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Squinting Through the Dawn of AI:

Embedding Algorithmic Literacy Principles in Library Instruction

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Another Literacy? A Statement of Purpose and Introduction to Algorithms

This paper will explain the relevance of algorithmic literacy to basic information literacy principles throughout the search process and its relation to artificial intelligence (AI). Furthermore, there will be examples of embedded conversations about algorithms in everyday library instruction sessions. These instruction sessions and activities took place at the University of North Texas Health Science Center at Fort Worth (UNT HSC), a publicly funded academic institution; we offer programs focused on training future healthcare providers, researchers, and public health professionals. Most students are in graduate-level programs, but there is a small (and growing) number of undergraduate programs available. Additionally, my teaching philosophy focuses on equipping students with skills they can use beyond the classroom in everyday life. I aim to provide an inclusive space that encourages every student to engage with the content, in order to become effective and ethical consumers of information. After an instructor requested that I include content about AI in an instruction session, I began to consider the role of AI in relation to my teaching philosophy and the *Framework for Information Literacy for Higher Education*.[1] Research on artificial intelligence and information seeking behaviors led me to explore how "the fundamental building blocks of AI systems"—algorithms—influence information seeking behavior in our everyday search practices beyond AI.[2]

At its core, an algorithm represents "finite sequences of rigorous instructions that have an input and an output" and while many types of algorithms serve different purposes, they generally use large amounts of data to "maximize engagement (and revenue) for the provider and/or platform."[3] In developing our awareness of algorithms, we might realize the pervasive existence of algorithms in an online search environment and their ability to "[select] what information is considered most relevant to us."[4] Every virtual interaction we have is influenced by an algorithm:

> Search engines help us navigate massive databases of information, or the entire web. Recommendation algorithms map our preferences against others, suggesting new or forgotten bits of culture for us to encounter. Algorithms manage

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> our interactions on social networking sites, highlighting the news of one friend while excluding another's. Algorithms designed to calculate what is "hot" or "trending" or "most discussed" skim the cream from the seemingly boundless chatter that's on offer. Together, these algorithms not only help us find information, they also provide a means to know what there is to know and how to know it, to participate in social and political discourse, and to familiarize ourselves with the publics in which we participate.[5]

Seemingly, "search engines are the 'public face' of algorithms [and] we tend to think of them as tools and evaluate them primarily based on their usefulness…this perception, however, sidesteps the rhetorical dimension of algorithms"[6] and users do not need to give it another thought. Algorithmic literacy aims to bring these behind-the-scenes decisions to light and encourage the user to consider how their reality is influenced by algorithms in search engines, artificial intelligence, and other technologies. A few actions are required for an algorithm to be functional and consequently a few ethical questions are raised.

First: someone must create the algorithm. As Dr. Safiya Umoja Noble outlines in her seminal work, *Algorithms of Oppression,* "there is a missing social and human context in some types of algorithmically driven decision making."[7] She points out ways in which Google has historically exemplified "how racism and sexism are part of the architecture and language of technology,"[8] seeping into result lists, such as racist images of Michelle Obama in lists of search results[9] and the word 'bisexual' being blacklisted from Instant Search.[10] Most unmistakably, a memo was written by an employee suggesting the inferiority of women.[11] Ergo, Dr. Noble's thesis: With bias embedded in the structure of algorithms, our search results are similarly impacted. We are acutely aware of Google's biases because "it has become a ubiquitous entity that is synonymous for many everyday users with 'the Internet' itself."[12] The scale and magnitude of Google's impact reveals gaping holes in search results, prompting us to question the reliability of search engines with smaller databases and other technologies that rely on algorithms to function. As a result, our first ethical question resides with the creator of the algorithm, their beliefs, and their values which they bring to our fingertips.

Second: the user's personal data is gathered for targeting. After an algorithm is created and "before results can be algorithmically provided, information must be collected, readied for the algorithm, and sometimes excluded or demoted."[13] User data is mined to personalize search results, prioritizing certain results in an effort to sell products or ideas. This raises the question: How much data mining is too much?

