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Building transformative search engines: Understanding differences in the reflectivity of essays produced using ThoughtShuffler and Google

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Abstract

Studies suggest college students/adult learners interacting with current search tools like Google display tendency to power-browse and adhere to page-ranking order in choosing sources to supplement writing. Such limitations may limit critical reflectivity. We present a tool, ThoughtShuffler which allows users to malleably alter neighborhoods of keywords and presents results as arrays of cards and collections that can be compared and contrasted. We conducted binary qualitative coding of essays produced by 39 users divided into experimental and control conditions and computed a one-tailed t-test to understand if using ThoughtShuffler produced greater likelihood for higher-order reflectivity expressed in writing about efficacy of varied healthcare models in the U.S., compared to the use of Google to write about the same prompt. Our results suggest that updating search engine interfaces to afford capacity for lateral reading may present potential to augment reflective information search.

Keywords: ThoughtShuffler, Higher-Order Reflectivity

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Introduction

The Internet supports both adaptive and nihilistic user activity. Its use has become pervasive since its inception in the 1990s to find information/services, interact with similar others, and seek new perspectives that change the thinking of users (Glassman, 2016). Searching for information on the internet precedes much exploratory online activity (Lurie & Mustafaraj, 2018). It may allow a person running an

online clothing store on a platform like Grailed to search for good deals to source items from online boutiques (e.g., SSENSE, SVRN) to list in their virtual thrift store. If individuals seek services (Tuomi, 2002) embedded in cultural markets, it becomes convenient when an online search engine like Google can provide results locating commodities.

When it comes to navigating very complex social and scientific topics and developing nuanced views about them, simply inputting questions into a traditional search engine like Google may produce one-dimensional answers. This can create filter bubbles of information that may bias thinking (Parisier, 2011). The reason may lie in Google's algorithm being rooted in page-ranking technology among 200 signals to provide surety to users (Oulasvirta et al., 2009). The PageRank algorithm, developed by Brin & Page (1998) lists results by link popularity, prioritizing the pages most cited on other websites, treating them as highly reliable. However, the question to ask is whether certainty in answering a question on one's mind can produce as nuanced an answer as an emancipatory knowledge creation process (Scardamalia & Bereiter, 2006) leading users to jump from perspective to perspective. Through knowledge creation, users can explore varied ideas and present integrated arguments, allowing transformation of their perspectives regarding topics they deal with.

Weighing varied perspectives to come to an integrated solution to a problem is central to Mezirow's (1991, 2003) transformative learning theory. The theory states sustained work on a problem statement to grapple varied sides of an argument can produce nuanced thinking, and also civil discourse with others. Applying this notion of transformative learning to an individual's use of a well-designed search engine, the goal would be to create a cyclical conversation between user and tool with the user becoming able to evaluate sources by comparing them to others (or lateral reading) rather than adhering to one-dimensional ideologies about topics. Essentially, this entails changes in search engine interfaces to allow users to malleably alter search terms to find specific conceptual relationships in online sources that are relevant to their current epistemologies may spur lateral reading (Wineburg & McGrew, 2017). Any tool, in the context of producing sustained reflection, should be able to intake conceptual relationships relevant to a user (Pask, 1975b) and produce arrays of ideas to compare to facilitate critical reflection.

When computer-mediated reflection is viewed using Pask's cybernetic principles, both user and machine become nodes in a sociotechnical system that can be fine-tuned to produce adaptive reflection, learning, or even information seeking, depending on the tool's purpose, and the task (Scott, 2021). The human brains/bodies/computer hardware are M-individuals, and the ideas imbued within them (this would be Internet results in the search engine, and the conceptual focus of the user's search) are P-individuals. For example, in searching for sources, a participant studying about women's sexual health rights can use a computer loaded with the search engine (both M-individuals) to compare and contrast varied information sources, and attain a nuanced view of the systemic issue in the U.S. related to hot topics like abortion, by considering the implications of pro-life and pro-choice perspectives (the user perspectives and Internet data, both P-individuals, interact, and produce a P-individual). In a post-truth era marked by polarizing debates about controversial issues (Barzilai & Chinn, 2020; Glassman et al., 2023), equipping users with the skills to critically navigate concepts on the Internet, and creating interfaces allowing them greater malleability to do so can sharpen both ends of a sociotechnical system (human efficacy, and designed tools). Sociotechnical human-computer interaction can be pivoted towards solving specific wicked problems (Behymer & Flach, 2016) salient to society or even to smaller goal-oriented groups.Collaborative reasoning and argumentative writing become educational avenues to move human agency in adaptive directions in these systems.

In this qualitative study, we present a new search engine, ThoughtShuffler, that revisualizes Google's results as horizontal rows of cards, using a calculation that determines combinations of user keywords that enhance curiosity and knowledge about a topic (Pangaro, 2008).We hypothesize this interface will spur critical reflection to a greater degree than Google owing to greater opportunities for lateral reading and source comparison. We use writing produced by humans as a proxy for conceptual operators and understand difference in the and magnitude of these conceptual operators for participants using ThoughtShuffler and Google. We use Mezirow's (2003) transformative learning theory to specify psychological processes (namely, critical reflection) we investigate within our cybernetic framework of

M-individuals (humans, computers loaded with interfaces) and P-individuals (Internet data, intentions for search, ideas produced in writing).

Theoretical Framework

Information Search and reflection

Research shows that during internet exploration, individuals evaluate the credibility of information by relying on sources presented by tools like search engines and comparing them with their own prior knowledge (McGrew et al., 2018). Commonly deployed search engines like Google rely on ranked algorithms that sort pages by link popularity (Pangaro, 2008). Google allows us to pick an argument and search for ideas matching it. But it produces results relying on popularity metrics, and even blurbs or knowledge panels, providing answers to specific questions that may bias users to think in one direction or another (Jeanneney, 2008). Pariser (2011) provides the example of an oil tycoon and environmentalist using Google to search about oil spills. Both individuals are presented different ideas drawn from past search histories and digital footprints. The oil tycoon may reinforce their own thoughts about economic development, while the environmentalist may become disillusioned by the fallouts of industrialization or be spurred to create grassroots and practice-oriented efforts to raise awareness about detriments of crude oil as a primary energy source.

The filter bubble concern is magnified when considering young adults and college students who turn to the Internet often struggle to critically evaluate online sources through lateral reading (McGrew et al., 2018; Wineburg & McGrew, 2017). The reason students struggle with understanding source credibility and making nuanced arguments by using opposing sources is because of the rapid expansion of online information. This being said, how users interact with information and how search interfaces organize information can also inform reflective processes. Internet-mediated learning is not solely about being guided to specific information aligning with our perspectives. Transformative learning through interaction with online interfaces can be facilitated by critically evaluating ideas to understand the ramifications of the ideologies one possesses as an active citizen in a digitized society.

