INFORMATION INFLUX (INFOFLUX) AND CRITICAL THINKING: EVALUATING EDUCACTION TECHNOLOGY EFFICACIES FOR TEACHING AND ASSESSING CRITICAL THINKING IN THE DIGITAL AGE

by

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A major research paper submitted in conformity with the requirements for the degree of Master of Teaching
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Abstract

This research evaluates the pedagogical success of mindJig, an educational technology created to foster critical thinking competencies in a large online class (Kapoor, 2015). The study is focussed on the importance of critical thinking in the infoflux: a term I am using to denote the reality where students are constantly bombarded with continually changing information through social media, smartphones, and the internet more generally. A lab test was conducted in a simulated classroom where students completed the mindJig assignment three times during the semester. Participants were undergraduate students who signed up for the study to fulfill their experimental participation requirement. A mixed methods analysis was done to analyse student understanding of critical thinking after using mindJig. Results suggest mindJig’s existing structure can be reorganized, however, the tool’s combined focus on critical reading, critical literacy, critical noticing, and critical listening, better supports students in exercising critical thinking in infoflux realities.

Keywords: Critical thinking, critical thinking education, critical noticing, critical literacy, critical reading, critical listening, education technology, online learning, infoflux, digital information, media literacy, information literacy.
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Chapter 1: Introduction

1.0 Research Context

Twenty-first century, or higher order thinking skills like critical thinking, creative thinking, communication, metacognition, and collaboration (Joordens, Paré, & Collimore, 2014) are increasingly considered core aspects of learning across all levels of education (Ontario Ministry of Education, 2016). According to the Partnership for 21st Century Learning (P21), these skills are considered essential in preparing students for the challenges of work, life, and citizenship as well as sustaining ongoing economic innovation and democratic health of the world (2018). In an effort to foster 21st century skills in an online class, Joordens and Paré created an educational software called peerScholar (Paré & Joordens, 2008). Joordens and Paré use peerScholar in their Introductory Psychology course at the University of Toronto Scarborough (UTSC). This course is delivered fully online and has an approximate enrollment of 2000 students in the fall and winter term and 400 students in the summer term. Using a three-step process, peerScholar asks students to write a brief essay, evaluate the work of six other peers, and then revise the original draft in light of the feedback they receive (Joordens, Paré, & Collimore, 2014). Students are expected to develop critical thinking skills in the process of evaluating the work of their peers, deciding the usefulness of the feedback they receive, and reflecting on their own work through the peer review process (Joordens, Paré, & Collimore, 2014). It was noticed that while students develop critical thinking skills by participating in peer-to-peer assessment, the essays students write to begin with are not very critical. Student grades for this assignment tend to average around 49-50% because their essays lack nuance and credible evidence from scholarly sources (S. Joordens, personal communication, 2015). Students in this class tend to defend one side of the issue being debated, without accounting for competing
perspectives or complexities. Students also tend to pick a thesis claim, and then pick evidence to support their claim as opposed to forming an argument from their scansion of the literature. For example, if the assigned question was, “Should humans eat meat?”, most students pick a yes or no answer to the question without taking other practical issues into mind (i.e. Is it feasible to tell all people to stop eating meat? Should we tell communities to stop eating meat if their religious or cultural practices tell them otherwise? Is it possible for all people to get sustained access to vegetarian foods in geographic locations like the tundra?)¹ Students tend to only cite evidence that supports their claims without exploring contradicting evidence. Even if the source they cite counters their original claim, students tend to ignore these alternative viewpoints and cite only the parts that favours their thesis. Students do not critically evaluate the issue nor the cited evidence.

In an effort to help students in the course produce more critical first drafts, I created a tool called mindJig (Kapoor, 2015). mindJig uses already established pedagogical strategies like literary criticism, Socratic debate, and jigsaw to get students to start thinking about information from multiple perspectives (Kapoor, 2015). The program positions students to create an argument (after noticing the data rather than the other way around), debate about their arguments with their peers to seek competing perspectives, and work collaboratively to reach nuanced consensus on the issue at hand. mindJig was also designed to help improve students’ overall critical thinking skills in digital environments because in an increasingly digitized era, students are constantly bombarded with information via social media, smartphones, and the internet more

¹ Questions are purposely kept simple because Introductory Psychology is a first year course and the goal of the assignment is to help students get practice in academic research and writing. However, even when more complex questions are assigned or if students are given a workshop from the Writing Centre or the Library on academic writing, this problem continues to persist.
generally. I define the notion of this information overload as the infoflux. mindJig aims to help
students develop a mindset where they critically evaluate all information they come across from
multiple perspectives, as well as identify what perspectives any given piece of digital
information omits.

1.1 Research Problem

Beta tests of an initial version of mindJig reveal this tool provided students with a clearer
idea of the critical thinking process (Kapoor, 2015). However, the tool’s efficacy in enabling
students to become more adept at critically analyzing digital information is unclear (Kapoor,
2015). While many educators acknowledge the problem of an information influx in preventing
students from critically evaluating information, there is a lack of empirical research that studies
how students can critically evaluate information in infoflux realities. Through media literacy,
information literacy, and critical literacy classes, instructors teach students how to evaluate
digital information—but how do we get students to develop a mindset where they think critically
in their digital lives continually? This in itself is a large goal and this study cannot unequivocally
demonstrate how students can be taught to think critically at all times; however, I highlight
potential pedagogical practices to support students in this direction moving forwards.

1.2 Purpose of the Study

The aim of this research is to use a pilot test to measure the efficacy of mindJig in helping
students think critically, specifically in terms of their peerScholar assignments and in terms of
their infoflux realities.

1.3 Research Questions

This study focuses on the following research questions and specific sub-questions:

1. Does a mindJig assignment help students think more critically?
1.4 Background of the Researcher and Reflexive Positioning Statement

My personal experience with Joordens and Paré’s research inspired me to pursue this study. I used peerScholar as a student in Introductory Psychology, currently work as a Teaching Assistant to grade peerScholar assignments, and also train other Teaching Assistants to effectively grade peerScholar assignments. My prior research on mindJig was also supervised by Dr. Joordens and this allowed me to gain a unique perspective about the needs of students in this course. However, this also means that my study is tailored for UTSC Introductory Psychology students and the results may or may not be generalizable to other students or courses.

With the arrival of “fake news” and “post-truth” as neologisms in pop discourse\(^2\), I am also especially interested in finding out how students can be taught to objectively analyse an issue when they are constantly presented with informational biases in the form of fact. If individuals are not developing a mindset where they are constantly questioning the validity of information they come across, are they more susceptible to accept biased information as fact? I

\(^2\) Oxford Dictionaries claimed “post-truth” the word of the year in 2016. Post-truth defines an adjective “relating to or denoting circumstances in which objective facts are less influential in shaping public opinion than appeals to emotion or personal belief” (Oxford Dictionaries, 2016, para. 1).
have an undergraduate degree in English Literature which focussed heavily on critical literacy and the critical analysis of culture and knowledge. My graduate degree focussed a lot on critical pedagogy and the importance of challenging posited hegemony. This allowed me to develop a constantly critical mindset and adopt critical theory, a mode of philosophical and empirical social analysis of modern culture (Leitch, Cain, Finke, Johnson, & McGowan, 2010), as a theoretical framework in my research and personal life. My interest in critical thinking, critical literacy, critical pedagogy, and critical theory, shaped the basis of mindJig. Yet in the pursuit of evidence based pedagogy, I want to determine the extent to which this approach is able to help students exercise better critical thinking competencies.

1.5 Study Overview

I conducted a mixed methods study to empirically determine the efficacy of mindJig’s pedagogy. A sample of students from Introductory Psychology were invited into the lab to test mindJig’s pedagogy (sans technology) over a course of three sessions, prior to completing the peerScholar assignment in their course.

In this paper, I will describe results from a literature review that explores how educators are getting students to think critically in infoflux worlds. I will then explain my methodology, experiment design, and results of the study. Finally, I will talk about the implications of my findings not just for mindJig’s pedagogical design, but also for teaching critical thinking in the 21st century more broadly.

Before I move on, I would like to make a note about the terminology that will be used in this paper. I will be using “critical thinking skills” and “critical thinking competencies” interchangeably. Existing literature claims critical thinking is better represented with the term competencies rather than skills because competency is a broader concept (Ontario, 2016). The
European Commission’s Cedefop glossary defines a skill as “the ability to perform tasks and solve problems, while a competency is seen as the ability to apply learning adequately in a defined context” (as cited in Ontario, 2016, p. 9). While I will be using critical thinking skills and competencies interchangeably, the underlying understanding persists that critical thinking is not a singular skill but rather a broader competency or set of competencies that must be learned over time.

When describing the influx of information in digital environments, I have also chosen to coin my own term, infoflux, instead of using existing terms like “information overload,” “infoxification,” or “infobesity.” Words like information overload, infoxification, or infobesity tend to describe the phenomenon of too many search results as relevant to library research or database searches, rather than focussing on the overarching reality of constantly being in a state of information overload, or describing the reality of the swiftly changing nature of information. In order to avoid ambiguity, I chose “infoflux” to discuss the influx of information I am discussing in this paper.

Furthermore, this paper highlights the importance of critical thinking skills in a digital world. When I make claims about the proliferation of digital information available to our students, I assume students live in environments with easy access to internet and other digital devices like smartphones, tablets, computers, etc. While it is unfortunately true there is a digital divide that disproportionately prevents people in lower income communities and countries from accessing the internet or digital devices to the degree that more affluent communities and economies can (Chen, Gallagher-Mackay, & Kidder, 2014), this paper focuses on communities who benefit from easy internet access, while making the claim that critical thinking competencies are important for all students using the internet, regardless of digital access.
Chapter 2: Literature Review

This review aims to explore how educators are preparing students to think critically in infoflux worlds. I coined the term infoflux to describe a constant state of being bombarded with information, and the swiftly changing nature of how information comes at us in the digital era. In an age of smartphones and social media, people are constantly bombarded with information from all ends. The number, variety, and rapid development of the apps and technologies that provide this information also changes which further contributes to a state of infoflux. A typical American is estimated to consume approximately 15.5 hours of traditional and digital information per day (Short, 2013). This is the equivalent of “8.75 zettabytes annually, or 74 gigabytes—9 DVDs worth—of data sent to the average consumer on an average day” (Short, 2013, p. 7). Yet, as Fornaciari and Roca (1999) highlight, “Information and knowledge are not the same thing...Information by itself is merely building material that requires synthesis and analysis to create knowledge and to lead to effective decisions” (p. 732). With the advent of the television, Neil Postman (1985) illustrated the beginnings of infoflux with TV’s famous “Now this!” jingle using which newscasters could jump from talking about a devastating tragedy to the latest celebrity gossip in a matter of seconds. Google, Facebook, Whatsapp, Snapchat, and Twitter, among a host of many more digital platforms, have heightened Postman’s original infoflux: according to a media usage report in the UK, 12 to 15 year olds alone spend 18.9 hours a week online (Ofcom, 2015). Rather than allowing students time to critically process the information they read, digital platforms foster a scroll fast culture where students get information through short fleeting bytes.