Third: an algorithm's output is not always understood by its developer. The machine learning algorithms that we interact with in search environments are generally in a state of constant improvement in order to provide a better, more relevant list of search results. However, once an algorithm is designed to improve certain aspects of itself independently, it no longer provides a rationale for how it returns a new list of search results, which creates a 'black box.' This environment of clouded conclusions is especially problematic at a health science center, where Evidence Based Medicine lies at the core of our practice. Black boxes prevent us from understanding how search result lists are compiled, but a lack of evidence is unacceptable when asking a generative AI chatbot (like ChatGPT) health related questions and using the answer to inform decisions that impact well-being and quality of life.[14] So, how do we justify the convenience of the input against the potentially harmful effects of the output?

Through a critical lens, we can safely conclude that "algorithmic systems make predictions that impact people's lives through choices in classification, sorting, ordering, and ranking; these decisions in turn shape what people know, who they know, what is visible, and what they experience."[15] Therefore, we should maintain a healthy level of skepticism not only when evaluating sources, but also when understanding how the tools we use to find sources impact our perceptions. It's impossible to avoid algorithms in research, but we can take careful steps to understand how "[algorithms] are responsible for the information—and point of view—presented to users,"[16] and better lead us to algorithmic literacy.

Algorithmic Literacy Defined

Definitions of algorithmic literacy range, focusing on different aspects of the roles algorithms play in daily life. A few definitions outlined by Archambault[17] are:

- "A critical awareness of what algorithms are, how they interact with human behavioral data in information systems, and an understanding of the social and ethical issues related to their use"[18]
- "The capacity and opportunity to be aware of both the presence and impact of algorithmically-driven systems on self- or collaboratively identified goals, and the capacity and opportunity to crystalize this understanding into a strategic use of these systems to accomplish said goals"[19]
- "Recognizing knowledge as situated, constructed within and in relation to the discursive landscape of social worlds and involving the cultivation of a critical consciousness through recognizing and responding to algorithms as expressions of broader systems of power"[20]

Oeldorf-Hirsch and Neubaum suggest four concepts that can be used to engage students in improving their own algorithmic literacy: curiosity, motivation, control, and practice.[21] First, while students are generally vaguely aware of an algorithm's role in curating their feed ("See similar articles" or "XX liked this post"), they must also develop a deeper *curiosity* to understand how the algorithm made the suggestion with remarkable accuracy. Next, students must be interested in how to manipulate an algorithm's output (maybe they are a content creator and are interested in boosting views or they are a member of a marginalized group and want to know why they are not represented in the content they see) and have a *motivation* to understand this. This is prevalent particularly in the context of social media applications like TikTok, where users feel more *control* in curating a For You Page than other forms of social media. Finally, the more users *practice* working with algorithms, the more competent and compelled they will be to use it strategically. Algorithmic literacy can be integrated into instruction sessions, but lasting impact lies with convincing students to take learning into their own hands.

The activities listed in this paper facilitate the knowing of algorithms, meaning we should at least "be aware of its presence and basic functioning, which varies greatly between individuals, and comes from a combination of formal learning, personal experiences, and third-party media and conversations."[22] Through a basic awareness of an algorithm, I hope students will be able to refine their search strategy, find relevant results, thoughtfully evaluate sources, and critically integrate them in order to inform their opinion (in or out of the classroom). This remains a lofty goal as it is the algorithm's purpose to be elusive and always just out of reach. A 'true' measure of literacy includes a feedback loop of questioning: "is it the user feeding the algorithm with more information so that it becomes more accurate or the user refraining from disclosing information to protect their privacy that is more literate?"[23]

Instruction Sessions Today

In a world inundated by information, especially information meant to persuade or sell, it can be overwhelming for students to parse out the "good" versus the "bad". Librarians are often seen as part of the solution in combatting misinformation and are called to deliver instruction sessions, where we are asked to "show students library databases," "teach students about research," or are invited on the first day of class as an introduction to tools they might need later in the semester. Faculty members requesting these sessions limit our interactions with students in time and/or content and librarians are left to juggle faculty expectations versus personal goals related to information literacy and library resources, all while gathering metrics that justify our work. We are left frustrated by the transactional nature of the one-shot instruction session, where "content is requested and then deposited into students' minds with a focus on measurable skills,"[24] but little opportunity for follow up and assessment. Students continue to wade through an Internet of information and each stakeholder in the library instruction session process is left wanting more.