Jeanneney (2008) suggests page-rank search engines like Google produce results based on popularity and rank rather than scholarly and topical worth and do not provide a sandbox that can be utilized for in-depth analysis of problem statement. Eye-tracking studies of user interaction with Search Engine Results Pages (SERP) produced by Google showed users focus their attention to the top left and hover in an area around the first few results (Hotchkiss & Alston, 2005). This is called the Golden Triangle. With the rapid expansion of video, images and other heterogeneous formats, and incorporation of Knowledge Graphs (relationalities between concepts) into Google's results, this Golden Triangle is still used to explore the first few results, but is supplemented by vertical scrolling emblematic of interaction observed on popular social media (Maynes & Everdell, 2014). These two processes lend to the tendency for adult users to rely on the most immediate results produced on the SERP (Gwizdka & Bilal, 2017) without deeply considering source and argument.

Sticking to one's ideologies and strengthening them through results ranked by link popularity may make users interacting with each other even in distributed ecologies less willing to understand the how and why of their ideologies and how alternate perspectives may have worth. It is no surprise that high schoolers and even college students interacting with search engines find it difficult to engage in critical analysis (Skinnell, 2021). Educational offerings, specifically classes in argumentative writing fostering 21st century skills such as search engine use and source navigation may help learners attain skills for critical thinking in an information saturated society. We suggest Mezirow's (2003) transformative learning theory, which focuses on individual and collaborative reflection, may help lay out processes users undergo during information search. We treat human-computer interaction as a conversation, situating our specific investigation of transformative reflectivity in information search within Pask's conversation theory (Tilak, 2022). We describe how using a search engine can be considered as a reflective act using the nomenclature of M- and P- individual.

Transformative Learning, Conversation Theory, and Information Search

While studies show adult users interacting with search engines perceive that critically evaluating the credibility and argument made by information sources is important, they display limited competence to critically evaluate sources (Petrucco & Ferranti, 2017) and falsify (Popper, 1963) stances they take to make their arguments more powerful. Mezirow (1991) suggests criticality in interacting with knowledge can help morph perspectives about a particular problem and understand it in a more nuanced manner; what he called transformative learning. While there have been psychocritical and psychonalytic interpretations of the theory focusing on individual reflection, these have been expanded to consider socio-emotional and collaborative learning (Mälkki, 2010). We tap into these aspects but treat users and technologies as interacting systems within a problem-solving space; what Behymer & Flach (2016) call a sociotechnical system. We implement Mezirow's theory within a cybernetic framework relying on Pask's (1975b) conversation theory. Humans and computer systems/interfaces are M-individuals linked by conversational feedback loops, embodying concepts (Internet data, and prior knowledge) that produce new concepts or P-individuals that define ideas being investigated, and processes engaged to create nuanced arguments related to these ideas.

We contextualize a critically oriented information process search culminating in writing an essay, by situating Mezirow's 11-step theory (1991) within Pask's M- and P-individual nomenclature (see Figure 1). The user (M_1) embodies a dynamic P-individual (P1), starting out with a dilemma, and may examine their own views about a particular topic before interacting with the computer interface's (M_2) data (another P-individual, P2) to search for ideas. They then input ideas and statements they would like to focus their search on and critically assess their ideologies by recognizing, exploring, and comparing competing sources. They may jot down initial ideas as points or a rough essay to plan further writing. Following this, they may search for additional sources to further acquire knowledge related to the topic being investigated, supplementing their initial brief exploration. This initial jotting may help users provisionally understand what their interpretation of a particular topic roughly is, building their own confidence in the stance they take. After having a basic structure for their essay, the user reintegrates ideas, and forges a new relationship with the tool by being able to critically evaluate their own views, transforming their thinking. The writing of the user (P3) becomes a proxy for the P-individual produced by human-computer interaction.

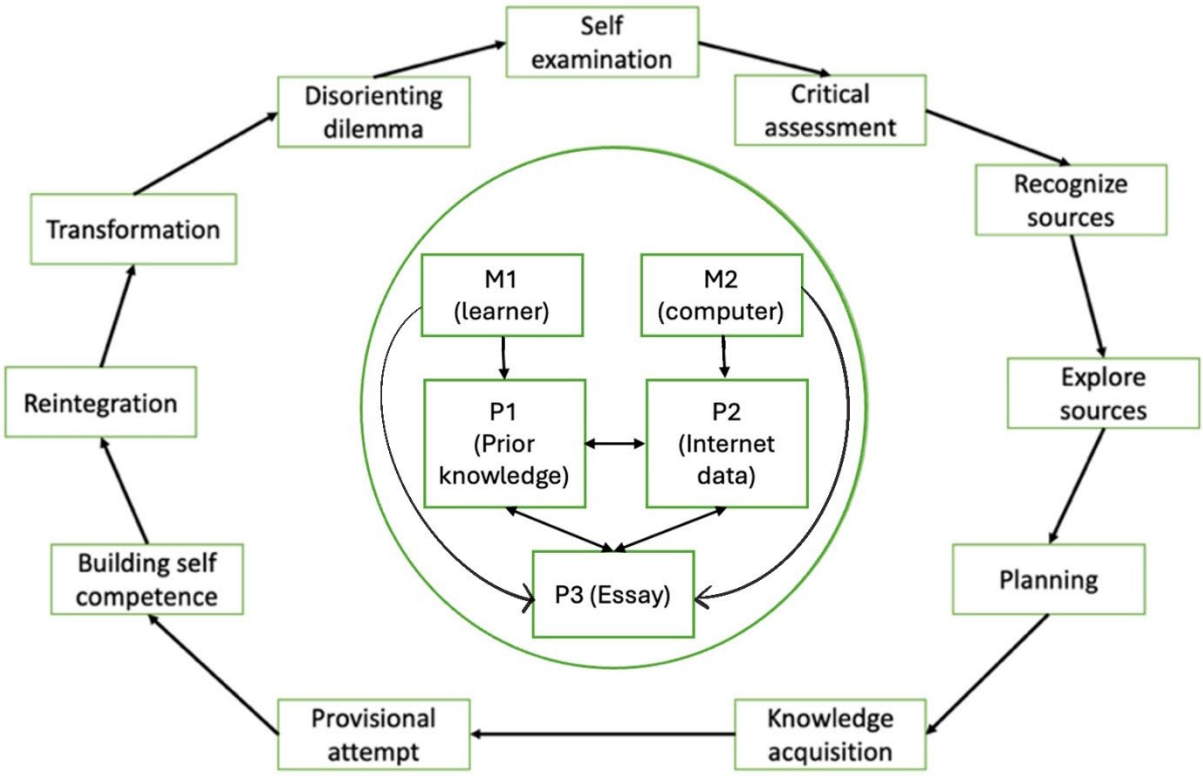

Figure 1: Critically reflective information search

While this interaction with a search tool presents hope for the creation of nuanced arguments and ideologies, our review of studies has shown that critically reflective human-computer interaction is a challenge with commonly deployed search engines like Google. In this study, we test user interaction with a new search engine known as ThoughtShuffler, to understand whether using it for tasks like argumentative writing can alleviate concerns with the lack of capacity for critical reflection in the use of traditional search engines.

