



Research Article

Lateral reading: College students learn to critically evaluate internet sources in an online course

The COVID-19 pandemic has forced college students to spend more time online. Yet many studies show that college students struggle to discern fact from fiction on the Internet. A small body of research suggests that students in face-to-face settings can improve at judging the credibility of online sources. But what about asynchronous remote instruction? In an asynchronous college nutrition course at a large state university, we embedded modules that taught students how to vet websites using fact checkers' strategies. Chief among these strategies was lateral reading, the act of leaving an unknown website to consult other sources to evaluate the original site. Students improved significantly from pretest to posttest, engaging in lateral reading more often post intervention. These findings inform efforts to scale this type of intervention in higher education.

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Research question

- Can college students learn to effectively evaluate Internet sources in an asynchronous online course?

Essay summary

- The COVID-19 pandemic has forced college students to spend more time online. However, research has shown that students are ill-equipped to evaluate information they encounter there (Hargittai et al., 2010; Kirschner & van Merriënboer, 2013; McGrew et al., 2018; Shellenbarger, 2016). In the midst of the pandemic and increasing disinformation, this lack of preparation threatens civic and public health.
- Prior interventions have shown that middle school, high school, and college students can become more skilled evaluators of digital content through in-person instruction when taught

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strategies used by professional fact checkers (Brodsky et al., 2019; Kohnen et al., 2020; McGrew, 2020; McGrew et al., 2019; Wineburg et al., 2019; Wineburg & McGrew, 2017, 2019). This study tested whether these strategies could be taught in an asynchronous college course.

- Students (n = 87) completed 4 one-hour modules. These modules included instructional videos; exercises in which students evaluated online sources about nutrition; and screencasts that modeled how to evaluate the credibility of these sources. The modules also provided instruction that addressed common misconceptions (e.g., that a dot-org domain makes a site trustworthy or that links to authoritative sources, by themselves, confer credibility). A repeated-measures ANOVA showed significant improvements in student scores from pretest to posttest.
- At pretest, only 3 of 87 students engaged in lateral reading by leaving the original site and consulting at least one other source. At posttest, 67 of 87 did so.
- Results suggest that students can learn to evaluate the credibility of online sources through asynchronous instruction embedded in regular course content. As higher education seeks to address digital illiteracy at scale, these findings can inform curricular revisions.

Implications

Recent events underscore the threat that digital illiteracy poses to public health and democracy. In February 2020, the World Health Organization declared that the coronavirus pandemic had spawned an “infodemic” of dangerously inaccurate health information (Zarocostas, 2020). Despite this warning, disinformation has spread with stunning speed. Millions viewed social media posts about miracle cures, some of which urged the ingestion of chlorine dioxide, a chemical that can cause vomiting, diarrhea, and even death (Eaton et al., 2020; Merlan, 2020). Pernicious disinformation surged during racial justice protests. Facebook groups spread conspiracy theories that demonstrators protesting the killing of George Floyd were paid by George Soros, a spurious claim as well as an anti-Semitic dog whistle (Seitz, 2020). Coordinated disinformation campaigns sought to discourage Black voters from voting in the 2020 election cycle (Halper, 2020).

As COVID-19 threatened public health, much of higher education in the United States shifted to remote instruction. College students are being sent online to complete assignments and do research (“Colleges’ reopening models,” 2020). At the same time, many studies have shown that college students struggle to evaluate Internet sources (Hargittai et al., 2010; List et al., 2016; Lurie & Mustafaraj, 2018; Martzoukou et al., 2020; McGrew et al., 2018; Pan et al., 2007). Still, a misperception tenaciously holds that because young people grew up with digital devices, they know how to evaluate the information that flows across their screens (Prensky, 2001). Without offering evidence or citing research, a recent *Politico* article claimed that Gen Z’ers “aren’t falling for the same fake news stories that may have duped their parents in 2016” (Choi, 2020). Such claims persist despite a 2019 national survey of 3,446 high school students that revealed major deficiencies in evaluating the credibility of online sources (Breakstone et al., 2019; Mathews, 2019). Fifty-two percent said that a Facebook video claiming to show ballot stuffing during the 2016 Democratic primary elections (a video that came from Russia—a fact easily established by searching for “2016 voter fraud video”) constituted “strong evidence” of U.S. voter fraud. Nine of ten students were unable to come up with a cogent rationale for rejecting the video. Across the survey’s tasks, students overwhelmingly judged websites on the basis of surface-level features: their top-level domain (i.e., whether a site was a dot-com or a dot-org), appearance and design, links to other sites, and information on the About page. Rarely did students leave the original website to consult other sources. Students from all demographic groups fared poorly. The chasm between young people’s perceived competence and their demonstrated performance (Hargittai et al.,

2010; Nygren & Guath, 2019; Porat et al., 2018) represents a growing threat when disinformation is ascendant and young adults spend more time on digital devices.