Carr (2010) argues, “When we go online, we enter an environment that promotes cursory reading, hurried and distracted thinking, and superficial learning” (cited in Baker, 2012, p. 266).
In a study on developing critical thinking in adolescents, Marin and Halpern (2010) discuss the notion of an infoflux and claim, “The proliferation of information via the Internet will only be managed effectively by individuals with well-developed thinking skills” (p. 3). This is especially important because students tend to accept the information they read without questioning its validity. Gibson and Tranter (2000) conducted a study on how critically students look at digital information and they determined 62.5% of middle school students (1058 respondents) perceived between 50-70% of the information they read on the internet as true, 21.8% of the students (369 respondents) perceived 80-100% of the information on the internet as true, while only 11.4% of the students (193 respondents) perceived 0-40% of internet information as true. Gibson and Tranter’s study was published in 2000 and predates the social media era. However, their findings seem to be true today too. Ofcom, the communications regulator in the UK found out, “One in five 12-15s who use search engines believe that if a search engine lists information it must be true” (Ofcom, 2015, p. 7). From a higher education perspective too, Al-Harrasi and Al-Badi (2014) found college students find it difficult to trust, filter, and select all the different information accessed from social networking. According to Al-Harrasi and Al-Badi’s study, the majority of students use social networking sites for research purposes and only 28% of students tend not to trust any social networking sites like Facebook or Twitter. In an era with more information than ever, there is a clear case for helping students develop a mindset where they are cognizant of this information influx and are consciously attempting to question the validity of digital information.

2.0 Literature Search Criteria

To research how educators are preparing students to think critically in infoflux worlds, a search with the following terms was used: ((“information overload” OR “infobesity” OR
“infoxication”) AND (“information literacy” OR “critical literacy” OR “critical digital literacy” OR “critical thinking”) AND (“digital” OR “online” OR “internet”). The search results were limited to peer reviewed articles in the following databases: Sociological Abstracts, PsychInfo, ERIC, CBCA Education, Library and Information Sciences Abstracts, and Education Source. Since infoflux is term I coined, I did not search using this term as it yielded no results.

2.1 Too Much Information: Infoflux, Information Overload, How Do We Define It?

Existing literature on the topic operationalizes the notion of too much information with terms like “information overload,” “infobesity,” or “infoxification.” Yet, a key issue with this terminology is that it looks at the notion of information influx predominantly in terms of academic contexts or librarianship. For example, Al-Harrasi and Al-Badi define information overload as receiving too much information (2014). However, they proposed a solution to this issue by asking educators to cultivate particular techniques among students to filter the information overload. Similar to my experience with grading peerScholar assignments, their study highlights, “64% of college students are selecting the first source in their search list, 35% use authentic or well-known sites, and only 1% use other techniques to filter the information they receive” (p. 131). However, when I discuss the importance of thinking critically for infoflux realities, I am not just talking about developing better filtering or database searching skills. Students can learn how to effectively search for literature as they progress into their university careers, but how do we get students to critically analyse the information itself? By asking students to filter information, we are treating a symptom of infoflux and not the root cause: even if students get fewer hits when performing online searches, it is imperative for them to learn how to critique the content in individual search results.
Al-Harrasi and Al-Badi emphasize the importance of using authentic or well-known sites, but this is another key issue with information overload studies. It is important to teach students how to critique information that comes from trusted sources because all information has some level of bias. Baker (2012) echoes this sentiment in claiming much of information literacy education tends to be framed as a technical issue of tools and skills. However, as Godwin (2009) explains, this may not be the best way to approach problems of information overload; instead of simply concentrating on databases, there should be a collaborative effort to help students understand what exactly trusted sources mean, understand how information is created, and how it can be transmitted ethically.

From a librarianship perspective, Blummer and Kenton (2014) describe information overload as the reality of getting too many search results. They conducted a literature review to identify best practices for reducing information overload. Their study found information presentation (the way information is organized on information guides or library websites), library instruction (helping students develop critical thinking and database search skills), user strategies and librarian roles (individual coping strategies), along with software technologies all play a part in reducing information overload. Most of these strategies focused on helping students receive fewer and more focused search results to avoid the information overload altogether. One of the strategies Blummer and Kenton discovered focused on helping students cultivate critical thinking skills. They cite Bawden, Holthan, and Courtney to explain, “Information literacy instruction fosters an individual’s critical thinking skills in the selection of materials” (as cited in Blummer & Kenton, 2014, p. 121), which allows students to better deal with information overload. In this instance too, critical thinking is defined as the ability to select materials rather than the ability to actually think about the material itself.
To help users reduce information overload, Taha (2005) created a knowledge map (k-map) as a model for e-literacy instruction. According to this map, students start with understanding the basic foundation of computer and Internet tools, move onto define the topic, choose an information seeking strategy, locate and access the information, understand the information, synthesize their searches, and then evaluate the information. When students evaluate information, they are supposed to do the following: “Judge the results (effectiveness); judge the process (efficiency); assessment (relevance, authority, reliability, accuracy, coverage)” (Taha, 2005, p. 74). Here, one tenet of assessment of information tends to be focussed on gauging authority of the text. While peer reviewed articles, for instance, can be more authoritative than social media posts on a topic, does authority equate credibility?

Even authoritative texts can be biased and lack competing perspectives because avenues like peer review are typically not accessible to marginalized voices. Likewise, when marginalized voices don’t have access to authoritative venues in the first place, then social media platforms become first person primary voices for these authors. For example, various school textbooks (i.e. *Canada Revisited*), journal articles, and government publications can present the narratives of Indigenous people in Canada through racist perspectives. These publications present the dominant perspectives of a white ruling class. Yet, first hand blogs and Twitter accounts by Indigenous voices like @âpihtawikosisân, @indigenousXca, @cricketcrocker, or @rjago offer competing perspectives about Indigenous experiences in Canada. In one of his tweets, Robert Jaggo claimed prior to Twitter, he was not able to get work as a journalist and
writer as an Indigenous person. However, after establishing his agency on social media, he was able to get work talking about the same issues he was tweeting about: something that was not possible prior to the Twitter era because mainstream publishing houses were not accessible spaces for Indigenous writers. While Jaggo and other such individuals are using platforms that would traditionally be considered unscholarly, that does not mean their ideas lack validity. When we aim to teach students to think critically in infoflux realities, I want to investigate how we can get students to critique the information being communicated instead of just the medium.

Other articles I found in my search also tend to ignore the importance of critical reading as a component of critical thinking in the digital era. Badke (2010) states, the biggest problem with information overload is learning to sift through all the data we come across. However, is it just sifting? What about learning to figure out whether the text in itself is true, whether it leaves out important voices, and how it is biased? Badke goes on to state it is important to teach students how to find the best information rather than the most convenient information (2010). While this is true, the focus of treating information overload here once again rests on the act of finding information rather than reading information. How do students know what is the best information? Reflecting on personal experience, T.A. Barron feels the role of modern day parents is much like the role of librarians because parents must teach their children how to distinguish between “solid research, Info Lite, and Info Wrong” (2010, p. 20). However, I argue we can’t just stop after teaching students whether a piece of information is solid research or not—we need to get students to critically engage with solid research to figure out the biases in

3 Interestingly enough, I am unable to provide citations of Jaggo’s claims because he recently deactivated his Twitter account to recuperate from an immense amount of racist and threatening messages he was receiving—he claims his account will likely be back up in the future (R Jaggo, 2018); this ironically exemplifies the fleeting nature of information in the infoflux.
even authoritative information. Barron (2010) suggests we need to help children learn how to “…sift, understand, evaluate, and prioritize information. Rather than try to keep children from ever being exposed to meaningless or destructive material...we need to help them gain the ability to judge for themselves” (p. 20). This is absolutely true, yet as we teach students these invaluable skills, we have to be careful that students do not end up relying solely on mental heuristics about what type of information is credible, and instead look at information critically from a variety of perspectives.

As Baker (2012) identifies, to help students overcome the infoflux, the issue of information overload must be approached as an epistemological or social problem concerned with reading and interpretation. Students may be able to escape the information overload when searching for information on library databases, but they cannot escape this overload in an infoflux reality more generally. Whether students learn to, or need to do boolean searches or not, the vast majority of adults will search the internet for information on an everyday basis (Cahill, 2008). With the advent of smartphones and social media, information is all around students both inside and outside of class. Unlike terms such as information overload, infobesity, or infoxication, infoflux is not just concerned with too many search results: infoflux is concerned with the overarching reality of having access to too much information, and how to prepare students to develop a comprehensive mindset that is cognizant and critical of all information.

2.2 Challenges of the Infoflux

While it is indeed important to help students develop a critical mindset towards all types of digital information, this is no easy feat to achieve. After polling his students on the issue, Badke (2010) explains one of the problems with the infoflux is that students are often unaware of this problem in the first place. With information constantly swirling around us, it is difficult to be
cognizant of the very fact that there is too much information for us to process. Goulding claims students get paralyzed by an inability to appropriately judge information (as cited in Blummer & Kenton, 2014). In an action research study on problems related to the infoflux, Scott (2005) also found the hypertext environment of the internet (i.e. things like website text, graphics, advertisements, navigational menus, colours, among other things which are on the same page as the main content itself) makes digital information processing more difficult for students.

In a study which compared student and faculty research practices, Head (2008) found unlike faculty, students quite obviously have little knowledge of existing scholarly research in their respective disciplines. Leckie claims, this causes students to “have a fixed level of cognitive development in which they find ambiguity and non-linearity threatening” (as cited in Head, 2008, p. 429). This is also perhaps why it is more difficult for students to make nuanced arguments that look at the shades of grey instead of choosing black or white extremes in their assignments. Assignments like peerScholar, which ask students to write argumentative research papers and evaluate scholarly evidence to advance a proposition are signature assignments for undergraduate university students (Head, 2008). Yet, pressures to be original and creative make this type of assignment challenging for students. Students struggle with limiting the scope of their research project and dealing with the influx of information when completing their assignments. Interestingly, students typically respond to these research pressures by simply accessing nearby and convenient resources. As a result, most students are challenged by basic information literacy skills like retrieving, evaluating, selecting, and using information.

Grappling with infoflux then is not something that can be taught to students with just one assignment. This is rather something students may learn over time by learning a variety of skills including things like how to properly conduct and understand scholarly research. While it is
clearly important to teach students information retrieval skills as current information overload movements are trying to do, the focus of infoflux education shouldn’t solely rest on information retrieval; there should be an equal focus on teaching students how to critically engage with texts. In fact, this might help alleviate some of the pressures students face when dealing with an influx of information because it reassures students that even if they are unable to sift through all existing knowledge on the topic, they can start by critically looking at a select number of search results. Currently, students grapple with the information overload by using time saving strategies like satisficing (limiting information acquisitions) or skimming off the top (Blummer & Kenton, 2014). Yet, this doesn’t allow students to deeply understand any of the information they read. If students are told to look at information critically, even a limited amount of information, it not only offers them a richer learning experience, it also allows them to start developing a mindset that critiques all information they come across.