With limited time and resources, I propose librarians consider a targeted focus on evaluating tools used to gather information and then translating those evaluation skills to the information itself. This can be folded into existing information literacy focused library sessions, as Archambault has begun this work by cross walking the principles of the *Framework for Information Literacy for Higher Education* and to algorithmic literacy.[25] Additionally, for library sessions focused on resources like databases (particularly those at health science centers), Kiester addresses the relevance in algorithms to databases and highlights that students should be "aware of the level of database transparency, [and this] should become a standard part of research training."[26] Users have a unique insight to the algorithms behind publicly funded databases (like PubMed), which is not true for databases maintained by privately owned companies. In taking time to understand how and why databases work, we can effectively direct students to the information literacy frames *Information Creation as a Process* and *Searching as Strategic Exploration*. Both frames can be used to center the role algorithms have in the larger information cycle and offer better insight to evaluation methods and decenter binary logic (a "good" versus a "bad" source) that is ultimately unhelpful in the larger information landscape.

Conversations about information seeking behavior now address tools outside of databases, like generative artificial intelligence. This is in part due to the release of ChatGPT, a generative AI tool developed by the company, OpenAI. For example, it has been reported that "health-related questions constitute 7% of Google's daily searches. Eighty-nine percent of patients use Google Search, WebMD, or other search engines before reaching out to their doctor. Those patients might conceivably adopt ChatGPT as another resource."[27] In brief, "Generative Pre-trained Transformer (GPT) models have revolutionized the field of natural language processing (NLP) with their ability to understand, generate, and interact in human-like language…trained on diverse internet text, it can generate coherent, contextually relevant responses and accomplish specific language tasks, making it a powerful tool with potential applications in medical research."[28] Generative AI tools including ChatGPT, Claude, DALL-E, Gemini, and more, are all supported by algorithms. In addition to the ethical concerns already presented by algorithms in this paper, the anthropomorphization of this technology creates an illusion of expertise and discourages evaluation of the information in the generated output. Due to the prevalent use of generative AI for information gathering purposes, it is arguably even more important to appraise this tool in full.

Algorithmic Literacy in Practice

Algorithmic literacy is challenging to assess, in part because algorithms are made to be invisible. Applying algorithmic literacy to technology is further complicated because some are marked as a tool "with AI" or "with a proprietary algorithm," but others are hidden behind the interface and make it hard to know when certain technologies are at work.[29] To bring these ideas to light, one activity I have implemented is popular in STEM classes (usually for K-12 education) but is a representative example of how algorithms are built. The work of translating algorithmic literacy to the classroom is diligent work, already started by Dr. Susan Archambault in "Expanding on the Frames: Making a Case for Algorithmic Literacy."[30] I have selected a few exercises and adapted them to my classes according to need and time constraints, building a Choose Your Own Adventure activity.

Most of the following activities are presented in conjunction with a few slides on artificial intelligence, usually at an instructor's request. AI is a special interest on campus and the library is often asked to conduct literature searches on AI in healthcare, as well as discuss the value of it in research. Yet, highlighting the ethical implications of algorithms and their use in artificial intelligence is not very popular with students. For a student, these technologies have the potential to completely transform the time and energy spent on assignments and only in a positive way. There is some resistance in engaging with the activities listed below, but students remain somewhat open to the idea that every tool requires evaluation.

Activity 1: Building Sets of Instructions

Before class begins, I place a stapler in a visible, but slightly hard to get to location; I will make sure that any instruction on getting there requires a mix of turns and a difference in elevation. After a short discussion on information seeking behaviors and the strategies that are best used in the research process, I will introduce a section on algorithms. A slide instructs:

> "We need a volunteer to grab the stapler across the room using the list of instructions below!
> - Move forward
> - Turn left
> - Bend down
> - Reach
> - Grab
>
> Can someone write down the directions as they're decided?"

After asking the class for volunteers, I choose someone who is significantly taller than me (this is easy) and once the class has instructed and documented the steps needed to grab the stapler, I change the slide. The next step instructs:

> "Using the directions we have created, I will attempt to grab the stapler again."

