The Challenges of Critical Thinking in the Era of Artificial Intelligence

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Abstract

I argue that critical thinking is based on active learning, engaged independent thinking, and examining all information including recently impactful ChatGPT and other AI sources. Thoughtfully questioning what is being learned as well as critically and creatively analyzing and evaluating information such as AI is necessary to gain a deeper understanding as an effective thinker. Critical thinking pedagogy should also promote "portability" and citizenship, including information-based online multimedia literacy such as AI, as well as employment and professional information. This means becoming a critical thinker inside and outside the classroom and take what is learned into our personal, public, and professional lives. The article begins with an examination of four discrepancies or issues related to critical thinking in higher education. The critical thinking literature and Kenedy's Model of Cyclical Critical Thinking will then be considered. This will be followed by the discussion and summary regarding suggested guidelines for critically evaluating AI. Finally, conclusions regarding further work including pedagogical models for teaching critical thinking in the era of AI and other future work are considered.

Keywords: Critical thinking, artificial intelligence, critical thinking pedagogy, active learning, effective thinking.

Introduction

We seem to be living in a post-truth world (Orwell, 1949, Postman, 1985) where students are exposed to pedagogical techniques that rely heavily on what Freire (2010) refers to as "banking" based on a student-teacher relationship of "depositing"

content-driven course material and "fill[ing] the student with content" in order to "memorize mechanically the narrated content…as an act of depositing" (Freire, 2010: 71-72). This could be a reason that we are academically adrift in this banking-based memorization teaching and learning environment instead of pedagogical engagement that promotes the critical thinking of all content (Arum & Roska, 2011). In other words, is the post-secondary education sector academically and pedagogically adrift in what Postman notes is a dystopic "sea of irrelevance" that is filled with meaningless and abundant content without any active learning or critical thinking (Postman, 1985)? In the era of AI, critical thinking is essential to evaluate all information due to "banking" and being academically adrift in a post-truth world where information is accepted prima facie from sources such as ChatGPT without any deep critical thought. Arguably, all AI output needs to be critically examined due to the limitations of Chat GPT and other AI programs (Exintaris et al, 2023; Plebani, 2023; Spector and Ma, 2019; Zhai, 2022, 2023).

I argue that critical thinking is based on becoming an active learner that is an engaged independent thinker examining all information including ChatGPT and other AI sources. The emphasis is on thoughtfully questioning what is being learned as well as critically and creatively analyzing and evaluating information from sources such as AI to gain a deeper understanding as an effective thinker. Critical thinking pedagogy should also promote "portability," moving beyond the classroom into the realms of citizenship such as voting, engaging in everyday information-based online multimedia literacy including AI, as well as in a person's employment and professional lives (Ajevski et al, 2023; Exintaris et al, 2023; Murray, 2023; Plebani, 2023; van den Berg & du Plessis, 2023). This means becoming a critical thinker inside and outside the classroom and take what is learned into our personal, public, and professional lives. To teach critical thinking, the pedagogical approach of Cognitive Apprentice (Kenedy, 2022) is introduced for future consideration.

In this article, I begin by examining four discrepancies or issues related to critical thinking in higher education including students receiving unprecedented levels of "education" without being taught to think critically; the tension associated with faculty members encountering resistance to critical thinking; the rise of AI and the priority of teaching critical thinking in order to evaluate the accuracy of AI outputs; the lack of "portability" regarding critical thinking skills to transfer these skills seamlessly to citizenship activities and employment impacted by AI. Then, the critical thinking literature and Kenedy's Model of Cyclical Critical Thinking will be considered. This will be followed by the discussion and summary regarding the four issues, literature, and suggested guidelines for critically evaluating AI. Finally, conclusions regarding further work including pedagogical models for teaching critical thinking in the era of AI and other future work are considered.

Daly (1995) notes that there is a need to promote independent thinking necessary for academic and professional success, recognizing the portability of these skills outside

the classroom. Infusing critical thinking pedagogy into post-secondary teaching is necessary and one of the reasons there are so many inconsistencies regarding critical thinking (Arum & Roksa, 2011; Bok, 2006; Casner-Lotto & Brenner, 2006; Gardiner, 1995; McMahon, 2005; Paul, 2011, 2012; Paul, Elder, & Bartell, 1997; Phillips & Green, 2011). One of the main issues is that critical thinking is not "being effectively taught nor even correctly understood" (McMahon, 2005, p. 1). Paul (2011) notes that research indicates critical thinking skills are not fostered in the typical post-secondary classroom, though faculty members usually believe otherwise (Arum & Roksa, 2011; Bok, 2006; Gardiner, 1995; Paul et al., 1997). While critical thinking is viewed as essential to promote analysis and evaluation, there is a lack a specific understanding of critical thinking (Paul, 2011). This is especially important in the era of AI and other challenges to independent and critical thinking, emphasizing analysis and creative thinking (Ajevski et al, 2023; Exintaris et al, 2023; Murray, 2023; Plebani, 2023; Spector and Ma, 2019; van den Berg & du Plessis, 2023; Zhai, 2022, 2023).

