search engines and databases and the different search strategies that each requires (Holman, 2011); young people describe themselves as developing their own search strategies through trial and error (Head & Eisenberg, 2009). Once they find source, their reading habits have been described by the University College of London's CIBER project as "horizontal information seeking" or skimming quickly and moving on, often clicking hyperlinks along the way: "this horizontal seeking does not always involve a systematic approach to searching for information; rather students almost accidentally come across information and use what they immediately find" (Holman, 2011, p. 20).

Student search strategies may be due in part to the way schools have approached research in general and the Internet in particular. Goldman and Scardamalia (2013) found that most school assignments require students to operate in "belief mode" (tasks where previous research is something to be learned) rather than "knowledge creation" (tasks where previous research is something to be built upon). To complete "belief mode" tasks, students may only need to find the "correct" information, regardless of source; in contrast, knowledge creation tasks require the "constructive use of authoritative sources" (p. 264) as part of building new knowledge. Yet understanding which sources may be "authoritative" is a challenge for students when their access to the Internet is limited. In a 2012 Pew survey of U.S. Advanced Placement and National Writing Project teachers, 97% of teachers surveyed worked in an environment where Internet filters were in place (Purcell et al., 2012). For "digitally excluded" youth, access outside of schools is also problematic (Eynon & Geniets, 2016).

In summary, secondary schools are quite different from the "real world" of searching for information, a world with no filters and where information sought is often needed for building

knowledge or making decisions. As students leave secondary schools and move into college and careers, they are often ill-prepared for the information-seeking challenges that await. Despite this lack of preparation, many students do figure out how to meet their information-seeking needs in college. In this focus group, we sought to understand how.

Methods

Data Source and Context

This analysis is based on an excerpt of a focus group discussion with 14 students at a U.S. university on the topic of Internet searching in general and source evaluation in particular. The university is regarded as one of the most academically rigorous in the U.S., regularly appearing on “top ten” lists (e.g., *U.S. News & World Report’s* National University rankings) and having one of the lowest acceptance rates for undergraduate admissions. The focus group was conducted in the fall of 2013; students were all enrolled in a Science Communication course for the purpose of fulfilling a humanities requirement (most, though not all, students were majoring in a STEM field). The focus group was facilitated by Wendy Saul, whom the students did not know prior to the classroom meeting.

Data Analysis

The recording was transcribed by a third-party service. Once the transcription was complete, we listened to the audio and corrected basic content errors in the transcript. The full recording was 66 minutes long; the first 5 minutes included introductory remarks by Saul followed by warm up conversations of pairs of students. At approximately the 7-minute mark, Saul asked the group to share their thinking with her. The next 23 minutes form the basis of this paper and include back and forth exchanges with Saul about Internet searching, rules of credibility taught by schools, and sources of science information. At the 35-minute mark, the

discussion turned to concepts of writing, good writing, and writing assignments, which are outside the scope of this paper.

We chose to use discourse analysis (Gee, 2005) in order to understand how meaning was constructed collaboratively by Saul and the students in this conversation. We began by dividing the transcript into 454 “idealized” lines (Gee, 2005), lines with one new piece of information. This allowed us to create stanzas according to topic (see Table 1).

Following Gee’s (2005) method of discourse analysis, we next asked the following questions of the transcript: “what identity or identities is this piece of language being used to enact?” “what conversations are relevant to understanding this language?” and “how does intertextuality work in the text?” The students were invited to enact the identity of successful students, “insiders” to a world Saul wanted to understand. Throughout the discussion, the students took up this identity, revealing Internet search strategies and habits that often ran counter to what they had been taught. In this way, the discussion was a “counter-conversation” to the conversations about credibility that we had observed in the secondary schools. The discussion was highly intertextual, assuming shared knowledge of the Internet and various sources, including JSTOR, Wikipedia, Google, blogs.