2.3 Critical Thinking in the 21st Century

If we want students to focus on critically analysing the content of information in infoflux worlds, how exactly should critical thinking skills be taught in the 21st century? Gainer (2013) believes to help students grapple with the influx of information in digital worlds, educators should focus on critical literacy because students must be able to read the world in order to develop 21st century literacies. Critical literacy advocates readers to adopt critical perspectives toward a text in order to uncover underlying messages. It ultimately asks readers to challenge and problematize texts because it assumes all texts are constructions, all texts contain belief and value messages, interpretation of texts vary from person to person, and all texts are created for different purposes (Ontario, 2009). Further, a text is not just limited to written information, but can be any means of communication that uses “words, graphics, sounds, and/or images in print,
oral, visual, or electronic form” (Ontario, 2006, p. 159). In a semantic way, all information students come across in digital worlds is a form of text.

However, critical literacy and critical thinking are different tropes. Critical thinking is concerned with systemic analysis and evaluation to make judgements (Vaughn & MacDonald, 2010). Whereas, critical literacy is:

The capacity for a particular type of critical thinking that involves looking beyond the literal meaning of a text to determine what is present and what is missing, in order to analyse and evaluate the text’s complete meaning and the author’s intent. Critical literacy goes beyond conventional critical thinking by focusing on issues related to fairness, equity, and social justice. Critically literate students adopt a critical stance, asking what view of the world the text advances and whether they find this view acceptable. (Ontario, 2008, p. 38 )

Critical literacy’s focus on social justice education makes it markedly different from critical thinking. Yet, in infoflux realities, students are bombarded with information, and this information often does not include competing perspectives. For instance, if an individual’s Facebook friends think in the same manner as the individual about issues related to politics, economics, and social policy, the individual is less likely to think about competing perspectives. As such, to help students adopt critical perspectives towards digital information, it is important to teach students to question whose voices are missing when they analyse any type of information. This inevitably lends itself to critical literacy approaches rather than more traditional forms of critical thinking. In the era of infoflux, it is increasingly important for students to question what the competing perspective is and what perspectives are not accounted for in the information’s underlying message. When we teach students to understand a text, we often get students to try
and comprehend what the information is saying, yet it is equally important to get students to identify what the information is not saying. To allow for more nuanced arguments, students must actively rely on elements of critical literacy to question what perspectives they are not considering in their analyses.

To foster students’ critical thinking skills, it is also equally important to teach students to critically listen to competing perspectives. Critical listening is directly related to critical thinking because when people come from completely different worldviews (such as Indigenous-Settler relationships for instance), people need to be taught how to critically listen to each other in an attempt to understand, instead of simply listening to defend their existing positionality. This requires an embodied approach to critical thinking where students critically question whose voices are missing and deeply think about competing worldviews. Yet, in this process, students must also exercise empathy because to welcome opposing worldviews into their lives, students must be able to empathize with people different from them, and go on to use metacognitive skills to think about their own thinking and challenge privileged or prejudiced thought processes.

In light of adopting critical literacy oriented perspectives, Aceituno (2011) believes literary criticism can be another extremely useful framework in helping students develop critical awareness of information and establish meaningful connections with the issues being studied. Literary criticism is defined as:

The estimation of the value of a particular work or body of work on such grounds as: the personal and/or cultural significance of the themes and the uses of language of a text; the insights and impact of a text; and the aesthetic production (or performance) of the text; particularly as these areas are seen to be mutually dependent, supportive or inflective...Judgments of value are not simple, however. They require that one consider
what constitutes value, what the personal and social value of literature is, what the value of 'the aesthetic' is. And they require that one interpret the text. As texts judged to be of high literary value tend to be marked by complexity and even ambiguity, and to yield diverse interpretations, judgment may ultimately require a theory of interpretation, or at least careful attention to the question of what constitutes, guides, and legitimates interpretation. (Lye, 1998)

Once again, this discussion of texts and their languages does not just denote written texts or works of literature. In the context of identifying how to think critically in an influx of information, the idea of literary criticism extends to all types of information. With a literary criticism like approach, students are taught to treat all information as a text needing to be critiqued. The piece of information is not just looked at in isolation, but rather, within the socio-cultural context in which it was produced.

This kind of literary criticism also requires students to dissect the information itself to identify the messages it imparts⁴. Students are reading the text to figure out what it is saying, rather than figuring out what aspects of the text conform to their beliefs. Rosenwasser, Stephen, and Babington explain this kind of literary criticism with their “Notice and Focus” technique (2006, p.26). To prevent students from using preconceived arguments when analysing information critically, with Notice and Focus, students have to train themselves to first notice the data and facts around them, and based on what they notice, focus and develop an argument. Successful analysis of information requires students to be able to notice all that the information

⁴ It is important to note there are a variety of schools of literary criticism (i.e. structuralism, formalism, new criticism, psychoanalytic, etc.). However, some schools are more appropriate to the argument presented in this research than others (i.e. postcolonial, feminist, queer, Marxist, critical theory, etc.).
has to offer before analysing their observations and drawing conclusions. The literary criticism approach to critical thinking can help students think more critically about their infoflux worlds.

In summary, this approach ultimately asks students to look at all components of the text to determine the underlying messages, and then determine the critical so-what: why is this underlying message significant? All information in the digital realm is a type of text: be it emojis, memes, Facebook posts, Instagram pictures, Tweets, Snaps, etc. All information can be critically analysed, and to help students problematize and dissect information in the infoflux well, critical reading, critical literacy, critical listening, and literary analysis, all play a hand in fostering effective critical thinking skills.
Chapter 3: Methods

This study used a quasi-experimental (Miles & Banyard, 2007), mixed methods design (Creswell, 2007). The study focussed on a sample of 66 (n=66) students from an available course population of 520 (n=520) students. Of this sample, 37 students (n=37) were in the control group (n=37) and 29 students were in the experimental group (n=29).

3.0 Research Approach and Theoretical Frameworks Used

This study was conducted using a mixed methods approach (Creswell, 2007). A mixed methods approach was useful in this context for a number of reasons. When determining the efficacy of mindJig’s pedagogy in helping students learn how to think critically, this study also inevitably focuses on finding meaningful assessment models. As such, it is important to find models of assessment that can be used in the massive online Introductory Psychology course. For example, in the existing Introductory Psychology course, it is often very difficult to qualitatively analyse teaching assistant feedback on student essays (peerScholar assignments), especially when there are close to two-thousand students in the course. Educators rely on numeric grades to determine how well students in the whole class are grasping concepts such as critical thinking (Joordens, Paré, & Collimore, 2014; Joordens, personal communication, 2013).

Nevertheless, when reviewing various critical thinking and assessment methods, Kaupp, Frank, and Chen (2014) highlighted a misalignment between critical thinking frameworks and standardized instruments that measure critical thinking. Kaupp, Frank, and Chen (2014) also argue critical thinking assessment should be approached holistically because the larger construct of critical thinking is closely connected to a variety of criteria or skills. Critical thinking is a complex thing to teach and I contend assessment of student ability to understand critical thinking cannot be captured with numerical grades alone. A mixed methods approach is more appropriate
in this context because it allows systematic and quantitative measurement of critical thinking competencies, while also understanding emerging trends of what elements of critical thinking students are comfortable exercising, and what elements they require more practice with (Creswell, 2007).

This research emulates a form of action research (Mertler, 2009). Even though I was working with a subset of students in a lab setting, this subset formed a type of classroom I engaged with throughout the course of the term. Teaching naturally evolved over subsequent sessions so an emergent design was used to allow room for the topics of study or medium of delivery to be modified based on student needs over time.

3.1 Study Context

The Introductory Psychology course for which mindJig was designed is in itself an example of a real life laboratory or a learning environment that encourages “reflective practice among students, teachers, and researchers” (Brown, 1992, p. 174). The premise of this classroom is such that during the regular fall/winter session, 500 students have the option of watching lectures in person, while the remaining 1500 students watch online recordings of lectures (Joordens, 2017). Over the summer, about 500 students are enrolled into the course and they all watch lecture recordings from the regular fall/winter session. All course assignments in both fall/winter and summer sessions are administered through education technologies developed specifically for this course. The efficacy of these technologies is continually tested in this live lab of 2500 students (Joordens, 2017). While education research benefits from reflexive practices that aim to create an intervention in the whole learning environment (Brown, 1992), in a course this large, it becomes important to pilot the intervention on a subset of the population, prior to making the intervention on the full population. Piloting the intervention allows educators to
identify best practices for implementation on a large scale and also controls for student frustration, administrative issues, and other problems that could potentially arise with the new intervention (Kapoor, 2015). I am trying to create an educational software that is rooted in evidence based pedagogical research, so prior to rebuilding and modifying the interface of this software, this pilot study also allows me to determine whether mindJig’s pedagogy actually works or not.

3.2 Participants

Participants included students from the summer 2017 session of Introductory Psychology (PSYA01 and PSYA02) courses at the University of Toronto Scarborough. These courses are online courses with a combined population of 520 students (n=520). mindJig was initially designed for Introductory Psychology students, as such, this experiment was conducted with students from this course. Students in PSA01/PSYA02 are required to participate in three hours of experimental participation as part of their course grade. Researchers throughout the university post their experiments on a web app called SONA. Students then login to SONA and self select studies they wish to participate in. Participants in my research all chose to be a part of this study via SONA. This study took place over the course of three months. It took a total of two and a half hours of each participant’s time in the experimental group, and one hour of each participant’s time in the control group (See Appendix C for full structure of study). Thirty-seven students signed up to be in the control group (n=37) and 29 students signed up to be in the experimental group (n=29). Samples obtained from SONA studies are often treated as random samples since every student has an equal chance of being able to choose to participate in the study. Both the Introductory Psychology courses are exactly the same in structure in terms of coursework and assignments, so the population parameters in this study were made up of
students in both courses (mean peerScholar grades tend to average around 50.67% every year in both parts of the course). However, there were some students who were enrolled in Part 1 as well as Part 2 of the course so their data was eliminated from the sample and the population means. As a result, peerScholar grades of a sample of 25 students (n=25) from the experimental group, were compared to the population of 424 (n=424). In the qualitative analysis, the data of six students from each group was analysed (Experimental Group: n=6; Control Group: n=6). These participants were selected through a systematic random sample, where every fifth participant from each group was chosen until all six participants were identified.