ThoughtShuffler: Updating search-engine interface design

ThoughtShuffler is an interface design that may extend capabilities of present search engines like Google. While current tools primarily rely on a ranked popularity approach and implicitly incorporate Knowledge Graphs into search result production, we suggest making relational processes of search less abstract to users may enable greater autonomy in comparing/contrasting varied sources. ThoughtShuffler, designed by Paul Pangaro, a student of Pask, can spur an exploratory, reflective approach to information search. Rather than examining relationalities within inputted questions and sentences and producing answers/blurbs and results ranked by link popularity and keyword frequency among other criteria (as Google does), ThoughtShuffler accepts keywords as input and produces horizontal arrays of cards that contain keywords fed by the user and those suggested by the tool through an analysis of source content. In this section, we provide an overview of ThoughtShuffler's functionalities and visually showcase the tool.

The landing page for ThoughtShuffler is minimalistic and comprises a search bar (Figure 2) where keywords one desires to investigate related to a particular topic can be inputted. We input keywords related to a prompt related to universal, privatized and mixed healthcare models in the U.S. context, that our participants answered, to showcase ThoughtShuffler's functionalities. The prompt asked: S*hould universal healthcare be seriously considered in the U.S. as it has been in other countries or is it worthwhile to continue promoting private healthcare? Why?* This topic seemed relevant to adult learners/college students approaching and beyond the age of 26 years since insurance and healthcare coverage are topics of contention owing to high costs of medical assistance in the U.S.

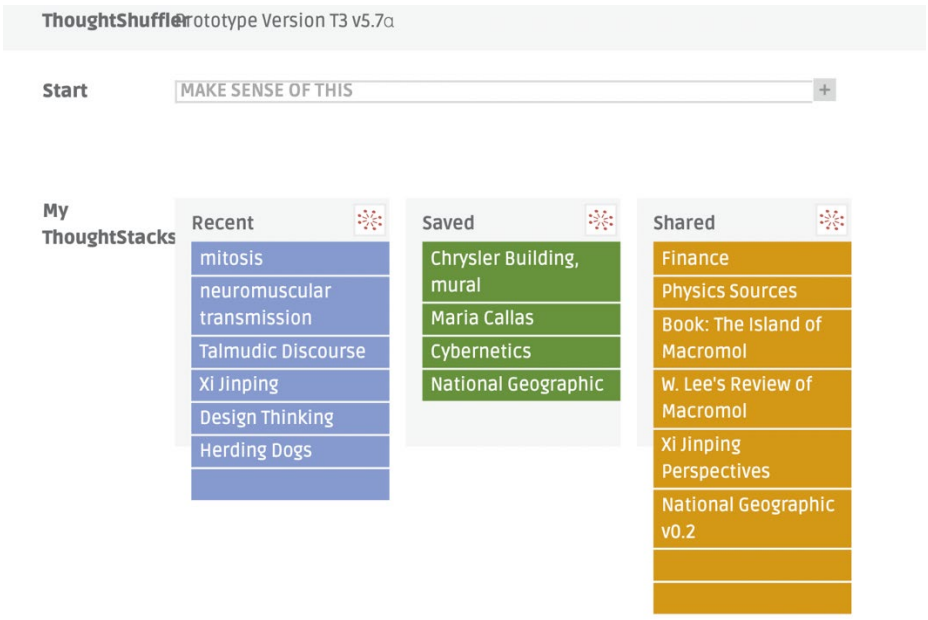

Figure 2: Landing page for ThoughtShuffler

If one is trying to search about efficacy of universal and privatized healthcare models using ThoughtShuffler, they can start with any number of base keywords separated by commas like "healthcare". This brings up the search interface (Figure 3) to input more keywords. Clicking the tool tips option at the top will provide specific directions for every time one hovers over a particular part of the interface. In our example, we inputted keywords like "universal", "cost", and "United States" to find more specific sources to better contextualize the essay writing task described in the methods section.