This worrisome mixture of digital illiteracy and misplaced confidence motivated the present study. We investigated whether a curricular intervention implemented asynchronously could improve college students' ability to evaluate the credibility of online sources. We based our intervention on strategies culled from observations of professional fact checkers recruited from leading fact-checking organizations and prominent news outlets located in New York City and Washington, DC. Fact checkers were videotaped and their screens recorded as they evaluated unfamiliar websites. Fact checkers' approaches were compared to those of undergraduates from an elite university and history professors from five different institutions (Wineburg & McGrew, 2019). When undergraduates and academics landed on an unfamiliar source, they tended to read it *vertically*, proceeding from the top of the screen to the bottom, examining the URL, mulling over the prose, clicking on internal links (such as the About page), but rarely leaving the target site. Fact checkers differed dramatically. Landing on an unfamiliar site, they left it almost immediately and opened new tabs across the horizontal axis of their browser, a practice we refer to as *lateral reading*. By briefly clicking away from an unfamiliar site to consult trusted sources from the broader Web, fact checkers answered a crucial question: Who's behind the information? In contrast, many of the academics and college students remained glued to the original site, unaware of its real backers. To verify claims online, fact checkers' judgments were also broadly guided by two other questions: (1) What's the evidence? (2) What do other sources say? (McGrew et al., 2018). Lateral reading allowed fact checkers to evaluate the credibility of online content more quickly and accurately than either the academics or students.

Fact checkers' strategies are akin to the "fast and frugal" heuristics that have enhanced performance across a broad spectrum of fields (Gigerenzer & Gaissmaier, 2011). Their strategies guided our development of curriculum for evaluating online sources. To date, interventions based on fact checkers' strategies have yielded promising results across a wide age span: middle school (Kohnen et al., 2020), high school (McGrew, 2020; Wineburg et al., 2019), and college (Brodsky et al., 2019; Fielding, 2019; McGrew et al., 2019; Supiano, 2019).

Despite these encouraging findings, substantial barriers limit widespread adoption. In these interventions, lessons were add-ons to the regular curriculum and were not tailored to course content. Additionally, researchers either delivered instruction themselves or provided teachers with substantial support. Such intensive involvement is obviously impractical to scale.

For the present study, we wove fact checkers' strategies into an asynchronous nutrition class at a large state university. We used examples directly tied to the course's focus on nutrition. Pretest and posttest data showed statistically significant growth in students' ability to evaluate online sources. Posttest data showed that students engaged in the specific strategy of lateral reading far more often post intervention. These results indicate that students can become more skilled evaluators of digital content through asynchronous instruction embedded in regular course content.

As higher education grapples with how to prepare students for civic life in an age of information overabundance, our findings suggest a practical way forward. Rather than design entirely new courses, these results suggest that curriculum developers could create subject-specific modules for instructors to integrate into existing curricula. The approach in this study could serve as a template in other disciplines. For example, in a history course, a module could be developed that shows how to debunk claims that thousands of Black Americans took up arms for the Confederacy—false claims that have proliferated on the unvetted Internet (Levin, 2019). Modules could be used in similar courses across institutions, and a national database of open educational resources could serve to disseminate this approach. Subject-matter experts could collaborate with curriculum developers to create modules for frequently taught courses (e.g., Biology 101). Once a bank of modules was developed, asynchronous

delivery would allow them to be added to courses without the need for extensive faculty development about how to teach these strategies.

Findings

Finding 1: Students' evaluation of online sources improved significantly after a series of course-embedded activities.