3.3 Study Process and Procedures

The experiment included one control group and one experimental group, each subject to a pretest-posttest design (Miles & Banyard, 2007). In the pretest, both groups answered a questionnaire (See Appendix E) that recorded students’ baseline understanding of critical thinking. Students in the control group also filled out a consent form as part of the pretest (See Appendix A). Students were asked to define critical thinking in their own words and also analyse two social media images so I could identify how they were applying their initial understanding of critical thinking when looking at digital information. In the posttest (See Appendix F), both groups answered a questionnaire similar to the pretest where they were asked to record their understanding of critical thinking at the end of the course and analyse two images of digital information. The posttest also gathered demographic data and asked students to answer other questions to illustrate their ability to think critically in digital environments.

The independent variable (IV) was the availability or lack thereof of mindJig pedagogy. The experimental group was given the intervention where they participated in three 30 minute sessions using the mindJig pedagogy. A repeated measures test (Miles & Banyard, 2007) was
used in the intervention because critical thinking is a learned skill which cannot often be taught in just one sitting (Joordens, Paré, & Collimore, 2014). Yet, by participating in a repeated measures test, students were exposed to this pedagogy multiple times over the course of a semester. One of the dependent variables (DV) of this study was how student conceptions of critical thinking changes over the course of the term in the experimental and control group. Another DV of the experiment was how students performed on peerScholar at the end of the term. The intervention in the experimental condition was completed before students had to submit their peerScholar assignment. Consequently, the study looked at whether the intervention had a noticeable effect on students’ peerScholar grades.

3.3.0 How does mindJig work? In phase one of the software, mindJig asks students to analyze a text, be it a video, image, or a written post chosen by the instructor and create a thesis interpreting what they analyzed. In phase two, students discuss and debate their arguments with peers and use the process to evolve their initial theses. In phase three, students work collaboratively in small groups to reach consensus on the issue at hand and produce a work of collaborative writing. In this experiment, students only participated in phase one and two of mindJig. In phase one, Notice and Focus, the student has a select amount of time to analyze the information provided by the instructor and make as many observations as possible. The goal is to encourage students to notice the information on their own without consulting external sources. Students are then asked to analyze their data and write a one-sentence thesis and evidence point. This strategy was borrowed from Rosenwasser, Stephen, and Babington’s, Writing Analytically With Readings (2011). Most students are used to walking into an analysis with a preconceived thesis. Yet new discoveries and innovations can’t be made with preconceived arguments. To be innovators, students have to train themselves to first notice the data and facts around them, and
based on what they notice, focus and develop an argument. In phase two, students are paired up with peer(s) and cued to provide counter arguments plus rebuttals for each peer’s thesis, and then participate in a free debate. At the end of this phase, students are asked to rate their original thesis and revise it in light of the discussion (See Appendix C and D).

Only the first two phases of mindJig pedagogy were tested in this experiment. This was partially because of timing constraints (as per SONA requirements, experimenters were only allowed to work with students for a maximum of two and a half hours). Another key reason why students only participated in phase one and two was because these phases were directly linked to helping students become more critical of information in the infoflux, and thus more relevant to this study.

3.3.1 mindJig and critical thinking. All phases of mindJig are designed to help students exercise critical thinking in infoflux realities: Notice and Focus encourages students to use literary analysis and critical literacy frameworks to critically read the information being presented. Discuss and debate gets students to listen to competing perspectives and evolve their original ideas. This in turn helps students realize critical thinking is a continual process instead of a fixed destination.

Many aspects of the critical thinking process mindJig fosters is captured by the Association of American Colleges and Universities (AACU)’s Critical Thinking Value Rubric (Rhodes, 2009). This rubric defines critical thinking as a “habit of mind characterized by exploration of issues, ideas, artefacts, and events before accepting or formulating an opinion or conclusion” (AACU, 2009, p. 1). This rubric scores students on a variety of categories including explanation of issues, evidence, influence of context and assumptions, student’s position: perspective/thesis/hypothesis, and conclusions and related outcomes: implications and
consequences (See Appendix H for the full AACU rubric). Most importantly, this rubric realizes critical thinking is a learned skill and the importance of developing a critical habit of mind. To specifically incorporate activities that inform the basis of mindJig, this rubric was adapted (See Appendix I), and used as a reference point to code which elements of critical thinking students understand and apply when navigating their infoflux realities.

The pedagogies used by mindJig are all evidence based—strategies like discussion or debate are not new or innovative instruction methods, and neither is critical literacy, literary analysis, or critical reading. I have taken strategies that are proven to work and compiled them in one tool for use in an online classroom. However, for a piece of education technology to be successful, it is important to continually test its’ efficacy. While these pedagogies sound beneficial, are they actually helping students? The no significance difference (NSD) phenomenon illustrates a comprehensive bibliography of hundreds of research reports, summaries, and papers that document no significant difference between mode of education delivery (face to face or distance) and student learning (Western Interstate Commission for Higher Education, 2010). Likewise, when it comes to education technology, it is just as unclear whether the tools we use actually show a significant difference between intended pedagogical goal and actual learning. Technology is widely encouraged in 21st century classrooms and there is an influx of apps available for teachers to use, yet as educators and education technology designers, we have to carefully evaluate whether the tools we recommend are having the impact we want (Fletcher-Watson, 2015). To this end, this research aims to identify whether mindJig is actually helpful in supporting students when it comes to critical thinking in the infoflux, and if not, how the program can be modified based on the outcomes of this pilot study.
3.4 The Intervention Process

Students in the experimental group participated in three mindJig sessions. Students were allowed to either complete the session in person or online based on their scheduling, and they could change this preference for each session. Every session was thirty minutes long. Prior to the first session, students participated in a 30 minute orientation where they signed consent forms (See Appendix A), learned about the structure of the study (See Appendix B), and were also taught how to appropriately Notice and Focus plus Discuss and Debate information (in a beta test of mindJig in a previous study, students in focus groups stated it was helpful to be first taught how to effectively think critically before doing the assignment (Kapoor, 2015), see Appendix D for more information). Existing literature also states students learn the critical thinking process better when it is taught explicitly (Marin & Halpern, 2010), so, prior to beginning the sessions, students were oriented about how they should be completing these activities. In the first session, students analysed a Twitter post looking at one side of a competing issue (See Appendix F). The topic chosen for discussion was the legalization of marijuana as this is a topic that was recently in the news and also something that is typically discussed in the Introductory Psychology course. Half the students were primed to consider the issue from one perspective, while the other half were primed to consider the same issue from an opposing perspective (i.e. some students saw a tweet about the pros of legalization, while other students saw a tweet warning about the dangers of legalization). In the second session, students compared different media images for credibility (See Appendix G). For example, students saw the screenshot of a Globe and Mail article, a Google scholar search result, and a search result of an academic article. All the screenshots discussed the overall topic of marijuana legalization. In session three, all students looked at the abstract of a peer reviewed article discussing the legalization of marijuana (See Appendix F). In
each session, students started with noticing the information they were asked to analyse, focussed their observations to create a one sentence thesis along with one evidence point, exchanged their theses and evidence points with a partner and gave each other counter arguments, rebutted the counter arguments they received, got an opportunity to discuss the topic further (except in session 3), and finally, revise their thesis in light of new perspectives and discussion. Prior to each session, a debrief of the previous session took place to facilitate students’ critical thinking of information (See Appendix C for more details about the structure of the intervention).

In this experiment, mindJig was used sans technology to test the efficacy of the pedagogy alone. When mindJig was first created for use in the Introductory Psychology course, technology was used because of its ease of access (Kapoor, 2015). Technology-enhanced tools are especially of benefit in fostering 21st century skills because technology can accelerate active learning experiences on a large scale, with minimal costs and investments (Fullan, 2013). In an online course with this many students, it was not possible to do a complex assignment such as this one without technology. To bring in similar assignments without technology, additional budgeting for teaching assistants and tutorials would be required which is not always possible. However, in a lab test, I was only working with a subset of participants so the need for technology was not apparent with this sample size. More importantly, mindJig is still in development and the current version is rather glitchy. The beta test showed students found the tool very frustrating and an impediment to their learning process when technical glitches were present (Kapoor, 2015). To avoid the confounding variable of technical difficulties, mindJig pedagogy was tested sans technology. The study investigates whether the pedagogy used in this software is still effective in helping students think critically when the technological element is removed.
3.5 Analysis Methods

The first research question, does a mindJig assignment help students think critically—namely, do students who participate in this study perform better on peerScholar, was analysed quantitatively. A one-tailed hypothesis test was run to determine if there are significant differences between peerScholar scores of sample of students who were exposed to mindJig pedagogy, compared to the mean peerScholar grades in the full population, or full course (Gravetter and Wallnau, 2013). The second research question, does a mindJig assignment help students exercise better critical thinking skills for infoflux realities, was analysed qualitatively. To understand if students explicitly understand the critical thinking process after completing mindJig assignments, student definitions of the critical thinking process were compared between the pretest and the posttest. To understand if students are better applying this understanding when analysing digital information after the mindJig intervention, student analyses of social media posts were also compared. Student answers for both of these things were coded deductively (Hyde, 2000) per the different elements of critical thinking outlined on the adapted critical thinking rubric (See Appendix I). New categories were created for answers that did not fit into the existing elements of critical thinking and frequency counts were established to see which aspects of critical thinking were utilized more or less in the control and experimental conditions. To establish interrater reliability, another coder was trained to analyse student answers and the cohen’s kappa test was used to establish reliability (Howell, 2013). In the posttest, students were also asked if they are analysing digital information differently in comparison to the beginning of the semester. Their answers were also coded qualitatively per the codes outlined in the critical thinking rubric (See Appendix I).
Chapter 4: Results and Discussion

4.0 Research Question 1: Do Students Who Participate in This Study Perform Better on peerScholar?

A one-tailed hypothesis test was run to determine if there are significant differences between peerScholar scores of a sample of students who were exposed to mindJig pedagogy (n=25), compared to the mean peerScholar grades in the Introductory Psychology course (n=424). The mean peerScholar grades in the population or Introductory Psychology course ($M = 6.34, SD = 3.33$), were lower than the mean peerScholar grades of students who were exposed to mindJig’s pedagogy ($M = 8.32, SD = 2.78$). The intervention of being exposed to mindJig’s pedagogy had a significant effect on peerScholar scores of students, $z = 3.00, p < .01$. The effect size for this analysis was found to be moderate ($d=0.59$). These results illustrate mindJig’s combined focus towards critical reading, critical literacy, critical noticing, and critical listening allows students to foster better critical thinking skills.

4.1 Research Question 2: Does a mindJig Assignment Help Students Exercise Better Critical Thinking Skills in Infoflux Realities?

Critical Thinking Skills in Infoflux Realities?