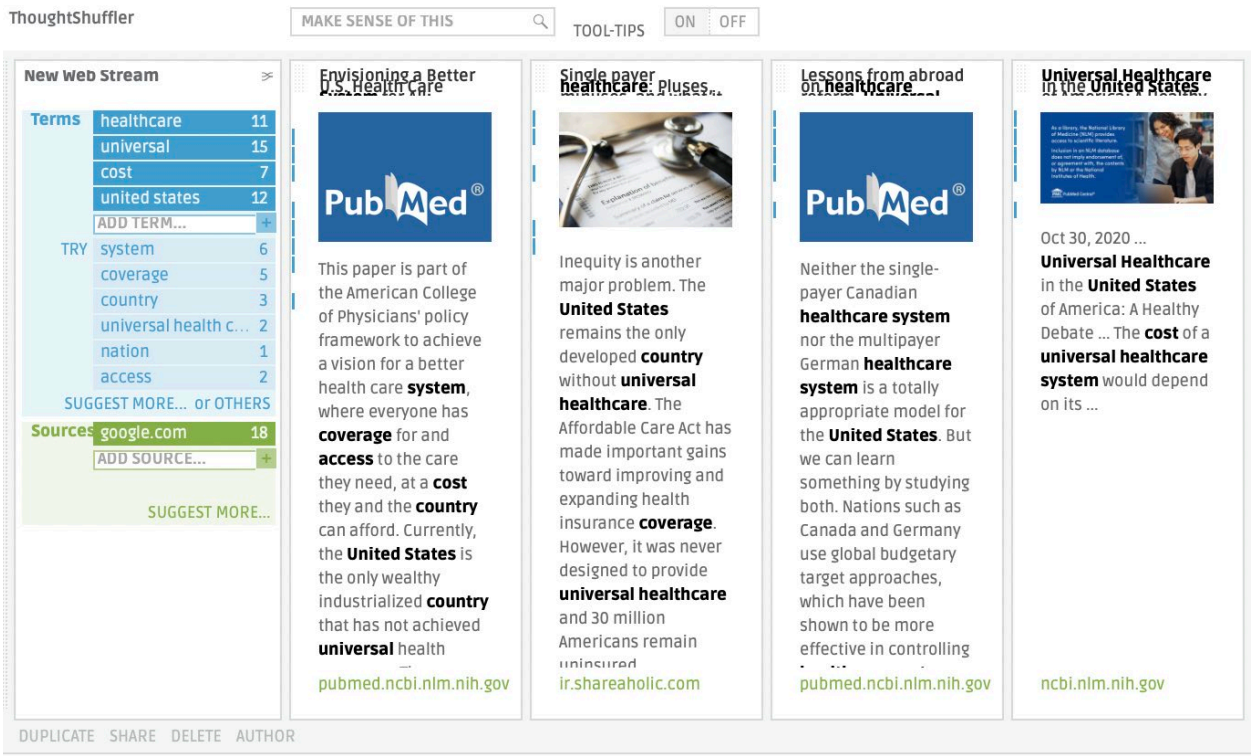

Figure 3: Array of cards produced in the search interface

The interface produced by inputting keywords into the engine comprises horizontal rows of cards to be clicked on (Figure 4). The tool suggests additional keywords by analyzing sources to find associated themes. Google's results are re-ranked based on the uncertainty presented by co-occurring user-fed and suggested keywords each source to users. The richest sources appear first, increasing both knowledge and curiosity about the search topic and regulating uncertainty. Each card can be expanded to reveal a notch displaying keywords it contains, displayed on the left-hand side of each card. The expanded card shows parsed text containing these specific keywords, allowing a user to understand immediately if it is relevant to their search. The user can modulate the number of keywords at will and doing so produces a different array.

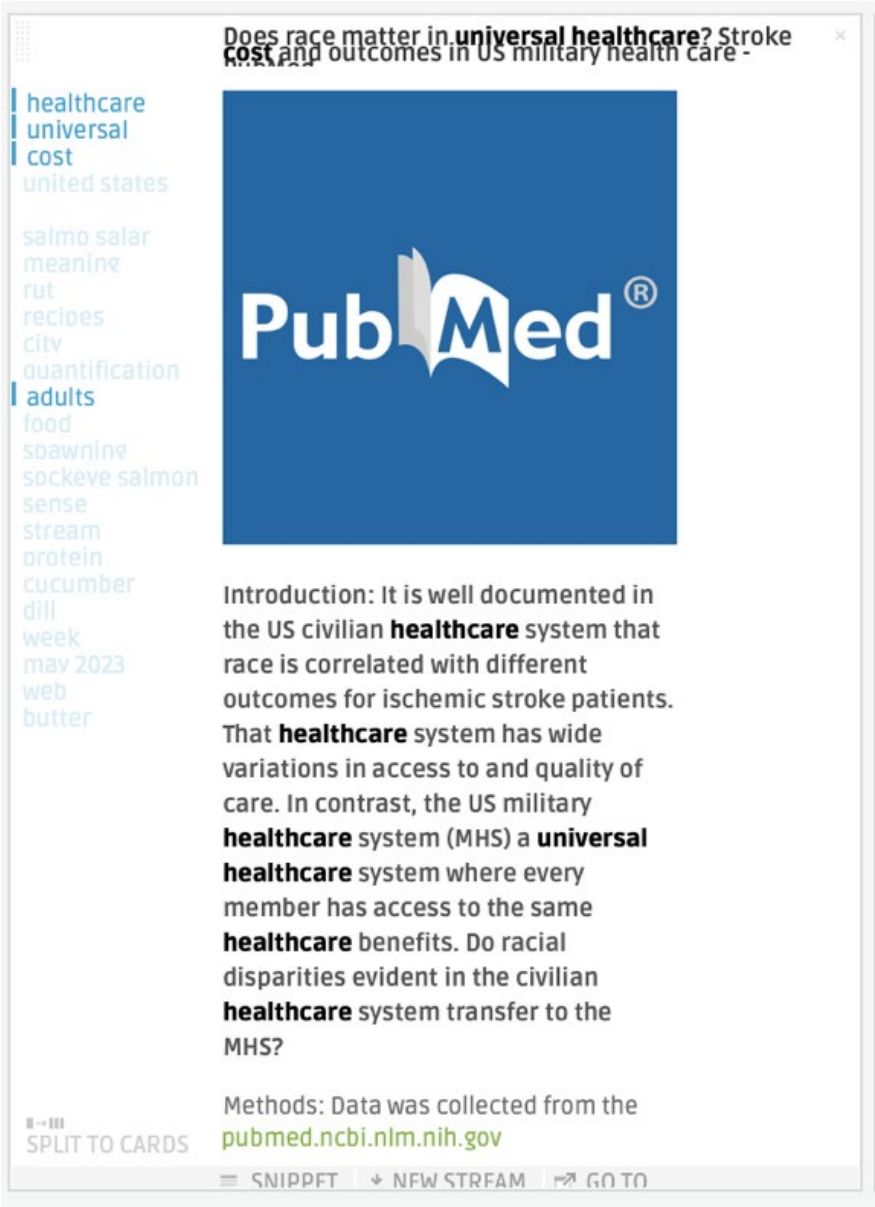

Figure 4: Expanded card displaying user inputted keywords

In addition to comparing ideas within one collection of keywords, the user may press the "Start New Collection" button in the center of the interface to initiate a search for a new neighborhood of keywords. In our example, we started a search about privatized healthcare in the U.S. context.

Figure 5 showcases the multiple collections that may enable users to compare and contrast universal and privatized healthcare models with greater ease. The tool allows users to engage in source comparison at two levels of specificity, within a collection of concepts, and between varied collections with nuanced differences and commonalities. Each source can be opened in a new window allowing the user to view the interface and the expanded source simultaneously. Those writing essays needing extensive source comparison may experience increased convenience in doing so.