Table 1
Transcript Macrostructure

Stanza/line numbers	Topic	Representative Excerpt	Summary
I. 1-79	Parents	“I grew up with parents who studied physics in college”	3 vignettes from 3 different students about childhood
II. 80-160	Books and Credibility	“that’s just what’s in a printed textbook, not with journals online”	Errors in textbooks; changes in textbook content over time; teacher/school preference for books over online sources
III. 161-292	Wikipedia	“Wiki will give me the basic intro”	Longest stanza in the transcript; co-constructed by several students, the professor, and Saul; various times

			Wikipedia is used contrasted with teacher/school rules about Wikipedia
IV. 293-413	Dot coms	“there’s information that you can only find on dot com sites”	Dot com information as reliable; the use of multiple sources to corroborate information; teacher preferences for unambiguous rules; bias in all sources
V. 414-454	Blogs	“most fields have at least a core group of respected bloggers who might be professors”	“Good” blogs; blogs written by graduate students

Other than the “Parents” stanza, each of the four stanzas in the transcript consisted of the students and Saul co-constructing ideas about credibility. In each case, the students grappled with a “rule” about credibility that is taught (or implied) in schools. After rereading the transcript several times, we began to see a trend in the discussion. Someone (either a student or Saul) introduced a rule of Internet searching, students commented about the rule and offered their own experiences as examples or counterexamples, and the students generated their own, often quite different, rule. To analyze this pattern, we created a “rules” table (see excerpt, Table 2). The conversation was organic and, as such, didn’t follow the pattern exactly, but creating the table was useful to see the contrast between the rules students had been taught and the students’ own rules of online searching and credibility. Within the table, contributions made by Saul are italicized.

In the remainder of this paper, we will explore the rules that Saul and students co-constructed under each of these topics.

Table 2
Rules of the Internet Excerpt

Stanza	Outsider rule	Student commentary	Student behavior	Student-created rule
II. Books	“If you see a typo or you see an error in the	“If you don’t know it well enough to find an error in their	“We found a lot of errors in one of the company’s books and we joked that there might have been	Checking information is important for both books and online

	information” (90-91)	information, then you wouldn’t really know” (93-94)	just as many errors in the bio book that this company made, but we would have never known because we didn’t have the means to check that book” (121-123)	sources (both are likely to be flawed), but most information cannot be verified by novices. Checking information is only useful in verifying the accuracy of “equation-based” information
IV. dot coms	“so you’ve got this rule in schools, ‘don’t use any dot coms’” (293)	“one of the reasons that it’s just so pervasive is simply because it’s unambiguous” (347)	“I was doing a project last year on primarily on rare earth elements, so we had to look at a lot of mining programs. We also looked at a lot of environmental sites that were opposed to those mining programs, a lot of government sites that were talking about, like, regulations” (361-364)	“every single site was biased, they were all biased in different ways. If we’d had a dot com rule, that would have completely destroyed it. It wouldn’t have been able to work. We would have been missing that voice in the debate” (377-380)

Findings and Discussion

In her introductory remarks, Saul explained that she had worked for decades in underserved elementary and secondary schools, trying to “level the playing field.” In order to support these students, she wanted to understand how the focus group students had learned to access information (particularly science information) and judge the credibility of what they found.

Saul’s introductory remarks positioned the students as “experts” and throughout the discussion she made comments that privileged the students’ age, knowledge, and school experiences. Her comments encouraged the students to see themselves as shaping her understanding of what it is like to seek and find information online. The students appeared willing to embrace this role. Although not every member of the class participated equally, many

participants offered their ideas and much of the conversation included challenges to what they had been taught. In some instances (discussed below) the students appeared cognizant of the classroom professor's presence and qualified their comments, but mostly they seemed to be thinking through their actual search strategies.

After describing the purpose of the research and allowing the students time to talk in pairs, Saul began with the broad question, "Who are you and how did you get to be good at what you're good at and why are you bad at what you're bad at?" (2-4). Probably because of Saul's early comments about the importance of conversations about science and credibility in the home (comments not included in this transcript), the students began the discussion with stories about childhood. The three students who participated in the first stanza ("Parents") offered three different portraits of parent-child interactions around science information outside of school settings. In all three cases, science information was a part of life outside of school, though sometimes the interaction was child initiated and sometimes parent driven. These childhood experiences were portrayed as precursors to concepts about credibility that were learned in school. The students identified themselves as people who interact frequently and comfortably with scientific information and who have done so from a young age. The third student to participate concluded her story with, "I also went to like really good schools, so we definitely did have actual lessons in 'this is a credible source, this is not a credible source,' but that came later" (81-83), giving Saul an opportunity to turn the conversation to school and school practices around credibility.