The two sub-questions of this research question were: do students explicitly understand the critical thinking process after completing mindJig assignments, and after learning the critical thinking process taught by mindJig, are students applying this understanding when analysing digital information? To understand if students explicitly understand the critical thinking process after completing mindJig assignments, and to understand if students are applying this understanding when analysing digital information, a qualitative analysis of student answers between the pretest and the posttest was conducted. In the posttest, students were asked if they think they are analysing digital information differently in comparison to the beginning of the
semester. Their answers for this question were also analysed qualitatively. AACU’s value rubric to assess critical thinking (AACU, 2009), was adapted for the purposes of this study and identified key markers of critical thinking education (see Appendix I). As per the adapted rubric (see Table 1), in order to think critically, students start by explaining/understanding the text, they observe it and notice all elements, analyse it, problematize viewpoints of experts, thoroughly analyse own and others’ assumptions, and so on. This rubric became the coding criteria for the qualitative analysis. Student answers were analysed to identify which elements of the critical thinking rubric students utilized. Student answers were not being graded; for example, a score was not assigned to identify to what extent a student might be problematizing information, the data was just analysed to identify how many times each category of the rubric was addressed in student answers.

| **Table 1** |
| **Critical Thinking Value Rubric Categories (Coding Criteria)** |
| **Explanation / Understanding of text** | Student comprehensively understands what the text is communicating. |
| **Observation / Noticing** | Thoroughly observes/notices all elements of text. |
| **Analysis:** Using information to investigate a point of view or conclusion | Uses enough interpretation/evaluation to comprehensively analyse or synthesize content and medium of information. |
| **Problematize** | Viewpoints of experts are questioned thoroughly to speculate about whose voices are missing. Actively problematizes messages and adopts critical perspectives toward text in order to uncover underlying messages of what’s being said (and not said). |
| **Influence of context and assumptions** | Thoroughly (systematically and methodically) analyzes own and others’ assumptions and carefully evaluates the relevance of contexts when presenting a position. |
| **Student’s position (perspective, thesis / hypothesis)** | Specific position (perspective, thesis/hypothesis) is imaginative, taking into account the complexities of an issue. Limits of position (perspective, thesis/hypothesis) are acknowledged. Others’ point of view are synthesized within position (perspective, thesis/hypothesis). |
| **Conclusion and related outcomes (implications and consequences)** | Conclusion and related outcomes (consequences and implications) are logical and reflect student’s informed evaluation and ability to place evidence and perspectives are discussed in priority order. |
The following tables display frequency counts of how many times each category of the critical thinking rubric was addressed in the pretest and the posttest of both the control group and the experimental group.

**Table 2**  
*Frequency Counts of How Many Times Each Category of Critical Thinking Rubric Was Addressed (Control Group)*

<table>
<thead>
<tr>
<th>Definition of Critical Thinking</th>
<th>Critical Thining Application – Analysing a Digital Image</th>
<th>Students analysing digital information differently</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pretest</strong></td>
<td><strong>Posttest</strong></td>
<td><strong>Pretest</strong></td>
</tr>
<tr>
<td>Explanation / Understanding of text</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Observation / Noticing</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Analysis</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>Problematize</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Influence of context and assumptions</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Student’s position</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Conclusion and related outcomes</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>Credibility</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

*Note.* The credibility code emerged from the data – it looked specifically at instances when students identified the importance of looking at credibility of information in digital settings.

**Table 3**  
*Frequency Counts of How Many Times Each Category of Critical Thinking Rubric Was Addressed (Experimental Group)*

<table>
<thead>
<tr>
<th>Definition of Critical Thinking</th>
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<tr>
<td>Credibility</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

32
When asked to define critical thinking and the steps associated with it in the experimental group, students in the pretest tended to approach critical thinking through a comprehension-based explanation or understanding of information, with some emphasis on the importance of deeper analysis. However, students did not focus on problematizing information or questioning the viewpoints of experts in their preliminary definitions. For example, one student defined critical thinking as, “Taking a set of information and data, then analyzing and examining that information to develop a concrete response or judgement.” While this student realized the importance of analyzing and evaluating information, the student’s language did not focus on questioning assumptions, challenging expert opinions, or looking at competing perspectives. It was also interesting to note students tended to approach the process through a problem-solving narrative or a means to an end. Students felt the need to evaluate evidence in order to “develop a concrete response or judgement” instead of thinking of critical thinking as a continuous process.

On the contrary, after the mindJig intervention, students spent slightly less time on the analysis category of the rubric, and more time problematizing information, or adopting critical
perspectives. For example, one student claimed in the posttest, a key step of the critical thinking process includes searching for “Counter arguments: Think about any potential arguments that can be made about my thesis or main idea.” Another student defined critical thinking in the posttest as, “Critical thinking is when you read and analyze the source in a way you would “judge” every aspect of it [emphasis added].” While in these examples students were not explicitly challenging viewpoints of experts, they were beginning to realize the importance of identifying competing perspectives and looking at information from a critical lens. In the posttest, students were also beginning to define critical thinking less through a problem-solving approach and more as a process that is engaged in continually. In the pretest, one student defined critical thinking as, “Evaluating all possible evidence in order to come up with an educated solution to a problem [emphasis added].” Yet, this same student defined critical thinking in the posttest as, “Carefully gathering and weighing evidence in order to come to an educated conclusion [emphasis added] on a given topic.” In both instances, the student did not use explicit language displaying a critical mindset, but by moving away from a focus on solving a problem, the student begins to realize critical thinking does not always have to be a concrete means to an end, but it can also be about making an educated evaluation that can change in light of new evidence (AACU, 2009).

When students were asked to define critical thinking and the steps associated with it in the posttest, they tended to pay more attention to the observation and noticing element of critical thinking in comparison to the pretest. This is likely related to the experiment’s explicit focus on the Notice and Focus strategy. Yet, there was an obvious disconnect between how successfully students define critical thinking compared to their ability to apply those definitions in practice. In the pretest, students were able to successfully define what effective critical thinking means. For
example, some of the many student responses to the question how critical thinking is defined were: “Critical thinking is taking a set of information and data, then analyzing and examining that information to develop a concrete response or judgement,” “Critical thinking is applying other concepts to explore beyond the issue presented,” “Analysing the information given to you; asking questions based on source, validity and emphasis or relevance to the topic,” “For me critical thinking, is the ability of the person to thoroughly review a subject without bias as much as possible,” etc. However, when asked to analyse digital information, students spent more time explaining or observing the surface message of the image, and less time analyzing implied messages, noticing the influence of context or assumptions, or highlighting implications or consequences. Here, students did not deeply question the full context of the issue or problematize information. For instance, when looking at the picture of the University of Toronto AI research team, one student was able to analyze this picture was posted in order to “increase the university’s recognition in the community.” Yet, none of the participants problematized this information after noticing all the details of the image (i.e. this research team was heavily male dominated and consisted predominantly of young, white researchers).

In the posttest, students paid more attention to the context and different perspectives of the issue when defining critical thinking (the “Influence of context and assumptions” category of the critical thinking rubric was only referenced 4 times in the control group, but in the experimental group, this category was referenced 10 times). They were starting to realize the importance of doing more research to better understand the different contexts surrounding the issue. However, students were also explicitly borrowing wording from the experiment intervention to define their revised understanding of critical thinking. This once again raised the question whether students were truly able to apply learned definitions of critical thinking in
practice. One student illustrated the steps of critical thinking in the posttest as, “-notice & focus (what is being said/how, question its validity) -discuss & debate (thesis, counter arguments, rebuttal).” Here the student explicitly borrowed language taught in the experiment of what the critical thinking process entails. Yet, when this student analysed media images in the posttest, this student was only able to notice details of what the image was displaying instead of fully critiquing the information or problematizing its meaning. When this student analyzed the GQ Donald Trump image (See Appendix G), the student said, “Based on what is presented in this image, it comes to say that Trump’s wife, Melania Trump despises Trump just because she slapped Trump’s hand away. -the image is of Trump and his wife looking to the right -Font size is larger and bold when it says the sentence including “coldly slapped”.” In comparison to student analyses in the pretest, this student is able to offer inferences that are rooted in detailed observations of the information (Melania’s feelings for Trump as noted by the emphasis on “Coldly slapped”). However, the student could have further problematized the image to question whether a zoomed in video even accurately offers insight about Melania’s feelings, the relevance of this information, and why articles such as this might be published in the first place. Despite this, students in the experimental group were beginning to problematize information more, question different contexts and assumptions, and notice limits of their own position after the mindJig intervention. However, a disconnect between students’ ability to apply learned definitions of critical thinking was still apparent.

In the control group, when asked to define critical thinking and the steps they would take to engage in critical thought, majority of the students did not use language that addressed the importance of problematizing information or considered competing perspectives. One student in the control group identified critical thinking in the posttest as, “Thinking on a deeper level,
analyzing and interpreting, as well as applying knowledge to a situation.” This student mentioned how analysis and digging deeper is integral to critical thinking; however, this student did not explain what it means to think deeper or importance of questioning competing perspectives. In light of this, it is important to note that unlike students in the experimental group, majority of the control group students analysed digital information by only explaining the surface level understanding of information. For example, one student felt the Chrissy Teigen image (See Appendix F) is not “very credible, seeing as how it is a post on Social Media showing a picture of what appears to be an online Tabloid.” In this example, the student is stating what the picture is about and the medium it is posted on, without engaging in a critical conversation about what these messages imply. What does the satirical tweet by Chrissy Teigen say about celebrity paparazzi culture? Why would the magazine want to publish this news in the first place? Why is both the original news, and Chrissy Teigen’s reply to it so popular? Further, a number of students also did not fully understand the satire in the picture and felt the image was indeed about how Chrissy Teigen underwent a lot of plastic surgery. One reason for this outcome could possibly be a lack of careful analysis. It is possible students quickly read this picture, much like the scroll fast reality of interacting with digital information in the infolux.

The posttest also asked students to answer the following questions: “Over the course of the term, did your perceptions of how you look at digital information change? (i.e. information you find on the internet, social media, etc.) Explain” and “Are you analysing information differently now? (i.e. information you find on the internet, on social media, etc.) If yes, explain how.” For both of these questions, 65.5% of the students in the experimental group felt they were analysing information differently in comparison to 48.6% of students in the control group. Four students in the control group also reported a change in how they were looking at digital
information but they attributed it more to the course generally or the reality of being in university. For example, one student said, “Yeah...due to my increased interest in media and due to my MDSA01 [Media Studies] course.” Another student said, “I analyse digital information differently now, as I am skeptical when it comes to reading less scholarly articles” since one of the core learning tasks in this course taught students to use scholarly articles. When answering yes to the posed questions, students in the experimental group though, were looking at digital information differently in comparison to students in the control group. For example, one student in the experimental group said, “Yes. I now don’t believe everything I see on the social media. I go on to do more research about the issue.” Another student claimed, “I am looking at entire webpages instead of just the articles themselves. For instance, if a web page has lots of ads, I suspect that they might have certain agendas or that their information may be biased.” Even though the student is not fully dissecting the content of advertisements here, both students are showing evidence of problematizing information and seeking implicit messages.