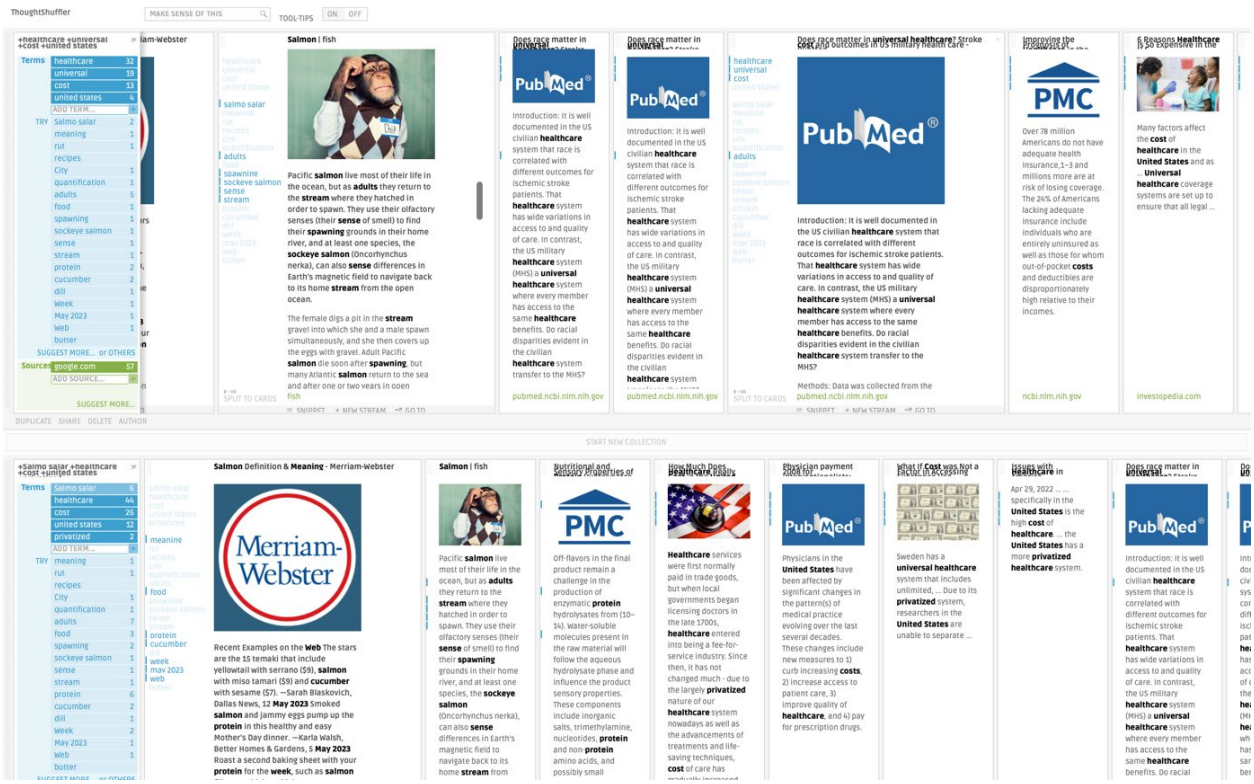

Figure 5: Varied collections to be compared and contrasted through lateral reading

Since ThoughtShuffler is in development, some features like multiple keyword input and creating new collections may exhibit bugs that our team is working on correcting through user experience studies that will inform the redesign process.

Present Study

We adopt a qualitative design and aim to understand differences in the magnitude of adult participants displaying different kinds of argumentative structure or reflectivity in writing produced using ThoughtShuffler and Google. Our aim is to understand if ThoughtShuffler can present users with higher likelihood for critical reflection that emerges from lateral source comparison; making it a potentially useful tool in college argumentative writing classes. We conduct coding of essays produced using both tools, and compute one-tailed t-tests to understand if there was significant difference in the proportion of users exhibiting higher-order reflectivity in our experimental and control groups. We hypothesize:
H1: *A greater number of adult learners/professionals using ThoughtShuffler will exhibit higher-order reflection in writing, compared to those using Google.*

Method

Data

Data were drawn from an experiment wherein adult participants were randomly assigned to a treatment or control group to write essays either using ThoughtShuffler or Google. Following the essay writing, the participants each gave a cognitive interview led by a member of the research team to answer questions about their information search process and describe it in greater detail. In this study, we test differences in the argumentative structure of essays in both groups, using a coding scheme our team previously developed (Tilak et al., 2020) to study the reflectivity of writing produced in college classes, based on Mezirow's transformative learning theory.

Participants

Thirty-nine adults (51.2% female, 48.8% male) participated, residing in the United Arab Emirates, the United States, and the Caribbean. The team used convenience sampling and recruited participants from classes in education and psychology at the university, and from their immediate network. Each participant received a $20 Starbucks gift Card. The study was approved by the university's Institutional Review Board. Local participants were invited to a well-lit room on the university campus to perform the task, while those situated in other states and countries were asked to participate via Zoom and share their screen with the observer to record their search process. Participants in the experimental condition were shown a short video tutorial about ThoughtShuffler before commencing essay writing and the following interview; those in the control group immediately began writing.

Coding Scheme

We employed a coding scheme that has been previously used to understand the type of reflectivity displayed in college students' writing (Tilak et al., 2020). The authors relied on Mezirow's theory of transformative learning and Habermas' ideas on instrumental and communicative rationality to create the coding scheme. Instrumental forms of reflection were rooted in considering just one side of an argument that a person adheres to in their own mind, while transformative reflectivity (akin to a more communicative rationality) involves reaching outwards to accrue new ideas and compare them to one's own. The four variables in the coding scheme are:

1. **Instrumental understanding:** involves collection of information or facts and its reproduction, rather than incorporating one's own standpoint, or critical analysis into writing.
2. **Instrumental critical reflection:** Involves making a one-sided argument and harshly critiquing a particular perspective, rather than presenting a balanced solution and critical analysis.
3. **Transformative understanding:** Involves weighing out varied sides of an argument without presenting a concrete solution or action plan.
4. **Transformative critical reflection:** Weighing out varied sides of an argument or problem statement and presenting a concrete solution or action plan based on this critical analysis.

The coding scheme treats each piece of writing (a blog, an essay) as a unit of analysis, and assigns binary contingency (0 for absence, 1 for presence) for each variable. Categories are mutually exclusive. In the next section, we provide examples of essays in our dataset that display each of the four types of reflectivity.

Coded Examples

We selected a handful of coded essays displaying reflectivity corresponding to each of the four coding categories. For each essay, the indication of the presence of a particular variable led them to be coded with a 1; all other three variables would be marked as 0 for their absence in a written essay.