The Role of Print Sources

The first cluster of comments about school practices, most occurring in the “Books” stanza, appeared to challenge the notion that print sources are superior to online sources. The “rule” students were discussing was stated or implied several times:

- “Teachers in middle and high school would sometimes say, ‘Hey, you can only use one Internet source on this project,’ or they would say, ‘Don’t use any Internet sources because nothing is trustworthy on the Internet’” (148-151)
- “It was expected that books were sort of a higher standard” (159)
- “I had a similar experience where we weren’t really encouraged to use Internet sources very often” (279)

Different students characterized this concept differently. The student who first brought up the idea of books was actually talking about a different school-based credibility strategy: “If you see a typo or you see an error in their information, that’s not a credible source” (90-92). Although this “rule” was taught to him in the context of online research, the student described the process of finding errors in his physics textbook (a print source) and how this caused him to question his biology textbook too. The problem with the rule, he stated, was that it was “based on confidence” (95) and on an ability to double-check the presented information. In the case of biology, the student said, “you can’t actually go and do the experiments they did to reach these conclusions. You have to take their word for it” (101-102).

On the surface, the student was not making a comment about privileging print sources but instead was commenting on the limitations of a different, common school rule: “check for errors.” If you can’t actually check, the student pointed out, then the rule is useless. Science teachers know this, of course, and most expect their students to rely on the textbook for answers, a problematic expectation for this student who found errors in his textbook.

What was interesting to us was the fact that the student took this “online” rule and applied it to a print resource. When the student first made his comment about error checking, Saul assumed he was talking about online research and asked a follow up question. The student replied, “I don’t know much about sites” (113) and then explained the errors he found in the textbook and his subsequent doubt. For this student, a rule about credibility was one that could apply to both online and print sources. His comments treated the two kinds of sources equally, negating the need for rules that would only apply in an online environment. Students, especially those who have been using the Internet from a young age, may not consider the divide between online and print resources to be as vast as some of their teachers do.

The importance of age and experience online was also brought up by the only non-traditional student in the class. At age 48, she described herself as having a “dual set of experiences” with the concepts of credibility and research (125): “the first time through, credibility meant primary sources...and coming back recently and hearing discussions about credibility, about whether or not it’s okay to use Wikipedia and that you go through government sites or dot edu...it’s elusive” (130, 132-134, 142). She supported her conclusion that credibility is “elusive” with a description of reading a biology textbook. She owned two biology textbooks; one was 30 years older than the other. She described the two texts as having “different facts and different truths...and that’s just what’s in a printed textbook, not with journals online” (138, 141).

For this student, one with a “dual set of experiences” around research, the division between print and online research was more complicated. Unlike the first participant in this section, she did not naturally apply rules about credibility created for the Internet to print sources. She was much more aware of the perceived differences in types of sources and

wondered out loud about the utility of such divisions. The fact that scientific information changes should not have surprised anyone in this class; as students taking a class on science communication, they would be well aware of the rapid pace of scientific research and the purpose of science to refine and revise previous conclusions. What worried this student appeared to be the *perception* of differences in the kinds of sources. If a printed textbook—a source that students were not regularly encouraged to question—could have incorrect “truths,” she suggested, then of course the credibility of online sources would be challenging. Her conclusion appeared to be that a simple set of rules (she enumerated rules against Wikipedia and privileging government and education sources) was insufficient.

Other participants who commented about print or online sources were more direct in their explication of the “rule” they had been taught. The idea that teachers believed “nothing is trustworthy on the Internet” (151) was an overstatement, the student who said this later admitted, but many students agreed that “books were sort of this higher standard” (139) according to their high school and middle school teachers. These students characterized this rule as outdated. In fact, one student commented, “as soon as you get to middle school, I mean, books, you pretty much don’t use them at all for sources anymore” (276-277).