To establish interrater reliability of the qualitative coding, another graduate student in the department coded 50% of the data after being trained with the coding process. Cohen’s $\kappa$ was run to determine if there was agreement between codes; however, there was poor agreement between evaluations, $\kappa = -.740, p < .001$. This was likely because the interrater coder was unable to be as deeply immersed in the research as I was. The interrater coder was not involved with the study as it was happening—she was simply trained in the coding process after the study finished. This prevented her from being immersed in the project’s pedagogy deeply. As a result of this, we were both coding the same information, however, we were ascribing different labels to it. For instance, she was coding majority of the information I coded under the “analysis” label with the “noticing information” label instead. This was an example of us understanding the same piece of
information through different labels, which could have been avoided if we were both immersed with the pedagogy of the study in the same way. Her coding memos still highlighted that we both understood the overarching critical thinking competencies of each student similarly. For example, the interrater coder memoed, “Low level analysis, but does consider medium and message” while looking at the answers of one student. I coded this information under an additional label of credibility (i.e. looking at the quality of medium). She did not code this information with the same categories I used, but upon reading her marginal comments, it was apparent our interpretation of this student’s work was the same.

4.2 Limitations

One limitation with this study was that even though there were different students in both the control and experimental group, not all students were coming from the same skillset. This is not something that can be controlled for because while PSYA01/A02 is a first year course, students in any year and from any specialization or major can enrol in this class. Students who were closer to the end of their university careers, or students who had exposure to a variety of other critical thinking competencies through programs like media studies, sociology, political science, among others, may have been more adept at critical thinking than their peers. However, it would be worth analysing how the number of years a student has been in university or the program they are enrolled in, impacts their critical thinking competencies. For instance, one student in the control group offered incredibly in-depth analyses of media images in ways even experimental group students were unable to do post mindJig interventions. When looking at the Canadian cabinet image in the pretest, this student noticed:

Relative to the picture above, this one is much more inclusive. It seems as if the primary goal of this image is to convey the openness and inclusivity of Trudeau's cabinet…[But]
the minorities are strategically placed. For instance, a woman in the front row is dressed in bright red, and a man behind her is also wearing a bright red turban. Another person wearing a turban is placed at the back against the wall, which makes him stand out. A clearly disabled individual as well as an Aboriginal woman are placed in the front row. The women and men in each row alternate. The caption does play a role in demonstrating inclusivity, as sexual orientation and some disabilities are not clearly visible traits. To me, the focal point of the image is the Prime Minister and the Governor General, both white males sitting in the centre of the front row. Although this image clearly shows a sea of predominantly white faces, the gender divide is not an issue here like it was in the last picture.

Through a detailed observation of the full picture, this student was able to realize how despite sending messages of diversity, this image centres on white males. She also notes how even after including a mix of racial backgrounds, the cabinet “clearly shows a sea of predominantly white faces.” This student made this analysis in the pretest, and as a result, was coming into the course with greater critical thinking capabilities in comparison to other students.

Another limitation was the timed nature of the study. In the initial beta tests of mindJig, the software included timed activities for two reasons: for one, students were participating in the activity synchronously so it was important to have set time slots for students to complete their activity at the same time as other students. Secondly, a timed activity was considered better for encouraging students to exercise their own critical thinking capacities rather than researching answers online (Kapoor, 2015). In this study, a timed experiment was also conducted because according to the experimental participation guidelines at the University of Toronto, researchers could not create experiments that took more than two and a half hours of students’ time in total.
Consequently, each individual mindJig intervention was half an hour, while the remaining hour was dedicated to half an hour for the pretest and half an hour for the posttest respectively (See Appendix C for the full structure of the study). Due to these time constraints, students only had a few minutes to engage with each element of the activity (i.e. noticing, focussing, discussing, etc.). However, the timed nature of mindJig’s interventions were not helpful for students. Timed activities prevented students from getting an opportunity to fully notice the image, while simultaneously writing their observations in detail. Furthermore, students reported the timed activity was incredibly stressful. The short amount of time prescribed to each part of the activity also prevented English language learners from getting an opportunity to fully express their ideas in detail.

In light of this, it is important to note that while the activity was encouraging students to use Notice and Focus and Discuss and Debate to realize competing perspectives, students may have been able to problematize information better if they were asked to explicitly think about missing voices from the information first. More specifically, the very nature of a traditional debate that asks students to challenge their peers’ ideas and rebut the criticism they receive, promotes more of a “defend your opinion to death” response rather than a “let’s critically listen to competing perspectives” approach to learning. Building on these ideas, mindJig’s pedagogy could have been more successful if the tool had focussed primarily on getting students to notice information critically from diverse perspectives. Instead of spending a few minutes on Notice and Focus and a few minutes on Discuss and Debate, students might have benefited from spending the bulk of the study just learning how to Notice and Focus. Students could still be allowed a chance to discuss, but instead of debating and defending their theses, the discussion could be framed around a conversation of whose perspectives are missing.
The two phases could also be better scaffolded where students first learn how to critically read information and notice which voices are missing, prior to engaging in a discussion with other peers. If the software were structured in this way, this would remove the need for a timed activity because students would no longer need to participate in a live debate synchronously. This would also make the activity more equitable because it would allow English language learners or students with accommodations to take as much time as they want to complete the task. The future focus of research with mindJig should shift to emphasizing critical noticing as a precursor to critical thinking, and the peer discussion that follows afterward should be focussed more on identifying how to evolve an idea to include various perspectives.

4.3: Challenges of Critical Thinking Education in the Infoflux

Some other limitations impacting this study include the greater challenge of how to teach critical thinking in the infoflux. How do we teach students to understand competing perspectives they don’t yet know about? In the increasingly global world we live in today, every student brings a transnational identity with them or is impacted by a transnational identity in some way shape or form (Rizvi, 2009). Yet, our world became so global so quickly that people are still struggling with the idea of welcoming entirely different ways of being into their lives. This creates conflict not just between ideologies, but also between hegemonic ideals and diverse world views struggling to be heard. Movements like Black Lives Matter (Black Lives Matter, n.d.) face criticism from the white ruling class in North America because historically, this ruling class has been so personally removed from the experiences of Black people. To uphold the continued dominance and privilege of a western, eurocentric, and a white settler state, there have been various attempts in different countries to bar immigrants; specifically people of colour (PoC), immigrants from the global south, refugees, and muslims in many parts of the world, with
a prime example being the United States of America (Carranza & Plevin, 2018; Vogue, 2017). However, this push has been possible, in part, because the settler consciousness of America was not taught its own colonial history of Indigenous land theft (Frideres, 2011; Matilpi, 2012; St. Denis, 2011). It is possible for a white ruling class to want to bar people of colour and be nostalgic about a white state when it lacks the historical perspectives surrounding the creation of modern day North America. This broader issue points to the important role of realizing contexts and history in critical thinking education in the infoflux. For example, a global warming denier may very well claim their voices are not being heard in the discourse surrounding climate change; however, when the larger context of the history and scientific body of knowledge is taken into account, it becomes apparent global warming is supported by a great deal of evidence. To help students understand competing perspectives they don’t yet know about, they must be taught to realize knowledge isn’t fixed and take on a constructivist approach to learning (Yang, 2007). It is imperative for educators to teach students to be open to listen to different voices, and evolve their stance on a topic as more information becomes available. Critical listening ultimately plays a key role in developing critical thinking. This includes the need to give students more experience being challenged and unsettled by new perspectives.
Chapter 5: Conclusion

In this research project, I tested the efficacy of a pedagogy that was based on evidence based strategies. This study indicated mindJig assignments help students think more critically, which was observed by their ability to perform better on peerScholar assignments. The assignment also helped students start exercising better critical thinking skills in infoflux realities. By testing the pedagogy of mindJig in an empirical manner, I was able to determine how this tool can be improved to better support students in exercising critical thinking competencies in the digital era. While internet and digital technologies have opened up a wealth of new resources and possibilities for students, they have also presented new challenges like the reality of an infoflux. However, tools like mindJig show promise to counteract the negative consequences of the digital era: instead of continuing to allow students to hurriedly accept information in the internet’s scroll fast culture, mindJig is asking students to pause and notice the information before accepting its surface level message.

This study also provided evidence-based feedback on ways mindJig can be adapted to more successfully support student learning. For instance, instead of simply learning about competing perspectives through peer discussion, the study suggests students should first be prompted to consider competing perspectives from a variety of lenses. For example, students could be encouraged to consider factors like what gender norms does the information perpetuate? Is it (how is it) ableist? Whose identity does the information seem to foster? Who is being marginalized? Who is being given power? Trying to grapple with competing perspectives in this way also draws upon interdisciplinary forms of learning where students think about sociology, literacy, psychology, anthropology, history, etc., in relation to whatever it is they may be analysing. In light of this, when students move on to peer discussion, instead of just debating
their ideas through the traditional counter argument and rebuttal model which encourages students to defend their original ideas, they should instead be encouraged to build onto or adapt their ideas based on new information.

The study also suggests when learning to critique the credibility of information, students must go beyond mental heuristics such as whether the source is peer-reviewed, is the author a reputed professional, is the source current, etc. Students must learn to critique the content of the information on top of the medium it is delivered because even peer reviewed scholarly sources can be biased and perpetuate hegemonic ways of thinking. To facilitate student learning in an era of infoflux where information is fleeting, it is important to teach students to realize the importance of critical noticing or critical reading as a component of critical thinking. Students should realize the value of pausing, looking at all components of information—both explicit and implicit, and use their observations to guide their evaluations of the information they come across. Finally, students must be taught to critically listen to competing perspectives to understand whose voices are not accounted for in their original analysis. This requires patience, empathy, and a pedagogy of discomfort that asks students to be comfortable being unsettled by significantly different world views (Boler & Zemblyas, 2003). Critical thinking in this respect embodies components of all critical reading, critical literacy, critical noticing, and critical listening.
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Appendix A

Consent Form - Experimental Group

Date:
Project: Teaching Critical Thinking and Interacting with Social Media ("Choose a New Assignment! Testing Educational Software for UTSC's Intro Psychology Course) study
Title: Informed Participant Consent

Email: aakrithi.kapoor@mail.utoronto.ca
Aakriti Kapoor, MT Candidate
Department of Curriculum, Teaching and Learning.
OISE/UT, 252 Bloor St. W.
Toronto, Ontario M5S 1V6

I am interested in developing online tools that are easy to use, web-based multimedia communication tools and resources, as part of your regular coursework in Introductory Psychology. One of the newest software I am creating for your course focusses on teaching students the critical thinking process and understanding students’ social media interactions. In this study, you will not be using the software I created in itself, but you will be completing some activities that will help me understand whether the pedagogy, or the educational techniques I have used in this software, are successful or not.