Example 1: Instrumental Understanding

This essay was coded as exhibiting instrumental understanding because it states varied factual information and statistics about the mixed healthcare model in the U.S. without much incorporation of the participant's standpoint. Moreover, it does not come up with a balanced solution; rather suggesting a shift towards universal healthcare based on existing facts.

> *Healthcare is a contentious topic across the globe and many countries have their own policies. The two main stances on health care are public or universal healthcare coverage versus private healthcare. The topic is particularly salient in the United States and has been incorporated into political debates, especially during election periods. Controversy surrounding Obamacare or the Affordable Care Act is one example of the debate in the USA; criticisms often regard disrupting the current system, increased tax amounts, and political beliefs (i.e. during the 2016 election cycle universal healthcare was increasingly associated with candidate Bernie Sanders and socialism).*

Despite or even because of the debates surrounding universal healthcare in the USA, it should be seriously considered as it has been in other countries.

A primary reason that universal healthcare should be considered is the high costs associated with private healthcare for individual citizens. Although most people in the USA are insured, this insurance is often tied to employment (individual or a family member's) and it is very expensive. If someone is not able to be insured by these means, they may have access to Medicaid or Medicare, depending on a set of criteria like income level and state of residence. Further, health insurances are divided into health, dental, and vision. This means that someone who has health insurance in the USA may not have dental or vision insurance, but these things are considered part of one's overall health (because these insurance programs are separate, they also come at extra cost).

The high costs associated with private insurance plans may lead some to "take a chance" on being uninsured. The average monthly cost for insurance in the USA is over $500, and insurance does not always cover the costs of all medical procedures or visits which also have co-pays that can be as low as $15 or $300 to go to the emergency room. The healthcare system is difficult to navigate as individuals often must work with their employers, insurance companies, and hospitals or doctors' offices to make sure that procedures are covered. These are just some of the reasons that 41% of adults in the USA have some kind of healthcare debt, often between $1000 and $2500. If one is unable to cover the high monthly and annual costs associated with private health plans, they gamble with their health and savings accounts as costs for uninsured individuals are even higher. For example, emergency room visits can be an average of $1000-3000. Further, depending on where you live and the contracts your private insurance company has (if you are insured), this does not include an ambulance ride which can be an additional $1000.

This situation is simply not the same in other countries. While Canada and the UK have been criticized for long wait times and insufficient care, the burden of healthcare costs and concerns does not lie as heavily on the individual as it does in the USA for countries that have universal healthcare programs. Countries like South Korea, Taiwan, Denmark, and Sweden are all ranked at the top of lists for best universal healthcare programs, and each have different mechanisms for implementation. Most of these places still have private plan options through employers or for those with enough financial means to access them, but most individuals are enrolled and utilize the universal system. This means that the USA changing the dominant system would mean a big change, but not require the complete elimination of private insurance options. The USA should begin its serious exploration of universal healthcare as a shift in funding and resources that would relieve healthcare debt and burdens from Americans, especially low-income individuals, elderly residents, and those in precarious employment situations.

Lastly, the World Health Organization has named universal healthcare as a strategic priority. The USA should align itself with global health goals and priorities, especially since the country has regularly been ranked last among industrialized and high-income nations in the matter of healthcare.

Example 2: Instrumental Critical Reflection

The essay outlines detrimental effects of privatized healthcare models affecting individuals with lower socioeconomic status and lack of insurance. It proposes widespread adoption of universal healthcare models in the U.S. rather than weighing pros and cons of both models before coming to their conclusion and suggesting a new solution.

Universal healthcare in the United States should be seriously considered like other countries for several reasons. For the U.S. being the only developed country that has not implemented it, it spends

the most on healthcare costs. Yet there are countless stories of people who don't go to doctors or the emergency room because of the costs, specifically out-of-pocket; people have expressed that they would rather ride in Ubers than call for an ambulance due to the cost. Even with payment plans, the cost can still be too burdensome for those who do not have the income.

Those who are low in socioeconomic status can face a lot of problems with healthcare including decreased accessibility to resources and lower quality of health insurance, even though they need accessible resources and quality insurance the most. This can lead to a higher mortality rate in those who may have conditions like diabetes or hypertension. For example, those who have type II diabetes and are uninsured have a 55% increase in visits to the ER, and individuals who are uninsured with uncontrolled hypertension have greater annual healthcare costs- about $2,000.

Criticism of implementing universal healthcare in the United States include being unfeasible due to significant costs and an inefficient system, where patients may wait weeks or over a year. However, there have been proposals to combat these costs increasing taxes which would make those of higher socioeconomic status pay more in their taxes. Though the cost would be high, it would address the infrastructure changes, insuring and/or treating those who have conditions they were not able to treat, and expansion in the amount of services being provided. Furthermore, although the U.S. may experience an increase in wait time, it may be short-term due to increased visits from the removal of the financial barrier.

With the implementation of universal healthcare, it can reduce the health disparities by socioeconomic status and increase health preventative initiatives. Healthcare that is accessible and affordable allows for early intervention that can make chronic diseases preventable or have individuals be at the lower risk. Furthermore, by doing so, it addresses the chronic health crisis in this country by mitigating the economic costs. This not only helps the people, but helps to lessen economic strain.

Example 3: Transformative Understanding

The participant weighs the pros and cons of universal healthcare. While the essay doesn't discuss privatized models, it makes a balanced argument about universal models. It does not propose a new action plan that could create social change in the U.S. context. Hence, this essay was perceived by the raters as exhibiting transformative understanding.

Firstly, I do believe that universal healthcare should be taken seriously and actually applied in the United States. Based on what I have seen so far by using ThoughtShuffler, I do think that the healthcare system in the U.S. needs to be seriously reevaluated, because there definitely are worrying statistics or phenomena right before my eyes.

After including key words such as "improvement," or "universal healthcare" in my search, I have found from an article published in 2014 claiming that "to date, Congress has resisted enactment of universal healthcare even until this day." In addition, most of the results I have found are all about certain organizations (presumably private ones) working to solidify universal healthcare in the United States. For example, AHIP tries their best to "provide health care coverage , services to hundreds of million of Americans everyday."

In an article titled "More Americans now favor single government program to provide health care coverage", it is found that "a majority of Americans continue to say the federal government has a responsibility to make sure all Americans have healthcare coverage." While these findings do not necessarily demonstrate that "universal healthcare is in any way shape or form better than private healthcare," they do indeed show that there are enough Americans who believe that way.