The pretest and posttest were parallel forms of the same assessment. They included the same questions with different online sources. (See Appendix A for parallel versions of a question.) Average scores improved from 3.95 points out of 13 at pretest to 7.08 at posttest, an average gain of 3.13 points. A repeated-measures ANOVA revealed that the gains from pretest to posttest were statistically significant, $Mean_{diff} = 3.13$; $F(1, 85) = 136.03$, $p < .001$. Scores improved significantly regardless of the order in which students took the two forms (see Figure 1). For Section 1, which took Form A at pretest and Form B at posttest, mean scores improved from 3.59 points ($SE = .31$, 95% CI 2.97 to 4.21) to 7.7 points ($SE = .42$, 95% CI 6.83 to 8.49). For Section 2, which took the forms in the opposite order, average scores improved from 4.3 points ($SE = .32$, 95% CI 3.68 to 4.93) to 6.49 points ($SE = .42$, 95% CI 5.65 to 7.33).

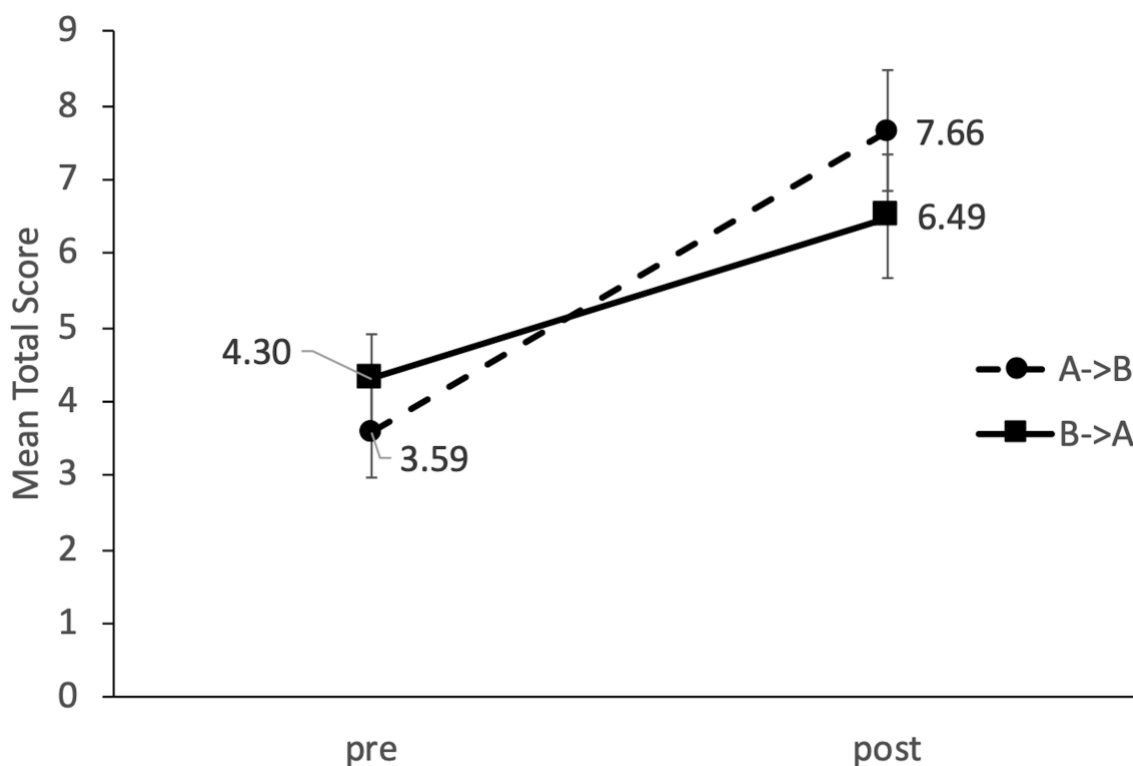


Figure 1. Mean pretest and posttest scores by test order.

Finding 2: Students employed the strategy of lateral reading more often on the posttest.

Students' written answers offer insights into how their thinking changed from the beginning of the course to the end. For example, Task 3 (Appendix A) presented websites that go against the scientific consensus on climate change (friendsofscience.org on Form A and co2science.org on Form B) and asked students to respond to this prompt: "Is this website a trustworthy source for learning about global

warming?” (Although the instructional modules featured sources related to nutrition, the pretest and posttest included sources about social and political issues. This was done to gauge whether students could evaluate the credibility of Internet sources regardless of content.) The task directions informed students that they were free to “open a new tab and do an Internet search if that helps.” For both websites, lateral reading turns up multiple sources that reveal funding from fossil fuel companies with vested interests in climate change denial.