The students collectively concluded that print sources may be presented as more credible than online sources, but they were not as useful as online sources for a variety of reasons (some of which are discussed below). In addition, print sources had their own problems—they were quickly outdated and were also subject to the same kinds of errors as Internet sources. For these reasons, students rarely used print sources for their research in or out of school. The students did not interrogate the rule further nor did they discuss the reasons teachers might consider books a

“higher standard.” The concepts of editorial oversight and peer review were not discussed, and no one mentioned the complicating factor of sources that are available both in print and online.

Student conclusions:

- All sources, online and print, may contain errors. Online sources are preferable to print sources because they are less likely to be out of date and are simply easier to access. (see Table 3 for all the student-created rules from this discussion).
- Checking for typos and errors is an inefficient strategy unless you really know the content well.

Wikipedia

The discussion of Wikipedia was the longest section of the excerpt, involving several students, the professor, and Saul. The first time Wikipedia was brought up in the conversation was when the non-traditional student listed “Wikipedia doesn’t count as a source” in her enumeration of the “new” rules she encountered when she returned to school. Wikipedia was next mentioned when the students were discussing how much the rules have changed in their memories. The student who next introduced Wikipedia struggled to articulate his point, perhaps anticipating an argument from his professor or Saul:

I think that recently, that’s really changed. Even Wikipedia, there are, I think, I see [Professor] is, because Wikipedia doesn’t count as a source. Well, I mean, I think that’s probably a really good practice, but it turns out—or my impression is that within, for example, algorithms in computer science, Wikipedia is actually a really, really, really great source and in fact, I actually know of a class, a graduate algorithms class here at [university] where the final assignment is you can either solve an open problem or you can update a Wikipedia article. (161-168)

The student's hesitations within his speech indicated that this was a topic he was treating carefully, conscious of the fact that his professor, who was in the room, had forbidden the students to use Wikipedia as a source of information in their writing. In discussing how credibility ideas have changed recently, the student presented Wikipedia as an extreme example—"even Wikipedia." Despite the fact that the professor didn't allow Wikipedia (which the student claimed to believe is "really good practice"), this student considered Wikipedia a "really, really, really great source of information" on specific topics.

In his comments, this student put together tangentially related ideas. The professor's position on Wikipedia was that it was not acceptable to *cite as a source* in an assignment for the science communication class (the professor clarified this position later in the discussion). To counter this rule, the student claimed that students in graduate level classes were allowed to *contribute to Wikipedia as authors* for their final exams. Because students are allowed to contribute to Wikipedia, the student claimed that Wikipedia is a "really, really, really great source of information" on topics like computer science and algorithms. This may be a reasonable conclusion. Although the student did not fully explicate his argument, the fact that the algorithms entries on Wikipedia are being updated by graduate level students from the university does suggest that Wikipedia is a reasonable source of some information. The student also appeared to be identifying more as an author of Wikipedia articles than as a consumer of information. Consumers might be able to be fooled by inaccurate information on Wikipedia, but this student was not one of them.

Rather than directly challenge the professor's ban on Wikipedia, this student added nuance: Wikipedia could be a good source for computer science information and still not be acceptable for science communication papers. Another student added a layer to the Wikipedia

discussion, stating, “for Wikipedia, I feel it’s a lot more reliable for scientific content than for political content because people just have opposing views, whereas scientific content is just very straightforward. It’s either true or not” (190-193). Once again, Wikipedia was presented as good for some things but not for all. In light of previous comments about scientific “facts” changing over time, the statement that science is “either true or not” initially seems contradictory. However, the previous participant established the idea that Wikipedia’s scientific information was being monitored and updated by qualified readers; the idea that errors were being ferreted out and outdated information was being replaced seemed to be accepted by these students. This student also introduced the idea of author motive. “Political content,” he suggested, was subject to bias and manipulation whereas “scientific content” was not.