I am requesting your participation in the following ways:

1) Complete two questionnaires about your education background
2) Take part in three 30 minute activities
3) Allow your anonymized contributions to be analyzed
4) Allow access to your performance in the course through the means of your course/assignment grades

Your feedback will help us evaluate what works and what does not. The experiences in the study will be helpful for you in completing your program and making and maintaining your connections to other students and faculty. Your decision to take part, or not to take part, in this study will remain confidential and will in no way influence your course grades.

Confidentiality

All the data will have identifying information (your name, etc.) removed and your responses identified by a number. Further, no participant will be identified by name in any research conference or publication in which these data are discussed. All identifying information (names, locations, etc.) will be changed to codes and pseudonyms. No names will be attached to any of the materials, including the interviews and online records. The data files will be encrypted using the password-protection facilities of Microsoft Word and Microsoft Excel. The anonymized data files will be stored on a secure encrypted server, and kept to allow us to do several iterations of this study. After that they will be deleted.
The results from the research are intended to inform the future design of online education programs and be reported in academic journals.

*I understand that I may withdraw my permission at any time and without providing a reason by contacting aakriti.kapoorn@utoronto.ca.*

However, please note that should you choose to withdraw after participating in the first half an hour of the activity, you will not receive any SONA credits for participating in this experiment. You will still be free to withdraw after that point and you will not be penalized in any way, but you will not get credit for participating in this experiment (i.e. if you choose to withdraw in the first thirty minutes of the experiment, you will still get 0.5 SONA credits, but if you choose to withdraw say after the first hour of the experiment, you will not get any SONA credits).

**Note:** All participants may also contact the Office of Research Ethics (ethics.review@utoronto.ca, 416-946-3273), at any time with questions or concerns about rights as a participant, or contact my supervisor, Professor Clare Brett at clare.brett@utoronto.ca

Name (Print): ___________________________ Date: ___________________________

**Please initial below. You will be given a copy for your records.**

_____ I agree to allow my data to be used as part of the research described above. I understand that these data will be used anonymously.

_____ I do NOT agree to allow my data to be used as part of the research described above. I understand that these data will be used anonymously.

Signature Participant: ___________________________ Date: ___________________________
Welcome to the research study!

In this survey, I am requesting your participation by allowing your anonymized answers to be analyzed. I am also requesting your participation by allowing access to your performance in the course through the means of your course/assignment grades. The study should take you around 10-15 minutes to complete, and you will receive 0.5 SONA Credits for your participation. Your participation in this research is voluntary. You have the right to withdraw at any point during the study, for any reason, and without any prejudice. If you would like to contact the Principal Investigator in the study to discuss this research, please e-mail Aakriti Kapoor at aakriti.kapoor@mail.utoronto.ca.

Confidentiality Policy
All the data will have identifying information (your name, etc.) removed and your responses identified by a number. Further, no participant will be identified by name in any research conference or publication in which these data are discussed. All identifying information (names, locations, etc.) will be changed to codes and pseudonyms. No names will be attached to any of the materials. The data files will be encrypted using the password-protection facilities of Microsoft Word and Microsoft Excel. The anonymized data files will be stored on a secure encrypted server, and kept to allow us to do several iterations of this study. After that they will be deleted.

Note: All participants may also contact the Office of Research Ethics (ethics.review@utoronto.ca, 416-946-3273), at any time with questions or concerns about rights as a participant, or contact my supervisor, Professor Clare Brett atclare.brett@utoronto.ca

By clicking the button below, you acknowledge that your participation in the study is voluntary, and that you are aware that you may choose to terminate your participation in the study at any time and for any reason. Please note that this survey will be best displayed on a laptop or desktop computer. Some features may be less compatible for use on a mobile device.

☐ I consent, begin the study
☐ I do not consent, I do not wish to participate
Appendix B

Structure of Study - Experimental Group

**About this Study**

**First Session**
1 Hour / (Each part is 30 minutes)

**Part 1:**
Introduction to the Study, Survey, Introduction to the Activity (0.5 Hours)

*If you do not complete the study after this point you will not get any course credits.*

**Part 2:**
Critical Thinking Activity (0.5 Hours)
To be completed in partners

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**Session #2**

0.5 Hours
Can be completed online if you prefer.

Critical Thinking Activity
To be completed in partners

---

**Session #3**

0.5 Hours
Can be completed online if you prefer.

Critical Thinking Activity
To be completed in partners

---

**Session #4**

0.5 Hours
Can be completed online if you prefer.

Survey
To be completed individually.
### Appendix C

**Structure of the mindJig Intervention**

<table>
<thead>
<tr>
<th>Session 1</th>
<th>Session 2</th>
<th>Session 3</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td><strong>Debrief of Learning</strong></td>
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<td>10 Minutes</td>
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<tr>
<td>Noticing</td>
<td>Noticing</td>
<td>Noticing</td>
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<td>3 Minutes</td>
<td>3 Minutes</td>
<td>5 Minutes</td>
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<tr>
<td><strong>Focussing (Make a Thesis/Evidence Point)</strong></td>
<td><strong>Focussing (Make a Thesis/Evidence Point)</strong></td>
<td><strong>Focussing (Make a Thesis/Evidence Point)</strong></td>
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<tr>
<td>3 Minutes</td>
<td>3 Minutes</td>
<td>3 Minutes</td>
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<tr>
<td><strong>Counter Argument</strong></td>
<td><strong>Counter Argument</strong></td>
<td><strong>Counter Argument</strong></td>
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<td>2 Minutes</td>
<td>2 Minutes</td>
<td>2 Minutes</td>
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<tr>
<td><strong>Rebuttal</strong></td>
<td><strong>Rebuttal</strong></td>
<td><strong>Rebuttal</strong></td>
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<tr>
<td>2 Minutes</td>
<td>2 Minutes</td>
<td>2 Minutes</td>
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<tr>
<td><strong>Free Debate</strong></td>
<td><strong>Free Debate</strong></td>
<td>-</td>
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<tr>
<td>2 Minutes</td>
<td>2 Minutes</td>
<td>-</td>
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<tr>
<td><strong>Revised Thesis</strong></td>
<td><strong>Revised Thesis</strong></td>
<td><strong>Revised Thesis</strong></td>
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<td>3 Minutes</td>
<td>3 Minutes</td>
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<tr>
<td><strong>Homework</strong></td>
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</tbody>
</table>

Remaining time was needed for transitions, instructions, and getting everyone setup (not all students arrived and were ready to start right at the allotted time slot). As per experimental participation requirements, researchers were not allowed to make students stay longer than the allotted time so it was important to account for this. In this time frame, all sessions spanned to a total of 30 minutes from start to finish. In this time frame, all sessions spanned to a total of 30 minutes from start to finish.
Appendix D

Student Handout: Understanding Notice & Focus and Discuss & Debate

- A thesis presents your well-thought out theory on the topic, and how it works in the given video.
- An excellent thesis is complex: it takes a definitive stand, yet also takes into account how complication, contradictions, exceptions affect that stand.
- A good thesis doesn’t make the evidence fit the thesis, but makes the thesis fit the evidence.

Counter-Arguments
When you counter-argue, you consider a possible argument against the thesis or some aspect of its reasoning. This will help your peers address the complexities of the topic and make their theses more nuanced. You are not trying to “edit” their theses or point out grammatical errors in this stage, instead you are trying to help make their claims stronger. For example:

- If you peer argues, “Elvis is a good singer because he had a huge fan following”, you may counter-argue, “This claim does not tell us WHY he is a good singer — many celebrities have a large fan-following but what musical qualities make Elvis a good singer?”

However, if your peer’s thesis is “really great,” you can still offer a counter-argument for that thesis. No thesis, no matter how analytical, is ever perfect, so you can always try to find ways to improve it. For example:

- If your peer says, “Elvis is a good singer because of his versatility: he excels in a variety of genres like pop, blues, and gospel”, this is a much better thesis, but you can still complicate it by giving a counter-argument like: “While Presley’s ability to excel in multiple genres signifies his talent as a musician, this thesis still does not address what aspects of Presley’s vocal abilities made him a good singer.”

The Rebuttal
The rebuttal is a reply to the counter-argument. A good rebuttal accepts the counter-argument, but not completely (if you need to accept the counter-argument completely, you need a new thesis) — you essentially want to take the “good” points and use them to make your thesis stronger, and then take the “bad” ones and try to prove why you are not using them to improve your thesis.

For example...

- If your thesis is: “Disney movies foster unrealistic romantic ideals among children.” And a counter-argument to this thesis is, “Well that’s true, but movies like Frozen question the idea of “love at first sight”, and they are changing traditional Disney ideals.”
- A rebuttal to this might be, “While movies like Frozen challenge traditional Disney ideals, they still continue equating the idea of love with princesses and royal idealism, which in itself is an unrealistic romantic ideal.” Here you agree with part of the counter argument: “Movies like Frozen challenge Disney ideals”, but you also give a reason why you don’t accept this claim in its entirety. This additional step complicates your original thesis and makes it stronger.

---

2 Gordon Harvey, the Harvard Writing Centre, 1999.
Appendix E

Pretest

"Choose a New Assignment!" Testing Educational Software for UTSC's Intro Psychology Course

What course are you currently enrolled in?
   a. PSYA01 – Introductory Psychology Part 1
   b. PSYA02 – Introductory Psychology Part 2

Have you taken either PSYA01/PSAY02 in the past?
   a. Yes
   b. No

If you answered yes to the question above, please write the year you took the course and the name of the course.
   Year: _________
   Course Name: _________

How would you define critical thinking?

If you are asked to think critically about a topic, outline the steps you would take to make sure you are thinking critically about the subject.

Do you use social media?
   a. Yes
   b. No

How frequently do you use social media?
   a. Numerous times a day
   b. Numerous times a week
   c. Numerous times a month
   d. Never

What social media accounts do you have? Check all that apply.

☐ Facebook
☐ Twitter
☐ Instagram
☐ Snapchat
☐ Whatsapp
☐ LinkedIn
☐ Other (Please specify) ____________________
What are your thoughts on the information presented in this image? (i.e. what do you think the image is about, what is your opinion of it, etc.)
What are your thoughts on the information presented in this image? (i.e. what do you think the image is about, what is your opinion of it, etc.)

*Justin Trudeau*’s cabinet includes two disabled ministers, two aboriginal ministers, a refugee from Afghanistan, four Sikhs and an openly gay minister. Trudeau says it "looks like Canada."
Appendix F

Posttest

1. Participant ID

2. How would you define critical thinking?

3. If you are asked to think critically about a topic, outline the steps you would take to make sure you are thinking critically about the subject.

4. Rate how credible the information is in this picture on a scale of 0-10 (0 = not credible, 10 = very credible)
5. Rate how credible the information is in this picture on a scale of 0-10 (0 = not credible, 10 = very credible)

6. Rate how credible the information is in this picture on a scale of 0-10 (0 = not credible, 10 = very credible)
7. Rate how credible the information is in this picture on a scale of 0-10 (0 = not credible, 10 = very credible)

8. Rate how credible the information is in this picture on a scale of 0-10 (0 = not credible, 10 = very credible)
9. What are your thoughts on the information presented in this image? (i.e. what do you think the image is about, what is your opinion of it, etc.).