As we all know, universal healthcare works in favor of those who are not as financially established. While universal healthcare probably puts more burden on the shoulder of the government, as a highly civilized as well as autonomous (which means free and sometimes democratic), the civilians are the absolute number one priority. An article on realkm.com claims what most of us already know: "universal health coverage (UHC) means that all people have access to the full range of quality health services they need, when and where they need." At the end of the day, a government is not some charity that just grants its people whatever they want, but universal health care is what enhances survival in the grand scheme of things.

Example 4: Transformative Critical Reflection

This essay describes ups and downs of universal and privatized healthcare models in the U.S. It looks at victories and challenges experienced in the American context and suggests a solution based on considering social determinants and systemic factors related to the cultural experiences of the larger populace to gauge the best models of healthcare to provide. It was thus labeled as transformative critical reflection.

The United States does not have a uniform health system and has no universal healthcare coverage. The health disadvantage of the U.S. relative to other high-income countries is health disparities in health services.

Although the U.S. is renowned for its leadership in biomedical research and cutting-edge medical technology, its medical system faces significant issues such as preventable medical errors, poor amenable mortality rates, and lack of transparency in treatment. Another problem that Americans are facing is difficulty in finding a good doctor. High costs of care and lack of insurance coverage for low and middle-class families have led to social and economic discrimination in healthcare services. The health care system in the United States is uncoordinated and fragmented and emphasizes intervention rather than prevention and comprehensive health management. Health care costs continue to increase at an unsustainable rate and quality is far from ideal.

The question was asked, "Should universal healthcare be seriously considered in the U.S. as it has been in other countries or is it worthwhile to continue promoting private healthcare?" My response to this question is "Yes! The United States of America should adapt to a universal healthcare system." By adapting to a Universal health coverage (UHC), more people would gain access to the health care they need without suffering financial hardship. UHC allows countries to make the most of their strongest asset: human capital. Supporting health represents a foundational investment in human capital and in economic growth—without good health, children are unable to go to school and adults are unable to go to work. It is one of the global economy's largest sectors and provides 50 million jobs, with the majority held by women.

Over the past two decades, policies implemented through the Children's Health Insurance Program (CHIP) and the Patient Protection and Affordable Care Act (ACA) have extended access to affordable health care coverage to millions of previously uninsured, non-Medicare eligible adults and children. The uninsured population reached a historic low of 8.8% under the implementation of these policies. The greatest gains in coverage have occurred among our most vulnerable populations and young adults. However, the rollback of some provisions of these policies has increased the percentage of those uninsured to 15.5%, close to what it was one decade ago when our uninsured rate was nearing 17%, with nearly 50 million people uninsured.

Ensuring that all people in the United States have affordable health care coverage that provides a defined set of essential health benefits (EHB) is necessary in order to move toward a healthier and

more productive society. Additionally, the health care system must begin to account for and address social determinants that have a profound impact on individual and population health outcomes and costs, such as socioeconomic status, housing and occupational conditions, food security, and the environment. As noted by the Commonwealth Fund, the design of a system to provide health care coverage to all people "will have a deep impact on its ability to make sustainable and systematic improvements in access to care, equity, quality of care, efficiency, and cost control." This is key to achieving the World Bank Group's (WBG) twin goals of ending extreme poverty and increasing equity and shared prosperity, and as such it is the driving force behind all of the WBG's health and nutrition investments.

Data Analysis

The three raters first coded 20% of the dataset and computed a three-way kappa score for each of the four variables in the coding scheme, using binary values and ensured that they indicated substantial to perfect agreement (O'Connor & Joffe, 2020). Upon ascertaining validity of the coding scheme through this agreement exercise, all essays were coded. Skewness and kurtosis values were computed for essays exhibiting each level of reflection. Following this, descriptives were computed in order to understand if there was a large difference in the number of control and experimental essays exhibiting each level of reflection. Based on insights from these descriptives, a one-tailed t-test was used to understand differences in magnitude of essays displaying transformative critical reflection in both groups.

Results

Interrater Reliability

Three raters coded 20% of the dataset (eight essays) using binary values (0 for the absence of each variable and 1 for their presence). Agreement was calculated using cross tabs in SPSS by computing a kappa value. Between three raters values between 0.6-1 were seen (Table 1) indicating substantial to almost perfect agreement on all four variables (O'Connor & Joffe, 2020).

Table 1: Interrater reliability

Raters	Instrumental Understanding	Instrumental Critical Reflection	Transformative Understanding	Transformative Critical Reflection
R1-R2	1	1	0.6	0.78
R2-R3	1	1	1	1
R1-R3	1	1	0.6	0.78

None of the four variables exhibited excess skewness or kurtosis ($>\pm 3$ and 10 respectively). There was slightly high skewness for instrumental understanding (Table 2). This meant data in the remaining variables were most suitable to conduct t-tests.

Table 2: Descriptive statistics (n = 39)

			Skewness		Kurtosis	
	Mean	*SD*	Statistic	Error	Statistic	Error
Instrumental Understanding	.10	.307	2.726	.378	5.722	.741
Instrumental CR	.28	.456	1.008	.378	-1.040	.741
Transformative Understanding	.31	.468	.867	.378	-1.319	.741
Transformative CR	.31	.468	.867	.378	-1.319	.741

We further computed simple descriptives to gauge if t-tests were warranted owing to a large difference in a magnitude of essays exhibiting a particular kind of reflection. Among 20 experimental participants, 45% exhibited transformative critical reflection (Figure 6) in their essays, while only three of 19 control participants exhibited this reflectivity. Both instrumental critical reflection (criticism of a perspective and unequivocal adoption of an opposing one) and transformative understanding (weighing opposing perspectives without suggestion of an integrated solution) were exhibited by more control group users.

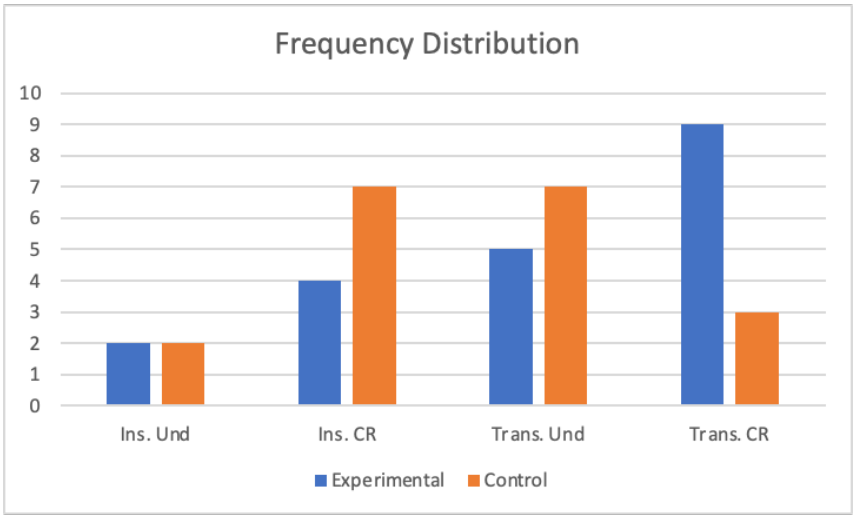

Figure 6: Frequency distribution in both groups

ThoughtShuffler was hypothesized to allow users to write essays about universal and privatized healthcare models in the U.S. context that weighed out varied pros and cons of both models but also suggested a new solution to create change. Such elements in their writing would be emblematic of transformative critical reflection.