Other students embraced Wikipedia for the following reasons: it is readable, broad yet concise, searchable, efficient, and predictable. After explaining that scientific content was “straightforward,” the student said that Wikipedia was useful when you just wanted to “learn something new about the topic, where you can read the intro on Wiki and then, once you get that, you know what other things to search for” (194-196). A second student built on this comment, applying it to homework problems: “Wiki will give me the basic intro. If I go over to econ, it’ll give me which equations I would need to use” (226-227). In these scenarios, Wikipedia was very much like the paper encyclopedias it replaced—for these students, Wikipedia provided a basic overview of a topic in condensed, readable form. When faced with the sheer quantity of information on any topic online, students gravitated toward this resource. One student admitted that in high school he was told to “Use JSTOR” or databases, not Wikipedia, but “I still find myself looking at other articles that cite the JSTOR articles [on Wikipedia] just because it’s a lot easier to read” (201, 203-204).

Another advantage of Wikipedia is that it was searchable. One student described doing biochemistry homework and coming across unfamiliar terms: “when I encounter a term that I don’t know...I look it up on Wikipedia and it’ll just say, ‘This is a marker for whatever or something like that’ and then, I basically just trust it” (245, 247-250). A second student elaborated: “There’s no other dictionary to look such things up in” (254). The students were aware that Wikipedia was frowned upon as a source, but in their academic lives it was quite useful. They suggested that at times they used Wikipedia to figure out “what other things to search for” (196)—in other words, Wikipedia could be a place to find search terms or links to primary or secondary source documents—but other times they simply “trust it” to provide the information they need. Without Wikipedia, the students suggested that it would be much more difficult to find basic overviews of information and definitions of terms that were highly specialized, such as cell markers or reagents. They felt confident that Wikipedia would *not* be incorrect, even though they understood (and had been told repeatedly) that it *could* be incorrect.

Furthermore, the students saw Wikipedia as the one, single resource that contains information on virtually every topic they needed, in a predictable and searchable format. Compared to paper encyclopedias, Wikipedia had numerous advantages, as one student stated: “paper encyclopedias are limited by the fact that you can’t search them easily and you have to know exactly what you’re looking for and it’s usually out of date and that’s a huge disadvantage” (283-287). At various points in the discussion, the students used “Google” and “Wikipedia” interchangeably and described how they often started searching for information by typing a query into Google and then accessing the Wikipedia entry from the search results. The use of Google as an entry point to Wikipedia added to Wikipedia’s searchability. Once they accessed

Wikipedia pages, the students appreciated the “template” that Wikipedia entries adhered to, adding to Wikipedia’s efficiency.

Student conclusion:

- Wikipedia is a useful, efficient, and readable resource for an overview of a topic and for looking up specific factual pieces of mathematical or scientific information.

Credibility by Domain Name

Early in the discussion, the non-traditional student mentioned that she had been taught to look at a website’s url and privilege information from government and education websites. Later, Saul also described hearing teachers tell their students “don’t use any dot coms” (294) when writing school reports. This kind of school rule—evaluate a website based on a domain name and give preference to “.gov” and “.edu” sites—was universally rejected by students in this class.

The first student to address this explained, “there’s very reliable people, there are a lot of people who put up reliable information online” (299-300) and that those who refused to look at information on dot com websites were “just limiting your own sources” (302). This comment is the opposite of what teachers and professors usually teach—that the Internet is filled with *unreliable* people and *unreliable* information. At this point in the discussion, the students had already talked about the process of updating Wikipedia pages and the importance of timely information; collaboratively, the students depicted the Internet as a place full of mostly good, reliable people and mostly good, timely information, rather than teeming with malicious authors and misinformation (note that this conversation took place before the “fake news” phenomenon; see Carson, 2017 for an overview).

Several other students saw the “no dot com” rule as very “schoolish,” a rule that exists in school, for school purposes, but has little utility beyond school and questionable utility within it.

One student thought the ban on dot coms was pervasive because it was “unambiguous” and therefore easy for teachers to teach and enforce (346):

I don't think it's necessarily a good rule, but then again the teacher doesn't want to have to say something like, 'Oh, yes, you can use—dot com sources are bad but there's this exception, this exception.' It's just easier to say, 'Don't use dot com sources' (351-354)

This student did not challenge teacher's need for “easy” rules and seemed to accept that an easy rule might be better than the messiness of ambiguity, but another student rejected this concept, calling “the dot com restriction” a “crutch of sorts” that deprived children the opportunity to learn to evaluate information and think for themselves (402). According to this student, unambiguous rules could have negative consequences for students (despite their usefulness for teachers).