'Everything is fake except my cheeks!' Chrissy Teigen admits she has had extensive plastic surgery on her face and body - including liposuction to get rid of her ARMPIT fat.

The 31-year-old model spoke to a group of beauty editors last night, and after being showered with compliments, pointed to her lips, nose and forehead saying 'Fake, fake, fake.'

EXCLUSIVE: 'They went back and forth having sex, screaming yelling, having sex...'

christine teigen @chrissyteigen - May 5
Reminder to never ever joke, ever (I did do the armpits, no regrets except it clearly came back) pic.twitter.com/8imHxG1Tkc
10. What are your thoughts on the information presented in this image? (i.e. what do you think the image is about, what is your opinion of it, etc.).

Melania Trump
Coldly Slapped
Away Donald
Trump's Hand
in Israel

BY JACK MOORE
May 19, 2017

Another day, another piece of evidence that Melania Trump hates her husband.
11. Over the course of the term, did your perceptions of how you look at information in digital environments change (i.e. information you find on the internet, social media, etc.)? Explain.

12. Are you analysing digital information differently now? (i.e. Information you find on the internet, on social media, etc.) If yes, explain how.

13. Please explain your previous education experiences (i.e. What country/province did you complete your previous education in? Did you go to Public, Private, or Catholic schools? Did you start or complete any other post-secondary degree in the past?)

14. What kind of grades did you receive in your previous education (i.e. in high school, elementary, or in other post-secondary settings)?

15. Are you involved in extra-curriculars on campus? If yes, explain what kind of extra-curriculars.

16. Did you participate in extra-curriculars before coming to university? If yes, explain what kind of extra-curriculars.

17. Do you currently have a part-time/or full-time job? If yes, explain what kind of job you have.
18. Did you have a part-time/full-time job in the past. If yes, explain what kind of job you had and when you had it.
19. What is your age?

20. What is your gender?
   - Female
   - Male
   - Non Binary / Third Gender
   - Prefer not to say
   - Prefer to self describe

21. What year of study are you in?
   - 1
   - 2
   - 3
   - 4
   - 5+

22. Please describe your race/ethnicity.

23. What is your cumulative GPA (cGPA)?

* 24. Please write your uTORID below.

* 25. Please write your full name below.
Appendix G

Information Students Analysed in mindJig Session #1

You’re wrong. Listen to, read, what EMERGENCY ROOM physician Dr Drew Pinsky says of the dangers of #marijuana:

Too many ppl are in jail because of failed war on drugs. It’s time to have a real conversation about legalizing marijuana in #W6thdistrict
Legalizing and regulating marijuana in Canada: Review of potential economic, social, and health impacts
Mohammad Hajizadeh.
International Journal of Health Policy and Management.
Abstract Notwithstanding a century of prohibition, marijuana is the most widely used illicit substance in Canada. Due to the growing public acceptance of recreational marijuana use and ineffectiveness of the existing...
Marijuana Experiences, Voting Behaviors, and Early Perspectives Regarding Marijuana Legalization among College Students from 2 States

Monroe, Megan A.; Whitenell, Jennifer M.; Quach, Vincent; Midamba, Nikita; Manskopf, Inga
Journal of American College Health, v64 n1 p8-18 2016

Objectives: The purpose of this mixed-methods study was to understand college students' (1) views and experiences regarding marijuana, (2) voting behaviors, and (3) early perceptions of the impact of legislation. Participants: College students from Washington and Wisconsin were interviewed between May and September 2013. Methods: Participants completed phone interviews assessing marijuana attitudes, intentions, behaviors, voting behaviors or intentions, and perceptions of the impact of legislation. Results: A total of 268 participants completed the interview (83.7% retention rate); 56.6% were female, 67.2% were from Washington, and 74.5% were Caucasian. Almost half of Washington participants (46.3%) indicated that they voted for marijuana legalization. Participants most commonly responded that the legislation did not change their attitudes towards marijuana, although some participants discussed perceived safety of the product because legislation passed. Conclusions: Findings indicate similarities in views and experiences among college students from states affected and unaffected by legalization; legalization may increase perceptions of safety.

Descriptors: Marijuana; Voting; College Students; Mixed Methods; Research; Student Attitudes; Student Experience; Legislation; Interviews; Longitudinal Studies; Intentions; Behavior; Likert Scales; Regression (Statistics)

Publication Type: Journal Articles; Reports - Research
Education Level: Higher Education; Postsecondary Education
Audience: N/A
Language: English
Sponsor: National Institute on Drug Abuse (NIDA/PHS)
Authoring Institution: N/A
Identifiers - Location: Washington; Wisconsin
IES Grant or Contract Numbers: 7RO DA00150004
Appendix H

AACU Original Critical Thinking Value Rubric

<table>
<thead>
<tr>
<th></th>
<th>Capstone 4</th>
<th>Milestones 3</th>
<th>Milestones 2</th>
<th>Benchmark 1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Explanation of Issues</strong></td>
<td>Issue/problem to be considered critically is stated, clearly and described, comprehensively, delivering all relevant information necessary for full understanding.</td>
<td>Issue/problem to be considered critically is stated, described, and clarified so that understanding is not seriously impeded by omissions.</td>
<td>Issue/problem to be considered critically is stated, but description leaves some terms undefined, ambiguities unexplored, boundaries undetermined, and/or backgrounds unknown.</td>
<td>Issue/problem to be considered critically is stated without clarification or description.</td>
</tr>
<tr>
<td><strong>Evidence</strong></td>
<td>Information is taken from source(s) with enough interpretation/evaluation to develop a comprehensive analysis or synthesis. Viewpoints of experts are questioned thoroughly.</td>
<td>Information is taken from source(s) with enough interpretation/evaluation to develop a coherent analysis or synthesis. Viewpoints of experts are subjected to questioning.</td>
<td>Information is taken from source(s) with some interpretation/evaluation, but not enough to develop a coherent analysis or synthesis. Viewpoints of experts are taken as facts, with little questioning.</td>
<td>Information is taken from source(s) without any interpretation/evaluation. Viewpoints of experts are taken as fact, without question.</td>
</tr>
<tr>
<td><strong>Influence of context and assumptions</strong></td>
<td>Thoroughly (systematically and methodically) analyzes own and others' assumptions and carefully evaluates the relevance of contexts when presenting a position.</td>
<td>Identifies own and others' assumptions and several relevant contexts when presenting a position.</td>
<td>Questions some assumptions. Identifies several relevant contexts when presenting a position. May be more aware of others' assumptions than one's own (or vice versa).</td>
<td>Shows an emerging awareness of present assumptions (sometimes  holds assertions as assumptions). Begins to identify some contexts when presenting a position.</td>
</tr>
<tr>
<td><strong>Student's position (perspective, thesis/hypothesis)</strong></td>
<td>Specific position (perspective, thesis/hypothesis) is integrative, taking into account the complexities of an issue. Limits of position (perspective, thesis/hypothesis) are acknowledged. Others' points of view are synthesized within position (perspective, thesis/hypothesis).</td>
<td>Specific position (perspective, thesis/hypothesis) takes into account the complexities of an issue. Others' points of view are acknowledged within position (perspective, thesis/hypothesis).</td>
<td>Specific position (perspective, thesis/hypothesis) acknowledges different sides of an issue.</td>
<td>Specific position (perspective, thesis/hypothesis) is stated, but is simplistic and obvious.</td>
</tr>
<tr>
<td><strong>Conclusions and related outcomes (implications and consequences)</strong></td>
<td>Conclusions and related outcomes (consequences and implications) are logical and reflect student's informed evaluation and ability to place evidence and perspectives discussed in priority order.</td>
<td>Conclusion is logically tied to a range of information, including opposing viewpoints; related outcomes (consequences and implications) are identified clearly.</td>
<td>Conclusion is logically tied to information (because information is chosen to fit the desired conclusion); some related outcomes (consequences and implications) are identified clearly.</td>
<td>Conclusion is inconsistently tied to some of the information discussed; related outcomes (consequences and implications) are oversimplified.</td>
</tr>
</tbody>
</table>
Appendix I

Critical Thinking Adapted Value Rubric (Coding Criteria)

<table>
<thead>
<tr>
<th>Critical Thinking Value Rubric, Adapted from Association of American Colleges &amp; Universities (AACC)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Capstone 4</th>
<th>Milestones 5</th>
<th>Milestones 6</th>
<th>Benchmark 1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Explanation / Understanding of text</strong></td>
<td>Student comprehensively understands what the text is communicating</td>
<td>Student understands what the text is communicating</td>
<td>Student somewhat understands what the text is communicating</td>
</tr>
<tr>
<td><strong>Observation / Noticing</strong></td>
<td>Thoroughly observes/notices all elements of text</td>
<td>Observes/notices all elements of text</td>
<td>Observes/notices some elements of the text</td>
</tr>
<tr>
<td><strong>Analysis</strong></td>
<td>Uses enough interpretation/evaluation to comprehensively analyze or synthesize context and medium of information.</td>
<td>Uses enough interpretation/evaluation to develop a coherent analysis or synthesis of context or medium of information.</td>
<td>Uses some interpretation/evaluation, but not enough to develop a coherent analysis or synthesis of context or medium of information.</td>
</tr>
<tr>
<td><strong>Problematic</strong></td>
<td>Viewpoints of experts are questioned thoroughly to speculate about whose voices are missing are made. Student actively problematizes messages and adopts critical perspectives toward text in order to uncover underlying messages of what's being said (and not said).</td>
<td>Viewpoints of experts are subject to questioning to speculate whose voices are missing. Student attempts to problematize messages and tries to adopt critical perspectives toward text in order to uncover underlying messages of what's being said (and not said).</td>
<td>Viewpoints of experts are taken as mostly fact, with little questioning or speculation about whose voices are missing. Student makes little attempt to problematize messages and adopts critical perspectives toward text.</td>
</tr>
<tr>
<td><strong>Influence of context and assumptions</strong></td>
<td>Thoroughly (systematically and methodically) analyzes own and others' assumptions and carefully evaluates the relevance of contexts when presenting a position.</td>
<td>Identifies own and others' assumptions and several relevant contexts when presenting a position.</td>
<td>Questions some assumptions. Identifies some relevant contexts when presenting a position. May be more aware of others' assumptions than one's own (or vice versa).</td>
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<td><strong>Student's position (perspective, thesis/hypothesis)</strong></td>
<td>Specific position (perspective, thesis/hypothesis) is imaginative, taking into account the complexities of an issue. Limits of position (perspective, thesis/hypothesis) are acknowledged. Others' points of view are synthesized within position (perspective, thesis/hypothesis).</td>
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