The high number of participant essays coded as displaying transformative reflection prompted us to analyze differences between groups for this variable. We also tested differences in the magnitude of instrumental critical reflection and transformative understanding displayed by both groups but found no significant difference.

When we tested for differences in transformative critical reflection, the violation of the assumption of homogeneity of variance indicated by Levene's test for equality of variance [$F(1, 38) =$

5.596, p = .0233], prompted a Welch's t-test (Table 3). Results of the one-tailed Welch's t-test (owing to a directional hypothesis) indicated the number of essays exhibiting transformative critical reflection in the experimental group (M=0.45, SD=0.510) were significantly higher [t(34.835) = -2.044 p = .024] than the number displaying such reflectivity control group (M=0.16, SD=0.375). This supports the hypothesis that using ThoughtShuffler would allow a greater number of participants writing essays exhibiting transformative critical reflection. A Cohen's d of 0.5 indicated a medium effect size for this difference in the number of users (Cohen, 1988).

Table 3: Results of the T-test of Transformative CR

	N	Mean	*SD*	*df*	*t*	*p*
Experimental Group	20	.45	.375	34.835	-2.044	.024
Control Group	19	.16	.510			

Our results displayed that more users interacting with ThoughtShuffler to write argumentative essays were able to explore and reintegrate ideas into nuanced arguments weighing out possibilities rather than adopt one-dimensional answers taking a particular side when compared to Google users. This would mean that the use of ThoughtShuffler can heighten the likelihood for users to engage in transformative reflection in their writing, fulfilling our hypothesis.

Discussion

Our single hypothesis (H1) posits: *a greater number of adult learners/professionals using ThoughtShuffler will exhibit higher-order reflection in writing, compared to those using Google.* Results of our t-tests suggest the interface offered by ThoughtShuffler that makes relationalities between concepts clearer rather than implicit (as in the case of Google's Knowledge Graph functionality) to the user can allow greater efficacy in lateral reading, comparing and contrasting varied sources, and presenting cohesive arguments and actionable solutions to a problem statement. Compared to Google's use, which has been characterized by vertical scrolling, tendency to follow along to the order ranked results (Maynes & Everdell, 2014; Gwizdka & Bilal, 2017), and power browsing to find ideas that solely match one's ideology, the writing produced by users interacting ThoughtShuffler showed greater likelihood to display nuanced reflectivity or transformative critical reflection. User essays weighed the ups and downs related to varied aspects of the healthcare-related prompt, and presented change-oriented solutions that could be applied to the U.S. context. We suggest search trajectories produced through ThoughtShuffler's use have a high likelihood spur transformative learning through human-computer interaction.

While Google has made massive strides in organizing the complexity of online information (Brin & Page, 1998), it may not give enough autonomy to users to engage in lateral reading, guiding users towards answers rather than trajectories of exploration. ThoughtShuffler may help counter concerns arising from filter bubbles on the Internet (Parisier, 2011) and limited engagement with critical analysis while exploring online sources. It does so by offering potential to present search results in varied collections, purely based on the uncertainty and curiosity that collections of concepts pique from users based on inputted and suggested keywords. Studies suggest training users in lateral reading (Wineburg & McGrew, 2017) and nuanced reasoning may help alleviate concerns with a lack of effortful reflection. ThoughtShuffler embodies a solution to this concern and may act as an educational technology that helps create scenarios for students to engage in deeply reflective online searches. Future directions to practically implement ThoughtShuffler include applications to argumentative writing classes focusing on

21st century research skills (Skinnell, 2021) at the college and high school level, to facilitate effortful source comparison in searching for data to refer to while writing.

Limitations

Our study is limited by a small sample of 39 participants. However, since t-tests extend from an in-depth qualitative analysis of each essay written by both control and experimental participants, this sample may suffice to understand quality of argumentative structures in the essays. Further experimentation with new adult participants and younger populations may help understand if reflectivity in using ThoughtShuffler can be generalized across age groups, cultural contexts, and to neurodiverse populations. The research team is aiming to further study the tool's use with late adolescents with learning differences to inform the scope of reprogramming, and ensure it accounts for the widest range of learning experiences. The second limitation is using essays as a unit of analysis. The coding scheme, previously utilized to longitudinally understand reflective qualities of student blogs (Tilak et al., 2020) focuses on general argumentative structure in a text. Sentence-by-sentence analysis of argumentative structure may prove helpful in investigating deeper nuances in reflection produced in our experimental and control groups.

The third limitation is the fact that ThoughtShuffler is still being developed to fine-tune its features for formal deployment. Our study is part of the first iteration of data-driven efforts to investigate its use. While keyword input, tool tips and creating new collections function smoothly, several features (saving searches, author notes) are yet in development. Multiple keyword input and appearance of keywords in each notch sometimes exhibit bugs reported in a few instances. Further analysis of interview data will facilitate effective reprogramming of ThoughtShuffler. The final limitation of this study lies in its goal to understand the use of ThoughtShuffler in a restricted one-to-one human-machine conversational context rather than a naturalistic classroom. Our proposal to further investigate the incorporation of ThoughtShuffler into classes on academic writing and language arts at the high school and college level calls upon a prolific path forward for this research program.

Conclusion

Our results show there is potential for updates in interface design to current search engines like Google. These updates, embodied by technologies like ThoughtShuffler, may encourage users to create nuanced reflective arguments about ideas they search for online. We argue the capacity to weigh varied arguments and integrate ideas is the hallmark of critical reflection, but also can have downstream effects on civil discourse, that allows consideration of the perspective of the other, falsification of one’s own ideas, and creation of informationally healthy social systems. In an era where arguments about issues like climate change, vaccines, and women’s sexual health rights turn into “post-truths”, efficacy for critical reflection and interface designs supporting it may hark upon a more hopeful future in the Information Age.

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