Another student thought that the “no dot com” rule, when coupled with the ban on Wikipedia, was simply unreasonable. In explaining his process for writing papers, he said:

I would first look at Wikipedia to get, 'Oh, I can write this first paragraph about this topic, thinking about this,' and so on. So to get the main ideas and from there I can search specific topics and sort of reaffirm that information on different sites. But the thing with dot coms is that you're reaffirming information on Wikipedia to see which sites you can source, which sites you can cite for that topic. That's just, you—there might have been a perfect site that had a lot of information you wanted, but you would have to skip it and find a different one that was a dot edu or something. (305-316)

In this passage, it is unclear whether or not the student agreed with the need to “reaffirm” information on Wikipedia by looking on other sites (the word “reaffirm” suggests that he rarely, if ever, found a contradiction between Wikipedia information and information found elsewhere,

but he didn't clarify whether or not he thought that checking multiple sources was sound research practice or simply necessary to get around school bans on Wikipedia). However, it is clear the student felt a ban on dot com websites would have made writing a paper too difficult.

According to a show of hands during the discussion, all students used Wikipedia to find information. Yet their comments revealed that they accepted that Wikipedia shouldn't be cited in papers. Wikipedia, they understood, was not a primary source and therefore the information found in Wikipedia could (and perhaps even should) be cross-checked with other resources. Although they didn't always verify Wikipedia's information elsewhere, they seemed to have an understanding of how to do so and were willing to for school papers and research (but not in situations where their sources did not need to be cited, such as completing problem sets in an Economics class). However, they did not accept the ban on dot coms as resources for papers. The student above appeared to think this ban simply made the process too long (if you already found the information on Wikipedia *and* on a dot com site, why bother finding it in a third place?). Another student stated that dot coms shouldn't be banned outright, but it was reasonable to be required to verify information found on dot coms (even if you verified that information on another dot com). Unlike many of her classmates, she claimed that her high school was "very eager to get us using the Internet a lot" (326). In middle school, she had credibility classes "so we weren't citing Wikipedia as a source or stuff like that" but she saw these classes as "very basic" (341, 342) She therefore developed her own "rule of thumb": "I would look up something and then look it up again and oftentimes look it up again and if I could find matching information from three sources, sometimes two, I would usually say, 'Okay'" (330-336).

In this instance, the process of finding multiple sources was for verification. She wanted to find "matching information"—the same thing—a few different times before accepting it. She

appeared to hold a skeptical stance toward information on the Internet (a stance teachers and journalists would probably agree with), but not a didactic one. She also suggested that verifying information—finding the same thing in a few different places—was itself enough to give that information credibility, regardless of where these places are. Although she did not describe the assignments that prompted this double-checking, the fact that she described looking for “matching information” leads us to suspect the assignments were either asking for a single data point or answer that might vary slightly from source to source (e.g., worldwide, how many adults are illiterate?) or perhaps for an opinion or a recommendation (e.g., what is the best way to prevent the spread of the flu?).

These kinds of assignments—ones with simple answers or requests for opinions/recommendations on fairly straightforward topics—are, unfortunately, the most common assignments students complete in schools (Goldman & Scardamalia, 2013) and for these, the previous student’s process of verifying information was probably sufficient. A ban on dot coms for these assignments would present a barrier merely in terms of efficiency, as the earlier student pointed out. Completing these assignments could occur without the use of dot coms, but there’s no compelling reason to do so. The next student, though, described a very different kind of assignment and a different reason for needing both dot coms and multiple sources.

She began by pointing out that in certain situation “there’s information that you can only find on dot com sites” (360). Unlike Wikipedia, which by definition is a tertiary source, some dot com sites are themselves primary sources. The student described an interdisciplinary freshmen seminar where she and her group were asked to complete a project on rare earth minerals. In order to do so, they had to look at “a lot of mining programs. We also looked at a lot of

environmental sites that were often opposed to those mining programs, a lot of government sites that were talking about, like, regulations” (362-363). This array of sources, including dot gov, dot org, dot com, and dot edu, was what made this project so valuable, the student claimed. Each source was “biased in different ways,” regardless of the domain name, and a ban on all the commercial websites would have meant the students “would have been missing an important voice in the debate” (378, 380).