I ask the student who noted the instructions previously to read them aloud and I follow them according to my own stride (varies according to height). Though I end up close to the stapler at the end of the activity, I do not end up in the exact same spot as the previous student. I use this observation to start a conversation about how this set of instructions worked perfectly in one situation, but when translated to a slightly different context, the outcome was not identical. In the same way, algorithms are created with one use case in mind but are ultimately used in many different applications. In Evidence Based Medicine, we are looking for information that is as transparent and reproducible as possible—algorithms are not always helpful in the pursuit of this goal.

Activity 2: Choose Your Own Adventure

In longer sessions, I also include an activity that explores data privacy and issues of bias inherent in algorithms. I let students know they have 15 minutes to complete at least two of the following activities:

- ClickClickClick: A website that documents a user's movement and activity
- How Normal Am I?: A website that uses facial recognition technology to compare you to other users; the user must grant access to their camera
- Survival of the Best Fit: An interactive activity that takes users through the hiring process with the goal of improving the process for speed and efficiency
- Read Authors Guild v. Google, Inc.: A lawsuit filed against Google for copyright infringement; the court ruled in favor of Google, concluding that Google's actions fell within the purview of fair use

After 15 minutes, students submit insights to a Padlet with a prompt for each activity that reads, "What did you notice? Respond to this post to create a thread," followed by discussion. Unsurprisingly, there were not usually any responses for the reading activity. In one class session, the activity with the most responses was "How Normal Am I" and received the following responses:

> "it's kind of creepy and makes me scared of how much info can be taken about me"
> "You could manipulate the scores if you knew what it was looking for, I mewed and my attractive score went up 2 points"

"Very weird and not completely accurate, but interesting."

Prevalent on TikTok, "mewing" refers to a specific tongue posture when taking photos so that your jawline is more defined.

For the "ClickClickClick" activity (second most responses):

"He has a sense of humor similar to our generation"
"The computer is really watching us"
"It was attentive to small details I wouldn't normally think about"

For the "Survival of the Best Fit" activity:

"Creating an algorithm has a lot of human output"
"It was stressful"
"It took my implicit biases and multiplied them… oops"

These comments prompt a larger discussion about how tracking user behavior helps influence the content a user sees—something perhaps more prevalent than students might think. This exercise offers students an option to take their learning into their own hands and regain agency in the classroom (if not online).

Activity 3: Slides

There are other teaching opportunities in which I am not afforded the time to have an in-depth conversation about algorithms. I remain committed to algorithmic literacy, so I will at least include a slide that prompts students to think about how content comes across their screen. For example, in a one-shot workshop for high schoolers learning to evaluate health information online, a slide reads:

"PAUSE! You see everything for a reason…
Algorithms determine the information you come across on your social media feeds.
[I built this fyp brick by brick]"

With the next slide reading:

"Cookies leave crumbs behind so a website remembers your favorite things…
Algorithms are like a smart friend that guesses what you like based on those crumbs."

The quote, "I built this For You Page (FYP) brick by brick," in the slide described above is commonly seen in comment sections of social media posts (especially TikTok) and reminds users of the folk theories about algorithms they come across online.[31] This, and similar sayings, indicate users' larger awareness of algorithms, knowing that interacting with certain content will curate the experience they have online, further 'improving' their social media feeds to be more relevant to their preferences and interests. Implementing algorithmic literacy principles can feel like an overwhelming and impossible task to complete amid normal information literacy lessons. However, breaking it down piece by piece and including algorithmic literacy whenever possible creates a more attainable goal. Evaluation of sources can no longer only be the standard and any conversation must now also include a note about how we come across information.

Assessing Metrics

To measure my success as an instructor, I administer a pre- and post-test that sometimes vary in length depending on learning outcomes, but consistently include four questions about algorithmic interactions:

1. I can successfully manipulate content I see online (search results, social media feeds, etc.) by controlling the content I engage with (view, likes, comments, follows/subscriptions).

2. My social media feeds are an accurate representation of my interests, values, beliefs, and experiences.
3. When completing research, I understand how search results pages are populated and feel comfortable adapting my search terms to fit my research question requirements, if necessary.
4. In the past, I have successfully used library resources to complete research assignments.