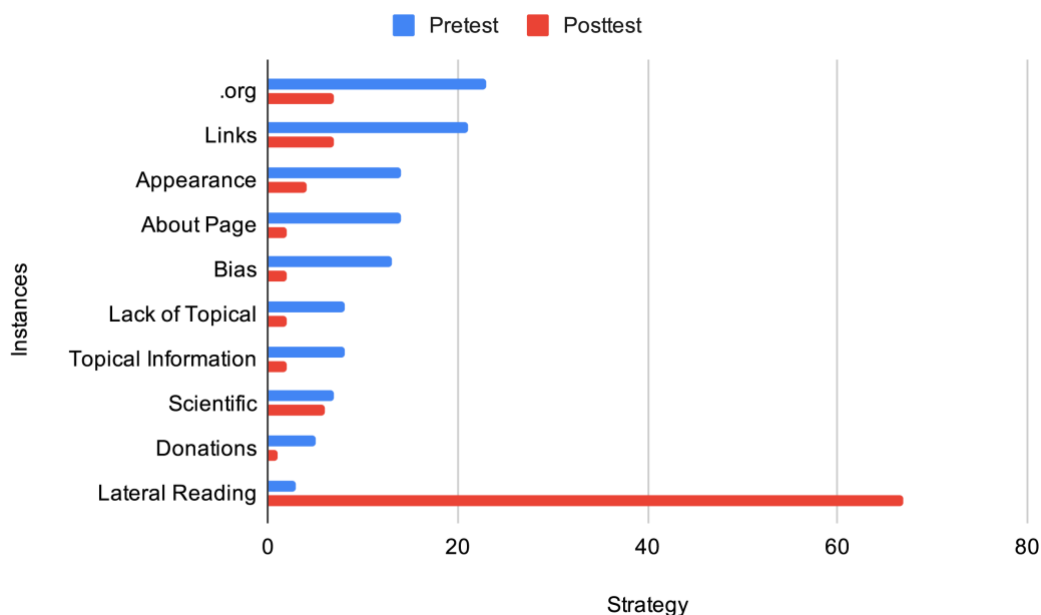
At pretest, only 3 of 87 students engaged in lateral reading by leaving the original website and consulting at least one other source (Figure 2). Two students correctly questioned the site’s credibility. The other searched outside of the site but did not locate information about its backers. The remaining 84 students focused exclusively on features that were either irrelevant or could be easily manipulated. Most importantly, students never consulted the broader Web. They focused on the site’s top-level domain (.org), whether there were links to other sites, the layout and graphics, and information provided on the About page. Leaving the site to engage in lateral reading was the least employed strategy. In sum, students’ attention remained focused on the original website, which precluded them from finding information needed to judge its credibility. Typical was this student’s pretest evaluation of friendsofscience.org:

First, it seems very disorganized. Way too many colors and boxes on the home page. I also see donation boxes as a red flag—even if it is a nonprofit. They claim validity with “professionals” which kind of swayed me at first, but they fail to mention any of their names for a point of reference. I would like to see that on the about page with their top professionals.

This student never left the site. Moreover, the student relied on the site’s About page without considering how groups craft their About pages to reflect positively on their aims.

At posttest, 67 of 87 students engaged in lateral reading by leaving the target website (either friendsofscience.org or co2science.org, depending on the form) and consulting at least one other online source. Thirty-six students correctly raised questions about the website’s credibility (Figure 2). Thirty-one engaged in lateral reading but concluded the site was credible or rejected it for irrelevant reasons. The same student who focused on surface-level features at pretest used lateral reading at posttest and found damning information on Wikipedia that was linked to established news sources: “They are funded by Exxon so automatically that raises flags of the reliability of the info. [Source: en.wikipedia.org/wiki/Center_for_the_Study_of_Carbon_Dioxide_and_Global_Change].”

Post-intervention, lateral reading went from the least to the most used strategy. Students’ reliance on ineffective strategies declined. At pretest, 23 students believed that a dot-org domain conferred reliability, a misconception common not only among college students but among adults (Wineburg & Ziv, 2019). On the posttest, the number fell to seven, a decrease of 69%. At pretest, 21 students maintained that the mere presence of links increased a site’s credibility. At posttest, only seven students did. On the pretest, 14 students evaluated the site based on its appearance compared to four at posttest. Fourteen students relied on the site’s About page at pretest; only two did so at posttest. In designing the instructional modules, we had directly addressed why each of the above strategies could lead to erroneous conclusions.