This student’s description of the class project presented it as an assignment that required students to read and understand an issue from the perspective of experts and stakeholders before offering their own recommendations. As the student stated, many organizations and individuals had perspectives on the issue; if the students were not allowed to use a source based only on the domain name (rather than on the website itself), an entire category of sources (some of them primary sources with information that was not available elsewhere) would have been forbidden. Her comments suggested that in complex policy debates, the “voices” of different experts and stakeholders speak in different places on the web: some “voices” are those of the government, some are those of scientists, some are environmentalists, some are mining workers, some are mining companies. A source might present the perspective of one group or another (and, as a result, have a bias) while still containing factually accurate information, the student claimed. In this instance, a decision or recommendation can’t be made without considering all these perspectives. For a careful reader, attuned to issues of perspective and bias, consulting multiple sources of information serves to do more than verify information. Information from one or two sites is not enough to get the whole picture.

Student conclusions:

- Regardless of domain name, all sources online have a bias and may or may not include credible information.
- Verifying information using multiple sources is a better way to ensure credibility than relying on the domain name.
- If you want to understand an issue from multiple perspectives, you must consult multiple sources. Commercial sources (e.g., dot coms) may include the perspective of experts or stakeholders that cannot be found anywhere else.

The Expert Blogger

Near the end of the transcript excerpt, Saul asked the students about their use of blogs, a question she said was important to her to understand. The question was a loaded one: “Do any of you use blogs if you really want to get hard-core information?” (414), implying through the use of “really” and “hard-core” that blogs might not be the best sources of scientific information. The length of the stanza (only 40 lines, compared to 131 for the Wikipedia stanza and 120 for dot coms) suggests that blogs were not a topic that the students had much to say about, yet they did mention a few situations where they found blogs to be useful resources.

One student described the role of blogs as similar to the role of Wikipedia: “I will often use blogs as a starting point, especially if I’m trying to find out sort of about...a lot of little things about a field” (417-418). Blogs provide an overview, he claimed, and could be trusted because “most fields have at least a core group of respected bloggers who might be professors” (419-420). Other students also found professors’ blogs credible and described how professors often linked to each other’s blogs. However, another student admitted that he rarely looked at the credentials of a blog’s author: “If it has information that I need, that’s nice and if it confirms Wikipedia then I sort of trust it, I guess” (434-435). Another student talked reading neuroscience

blogs even though she wasn't "into neuroscience" (442) as a field of study. These blogs, she said, were written by graduate students and were intended "for the general public" (445). In terms of credibility, she said: "they also link to other studies that have been done so you can go look at that study, read the abstract. If the blog represents the abstract fairly well you can feel that it's probably credible" (451-453).

In this short stanza the students once again complicated what might seem like a straightforward rule: don't use blogs as sources for papers. There are different kinds of "blogs," the students' comments revealed, and "respected bloggers" might be credible sources, depending on your information-seeking needs. If necessary, careful readers could check the credibility of blogs by verifying the author's credentials or utilizing the links to primary sources, although the students did not usually do either.

Student conclusion:

- Blogs written by scientists are useful for providing a general overview of a topic or for entertainment.

Table 3
Summary of Student-Created Rules

"School" Rule	Student Rule
Books are more credible than web sources	All sources, online and print, may contain errors. Online sources are preferable to print sources because they are less likely to be out of date and are simply easier to access
Check for errors to check the credibility of a web source	Checking for typos and errors is an inefficient strategy unless you really know the content well.
Don't use Wikipedia	Wikipedia is a useful, efficient, and readable resource for an overview of a topic and for looking up specific factual pieces of mathematical or scientific information.
Don't use dot com's	Regardless of domain name, all sources online have a bias and may or may not include credible information.
	Verifying information using multiple sources is a better way to ensure credibility than relying on the domain name.
	If you want to understand an issue from multiple perspectives, you must

	consult multiple sources. Commercial sources (e.g., dot coms) may include the perspective of experts or stakeholders that cannot be found anywhere else.
Don't trust blogs	Blogs written by scientists are useful for providing a general overview of a topic or for entertainment.