Each question is given multiple choice options:

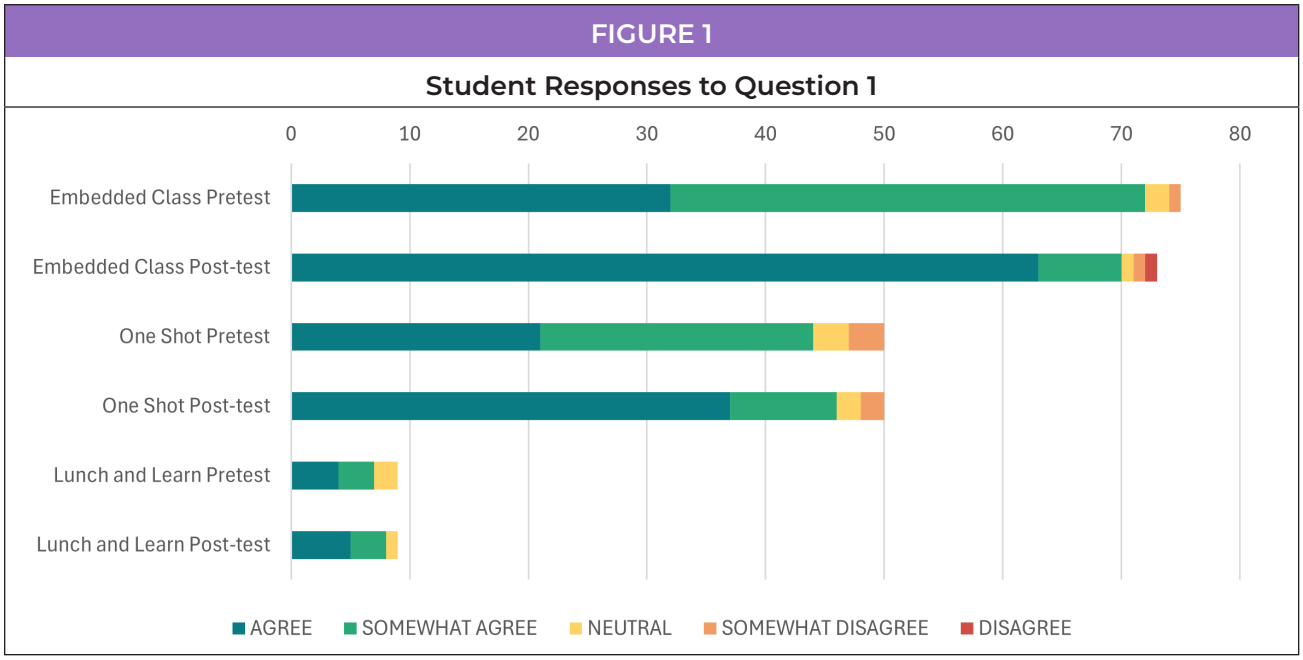
A. Agree
B. Somewhat Agree
C. Neutral
D. Somewhat Disagree
E. Disagree

Below are data from three different class types: an embedded class, a one-shot instruction session, and a lunch and learn workshop. The embedded class included all three activities, the one-shot instruction session included activities one and three, and the lunch and learn workshop only included activity three. Responses across all three class types remained consistent, with confidence significantly increasing in the post-test.

Question 1

I can successfully manipulate content I see online (search results, social media feeds, etc.) by controlling the content I engage with (view, likes, comments, follows/subscriptions).