Strategy	Instances	
	Pretest	Posttest
.org—Believes .org domain (or other features of the URL) confers legitimacy to site	23	7
Links—Equates the presence of links or citations with trustworthiness	21	7
Appearance—Evaluates the site based on design, layout, colors, resolution, or logo	14	4
About page—Evaluates the site based on information from the About or Contact page	14	2
Bias—Rejects site based solely on the presence of biased or opinionated language	13	2
Lack of topical information—Evaluates the site based on insufficient information about climate change (without considering its quality)	8	2
Topical information—Evaluates the site based on the presence of information about climate change (without considering its quality)	8	2
Scientific consensus—Evaluates whether the content is in line with science	7	6
Donations—Believes a tab for donations means the site is less trustworthy	5	1
Lateral reading—Consults at least one additional site to learn whether the target site is trustworthy (student may still not arrive at the correct conclusion)	3	67

Figure 2. Evaluation strategies used before and after students completed modules.

Methods

Research question

Can college students learn to effectively evaluate Internet sources in an asynchronous online course?

Course context

Curriculum materials were integrated into two sections of an online nutrition course at a public research university in the southwestern United States. In Summer 2020, the course was offered during two 5-week sessions with the same instructor and content. All instruction was delivered asynchronously using an online learning management system.

The class introduced students to the basics of human nutrition, including a review of nutrients and how food choices impact health and risk of chronic disease. The course sought to provide students with the tools to make informed decisions in the nutrition marketplace and was required for undergraduates majoring in human development and family science. For students in other majors, the course fulfilled a general education requirement.

Intervention

The intervention included four modules. The first was a brief introduction to evaluating digital information and the problems of online disinformation. The next two focused on the strategy of lateral reading. The last one provided instruction on how to evaluate the quality of online evidence. Across the modules, we also addressed common misconceptions about assessing digital sources, such as trusting a site because it carried a dot-org top-level domain or accepting at face value information on a site's About page. The decision to emphasize lateral reading was based on prior research (e.g., Hargittai et al., 2010; McGrew et al., 2018) that showed students' tendency to evaluate a website by remaining on it, without ever turning to the open Web to vet it.

Each module included three types of activities. First, videos provided direct instruction about evaluating the credibility of Internet sources. Developed as part of an earlier project, these videos were produced in collaboration with John Green and Crash Course, creators of popular educational YouTube series (Crash Course, 2019a). Videos broadly addressed how to judge the credibility of online sources and were not specific to nutrition. After viewing, students completed multiple-choice questions about their content. Next, students completed guided evaluations of online sources. Students answered questions about various sources and how to evaluate them. Finally, they watched screencasts created by the research team that demonstrated how to evaluate these same sources using fact checkers' strategies. Screencasts were a form of *cognitive modeling*, an instructional approach that makes expert strategies visible to novice learners (Collins et al., 1989, 1991; De La Paz et al., 2016).

For example, Module 2 introduced students to lateral reading, beginning with a Crash Course video (Crash Course, 2019b). After viewing, students answered multiple-choice questions and then evaluated an article from the American Council on Science and Health (ACSH), an organization that describes itself as a "pro-science consumer advocacy organization and a 501(c)(3) nonprofit" (American Council on Science and Health, 2020). ACSH receives funding from corporations that have vested interests in the debates ACSH seeks to influence, such as proposed taxes on sugary drinks or the requirement that restaurants post nutrition information. Students then watched a screencast of a member of the research team using lateral reading to evaluate the same article. Finally, students practiced reading laterally using

an article on proposed soda taxes from The Odyssey Online, a crowd-sourced website known for producing clickbait (Porter, 2017).

Each module took about an hour to complete. Students were assigned one module per week. The modules were required, and the instructor awarded points for completing them. However, the quality of students' work on the modules did not affect course grades.

Participants

Eighty-seven undergraduate students completed all parts of the study. Forty-four students were in one section of the course and 43 in the other. Table 1 provides an overview of participants' race, gender, and ethnicity. Although the modules were a required part of the course, students' participation in the pretest and posttest was voluntary. Students received a \$5 gift card as a token of appreciation for completing the pretest and a second \$5 card for completing the posttest.