Conclusions

This research confirms the findings of several previous studies. Students in the focus group described looking for sources that were easy to read and access rather than those that had been declared “credible” by their teachers (Barker & Julien, 2012; Heinström, 2006; Rieh & Hilligoss, 2002). They also created their own “rules” of Internet searching, mostly through trial and error (Head & Eisenberg, 2009). The assignments they described from school mostly could be considered “belief mode” assignments rather than “knowledge creation mode” (Goldman & Scardamalia, 2013). This study adds to the research base by examining *how and why* students adapt the search strategies they are taught in order to succeed at information-seeking tasks in and out of school.

Why did they engage in these strategies rather than using what they had been taught? First, and perhaps most obviously, they did so *because their strategies worked*. Regardless of whether or not these strategies represent the optimal way to search the Internet, according to the students, these strategies allowed them to succeed at school. If we wish students to take other approaches to information seeking on the Internet, we must look first at the tasks students are given.

However, we also point out a second fact about this list. The students’ strategies *are more nuanced than strategies handed out by schools*. Researchers like Thomm and Bromme (2012) worry that students only engage in “source” evaluation rather than text evaluation as they judge credibility, but students are often encouraged to do exactly this by the Internet rules they are

handed. The typical “school rules” that the students and Saul discussed appear to be an attempt at making something very messy and context-dependent unambiguous. These attempts included banning/restricting an entire medium (Internet resources), a particular website (Wikipedia), a domain name (dot coms), or a genre (blogs). Underlying some of these restrictions is a tendency for school rules to privilege traditional publishing (which includes editors and/or peer review) over crowd-sourced or open-access information. In creating unambiguous rules, schools also present the false notion that the Internet is static, ignoring the rapidly changing nature of the information landscape. For example, as scientists update Wikipedia pages or create their own blogs to share research, they alter the way scientific information gets to the public. Unambiguous rules about the credibility of a single source or category of sources can’t account for this.

In the student-created rules, there is an attention to the information-seeker’s purpose that is absent from school rules. Students identified the following purposes for their online research:

- Completing problem-set homework: the information is factual, generally accepted (and unlikely to be inaccurate), but could be difficult to read and access. Doesn’t tend to involve controversial topics.
- Completing paper/project homework: information from a variety of sources is required. Source/bias evaluation may be necessary. Topics may be controversial.
- Satisfying curiosity: the information needs to be readable and enjoyable. No single question needs to be answered or task completed.

In each of these scenarios, the students’ search strategies also appeared to be guided by four underlying questions: how badly did they want the information? How important was accurate information? How likely was the information they found to be correct? What (if any) external rules had been imposed on their sources? In completing most of their problem-set homework, the

students usually wanted to know the information badly and wanted it to be correct. However, they did not believe that the information they found would be incorrect. Their search strategies were then focused exclusively on *finding information that they could read and understand* rather than evaluating information. On the other hand, as they described projects from high school, they described a lack of investment in the topics (they didn't want to know the information all that badly) but a set of rules that required them to avoid certain sources, usually Wikipedia. In these cases, their search strategies were focused on *completing the task quickly while following the rules*. They first went to Wikipedia to understand the topic and outline their project and then utilized the links to find sources they could cite in their paper without losing points.

Very few projects were described where the students badly wanted to find information that they worried might be incorrect. In these cases, most notably the “rare earth elements” project described by a single student, the search strategies involved *reading widely from all perspectives on a topic*. In this case, the student had to find several sources and understand not only the content of the information but also the perspective.

Teaching students to look for and evaluate information online is a complex task. We conclude this paper with questions we believe are worth further research:

- Where do accessible sources of expertise, especially scientific expertise, actually exist online? How do the “rules” that schools teach address this shifting landscape?
- How can we teach students about the various kinds of searches they will engage in and the strategies that might be best suited to each, in the face of all this changing?
- How can teachers and schools create authentic tasks that invite students into this conversation rather than artificial tasks that oversimplify searching and encourage students to follow our “rules” simply for the sake of following them?

We believe answering these questions will be important to preparing all students for the literacy demands of the 21st century.

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