FIGURE 1



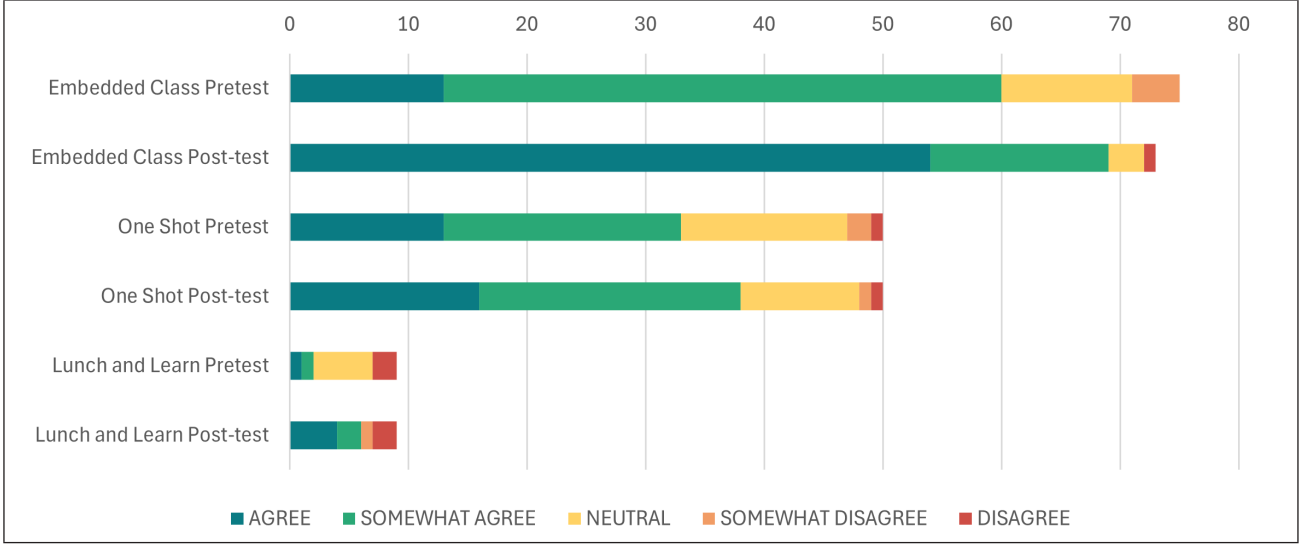
Analysis: Measuring students' confidence in curating algorithms before versus after the class session indicates how intentional the student is when engaging in online environments. One way to improve this question or pinpoint algorithmic awareness is to clarify how often they interact with algorithms and their perceptions about where algorithms do or do not exist. From the data, it appears the increase in confidence was higher when more activities were completed during class.

Question 2

My social media feeds are an accurate representation of my interests, values, beliefs, and experiences.

FIGURE 2

Student Responses to Question 2



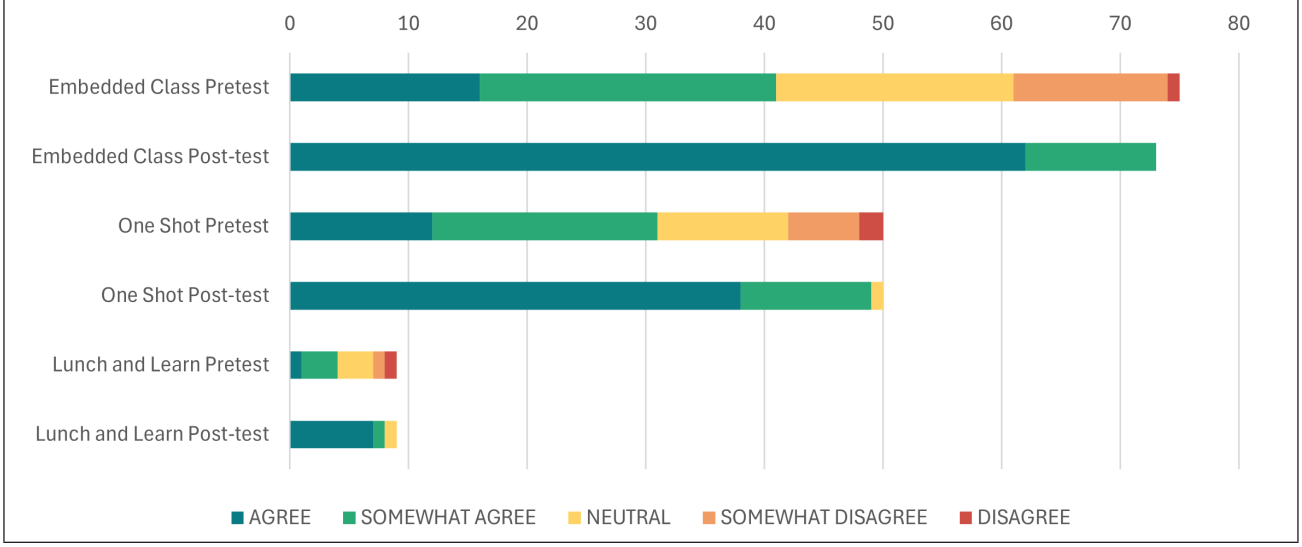
Analysis: Responses to this question were somewhat surprising because I expected confidence to decrease. Algorithms are a combination of personal data and interests of corporate entities. I imagined students would feel less represented after learning that their feeds are influenced by social, political, and economic interests outside of their control. This question could be enhanced with an additional question(s) about their demographic. If they identify as cis-white and/or heterosexual, they are more likely to feel seen online rather than a person of color or someone who identifies as LGBTQ+.[32]

Question 3

When completing research, I understand how search results pages are populated and feel comfortable adapting my search terms to fit my research question requirements, if necessary.