Table 1. Race, gender, and ethnicity of participants.

	Session 1 (44 students)	Session 2 (43 students)	Total (87 students)
Race			
African American	11.4% (5)	20.9% (9)	16.1% (14)
Asian/Pacific Islander	11.4% (5)	9.3% (4)	10.3% (9)
Native American	2.3% (1)	0	1.1% (1)
White	59.1% (26)	58.1% (25)	58.6% (51)
Prefer not to say	15.9% (7)	11.6% (5)	13.8% (12)
Gender			
Female	68.2% (30)	76.7% (33)	72.4% (63)
Male	29.5% (13)	18.6% (8)	24.1% (21)
Nonbinary	0	2.3% (1)	1.1% (1)
Prefer not to say	2.3% (1)	2.3% (1)	2.3% (2)
Hispanic			
Yes	27.3% (12)	25.6% (11)	26.4% (23)
No	70.4% (31)	67.4% (29)	69.0% (60)
Prefer not to say	2.3% (1)	7.0% (3)	4.6% (4)

Outcome measures

Each assessment form included nine items that asked students to evaluate the credibility of different types of online sources. (See Appendix B for descriptions of the items.) As part of a prior project, the research team developed the questions through an iterative process of prototyping, expert review, piloting, and think-aloud interviews (McGrew et al., 2018). The items assessed a range of the approaches to evaluating the credibility of online sources taught in the instructional modules. Four items were constructed-response; five were multiple-choice. (See Appendix C for an example of a multiple-choice question.) Prompts were identical across forms, but the questions featured different online stimuli. (See Appendix A for an example of parallel versions of Task 3.) Distractors for the multiple-choice items reflected common errors observed when students in a prior study completed constructed-response versions of the same tasks (McGrew et al., 2018).

Students could earn a total of 13 points on the assessment. Multiple-choice items were worth 1 point and constructed-response questions 2. Constructed responses were evaluated using a three-level rubric (*Beginning* - 0; *Emerging* - 1; *Mastery* - 2). In *Mastery* responses, students evaluated online

content by investigating the source of information, interrogating the evidence presented, or seeking out information from other reliable sources. Emerging responses were on the right track but were partially incorrect or did not fully articulate sound reasoning. Beginning responses relied on incorrect or irrelevant strategies. (See Appendix D for a sample rubric.)

Design and analysis

Students in one section took Form A as a pretest and Form B as a posttest. Students in the other section completed the forms in the opposite order. Counterbalancing reduced the risk that the findings would be affected by differences in the difficulty of the two forms. If students showed significant improvement from pretest to posttest in both sections, we could be confident that gains were not attributable to one form being more difficult than the other.

Two raters independently scored student responses. Scores were identical for multiple-choice items, and weighted kappa was used to estimate inter-rater reliability for constructed-response scores on both forms, Form A weighted $\kappa = .956$ (95% CI, .934 to .979), $p < .001$, Form B weighted $\kappa = .968$ (95% CI, .948 to .988), $p < .001$.

Two independent raters also coded the strategies students used to evaluate the climate change denial websites (Task 3). Responses were coded for each strategy used, so a single response could receive multiple codes. Codes were applied regardless of how a response was scored. For example, at posttest, many responses received a lateral reading code but were not scored as Mastery. Intercoder reliability was high at both pretest and posttest, Cohen's $\kappa_{pre} = .921$ (95% CI, .881 to .961), $p < .001$, Cohen's $\kappa_{post} = .949$ (95% CI, .916 to .982), $p < .001$.

A repeated-measures analysis of variance (ANOVA) was used to determine whether students showed significant improvement in evaluating the credibility of Internet sources. This analysis tested whether the average posttest score was significantly different than the average pretest score. The analysis also controlled for potential effects of counterbalancing administration of the forms. Controlling for order effects leads to a more accurate estimate of the size of the observed treatment effect.

Limitations and future directions

Further research is needed to investigate the efficacy of embedding web credibility modules across varied disciplines in the college curriculum. Additionally, it will be important to investigate the effect of including controversial subject matter in order to better understand how motivated reasoning influences student behavior.

Although this study suggested that students could become more skilled evaluators of online sources, we don't know the durability of these changes. Nor do we know whether students carry these evaluative strategies into their everyday lives. Additional research on both fronts would provide a more robust understanding of the efficacy of these types of interventions.