FIGURE 3

Student Responses to Question 3



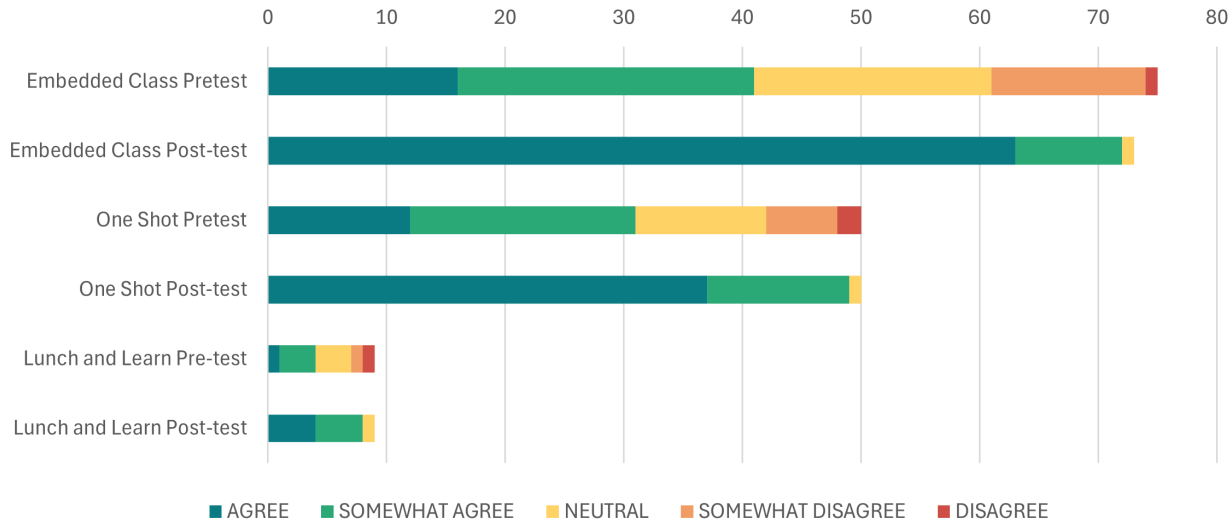
Analysis: There was a significant increase in confidence in all three types of classes, perhaps because of the special focus on PubMed's Best Match algorithm. In all instruction sessions, there were at least two slides explaining how understanding the database's algorithm will improve search strategy.

Question 4

In the past, I have successfully used library resources to complete research assignments.

FIGURE 4

Student Responses to Question 4



Analysis: As discussed throughout this paper, algorithms are inherent to search engines, therefore they are also a significant aspect of library resources. Most students today have only known a world where technology is integral to daily life but have never been instructed on how to effectively use these tools. Now that the research process has been moved online, it's imperative that research instruction includes ways to increase algorithmic literacy in order to lower the barrier to research and make it less overwhelming.

Discussion

Overall, after each instruction session, students seemed significantly more confident about their ability to identify and manipulate algorithms to their advantage. Even though it was not my outright intention, students' gained confidence aligns with the "control" aspect of the algorithmic literacy engagement framework and can be used to encourage students to further their own literacy. Survey results also indicate an awareness that a better understanding of algorithms will help them see more relevant search results and increase confidence when using library resources. At the very least, discussions about algorithms seem rare in classroom settings. I feel lucky to engage students in thinking about their information seeking behavior and ways to practically improve how they form opinions in and out of the classroom.

The range of services that libraries offer afford librarians the opportunity to spark important conversations about access and use of information. In highlighting the way different technologies influence our perceptions of the world; I hope students give at least one extra thought to their information seeking behavior and translate these skills to other areas of their life, particularly in patient care.

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