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Competing interests

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Ethics

The research was approved by an institutional review board, and human subjects provided informed consent.

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Data Availability

All materials needed to replicate this study are available via the Harvard Dataverse: <https://doi.org/10.7910/DVN/N6HY37>

Appendix A

Parallel forms of Task 3 (of 9) on Form A and Form B of the pre/post assessment

Form A

Please take about 8 minutes to complete this task.

You are researching global warming and come across this website: <https://friendsofscience.org/>. Please decide if this website is a trustworthy source of information on global warming. You can open a new tab and do an Internet search if that helps.

Is this a reliable source of information about global warming? You may use any information on this website, or you can open a new tab and do an Internet search if you want.

- Yes
- No

Explain your answer, citing evidence from the webpages you used. Be sure to provide the URLs to the webpages you cite.

Form B

Please take about 8 minutes to complete this task.

You are researching global warming and come across this website: <http://www.co2science.org>. Please decide if this website is a trustworthy source of information on global warming. You can open a new tab and do an Internet search if that helps.

Is this a reliable source of information about global warming? You may use any information on this website, or you can open a new tab and do an Internet search if you want.

- Yes
- No

Explain your answer, citing evidence from the webpages you used. Be sure to provide the URLs to the webpages you cite.

Appendix B

Descriptions of assessment items

Item	Constructed-response or multiple-choice question	Description
1. Sponsored content	Constructed-response question	Evaluate whether a sponsored post is a credible source of information
2. Online image	Constructed-response question	Evaluate whether an image posted to a social media site constitutes strong evidence
3. Website evaluation	Constructed-response question	Explain whether a website is a credible source of information about global warming
4. Social media evidence	Constructed-response question	Examine two social media posts and explain which provides better evidence
5. Claims on social media 1	Multiple-choice question	Select a reason why a social media post is a useful source of information
6. Claims on social media 2	Multiple-choice question	Select a reason why a social media post might not be a useful source of information
7. Webpage comparison	Multiple-choice question	Identify which of two webpages is a better place to start doing research
8. Comments section	Multiple-choice question	Determine whether information from an anonymous comment section should be used in a research paper
9. Website comparison	Multiple-choice question	Identify which of two websites would be a better source of information on a given topic

Appendix C

Sample multiple-choice question from Form B

Imagine you are doing research on gun control and you find the following webpages. Because webpages can change frequently, these links will take you to archived versions of the articles. Please do not consider that in your evaluations.

Webpage A: <https://people.duke.edu/~gnsmith/articles/myths.htm>

Webpage B: https://en.wikipedia.org/wiki/Gun_politics_in_the_United_States

Which of these two webpages do you think is a better place to start your research?

- Webpage A is better because it is from Duke University, and Webpage B is worse because anyone can edit a Wikipedia page
- Webpage A is better because it is a .edu site, and Webpage B is worse because Wikipedia is never a good source to use
- Webpage B is better because it has more information than Webpage A
- Webpage B is better because it links to reliable references, and Webpage A is worse because its content is from an unreliable organization

Appendix D

Three-level rubric used to score student responses to Task 3 (see Appendix A)

(2) MASTERY	<p>Student does <u>all</u> of the following:</p> <ul style="list-style-type: none"> • Raises a question about the trustworthiness of the group/funder/sponsor behind the website • Provides at least one correct and relevant reason why the site is unreliable (e.g., explains conflict of interest/influence of funders or lack of transparency about funding or describes purpose/motivation of the organization) • Shows evidence of lateral reading (e.g., references other websites)
(1) EMERGING	<p>Student identifies the website's group/funder/sponsor as problematic but either:</p> <ul style="list-style-type: none"> • Does not provide a completely correct explanation • Does not show evidence of lateral reading <p>OR</p> <p>Student questions the reliability of the site because it promotes ideas/content refuted by established science.</p> <p>OR</p> <p>Student reads laterally but comes to an incorrect conclusion.</p>
(0) BEGINNING	<p>Student rejects the source based on incorrect or irrelevant considerations without questioning the organization behind the page. For example:</p> <ul style="list-style-type: none"> • Appearance (presence of ads, donations tab, Flash Player, poor web design) • Critiques information on site instead of the organization behind the site (e.g., student says content is biased; disagrees with the content/perspective; site lacks evidence, etc.) <p>OR</p> <p>Student argues that the site is reliable.</p>