There are discrepancies with both post-secondary critical thinking pedagogy and conceptualizations of critical thinking. This work primarily focuses on four inconsistencies that have been noted in the literature to assist faculty members teaching critical thinking skills. After considering these four interrelated discrepancies around education, definitions, frameworks of critical thinking are reviewed to establish a clearer understanding of critical thinking. Then, my working definition and model of cyclical critical thinking is introduced.

The first discrepancy or issue is while higher education is providing students with unprecedented levels of "education" through course content, these students are not explicitly being taught to think critically about what they are learning. Second, there is a tension associated with faculty members trying to teach students to think critically in the classroom and the resistance due to exposure of large quantities of internet information and being "amused to death" outside the classroom. The third disjuncture is the popularity of AI and programs such as Chat GPT that has made teaching critical thinking even more important to be able to evaluate the accuracy of AI outputs. Finally, there is the lack of "portability" regarding critical thinking skills and the need for students to be able to transfer their use of critical thinking skills seamlessly throughout their formal education, as well as toward citizenship activities and employment that may be impacted by AI.

First Issue

Post-secondary education seems to focus on quantity over quality, as students are expected to learn large amounts of course content without necessarily acquiring critical thinking skills to be able to qualitatively analyze and evaluate the content. Tsui (2002) notes that students are supposed to be more highly educated, but not necessarily "better educated" (p. 740). Though higher education is providing students with unprecedented levels of information through course content, students may not be learning how to think. That is, the amount of information that students are

acquiring has increased, but the quality of their learning has decreased (Arum & Roksa, 2011).

As a corollary to the issue of quantity over quality in learning, faculty members may note the importance of critical thinking and implicitly include it in their teaching without making it an explicit pedagogical goal. They also may not be properly defining critical thinking or including critical thinking as a pedagogical skill that is explicitly connected to course content. Paul (2011) notes that "[m]any college and university professors say they have little time to focus on the students' thinking because of the need to cover content…they fail to see that undigested content is content unlearned or mislearned" (p. 19).

Course content is important, but the point is to use it as a vehicle for teaching students to explicitly think critically about the course material to offer better quality teaching and learning. This usually does not happen unless specific critical thinking strategies are integrated into the subject or course content to enhance students' learning and critical thinking skills in terms of promoting more engagement and active learning. Rao (2005: 173) notes that the "…infusion of critical thinking skills into course content and their explicit introduction stimulates students thinking and improves their learning ability" in artificial intelligence courses."

There are others who directly attempt to integrate critical thinking into their pedagogical approach without explicitly teaching students critical thinking skills. Paul (2011) notes that "[m]any academic departments and faculty presuppose that they are fostering critical thinking, when in fact their expressions of it are often vague and lack any demonstrations of it…" (p. 17). There is also the problem of "academic departments, faculty and administrators that tend to trivialize critical thinking, giving lip service to it in mission statements, course catalogues, and marketing material, while ignoring it in instruction" (Paul, 2011, p. 17). Students may implicitly learn critical thinking through the content, as post-secondary teaching implies learning these critical thinking skills, or the situation arises that faculty members will ask students to think critically without explicitly teaching them to do so or providing clear definitions of critical thinking. As a final note, Paul (2011) discusses findings from his 1997 study of university faculty members which found that, while 89% declared that critical thinking is a primary objective of their own teaching, only 19% could elaborate on what they meant by critical thinking, and that while 81% indicated that their department's graduates achieved high levels of critical thinking while in their program, only 20% reported that their departments shared a common approach to critical thinking. This research clearly points to the need to promote deliberate teaching of critical thinking using explicit definitions and a clear pedagogical approach.

Second Issue

Students need to be critical thinkers as consumers of mass information in our rapidly changing world (e.g., social, political, economic, cultural, and environmental spheres)

to evaluate an ever-increasing amount of information from the mass media, Internet, AI generated documents, and other sources (Exintaris et al, 2023; Plebani, 2023; Spector and Ma, 2019; Zhai, 2022, 2023). For instance, in the media, there appear to be fewer instances of true investigative journalism or even simple fact reporting, and the rapid rise of editorializing (e.g., tweets, blogs, pundits, talking head news analysts) results in a greater need to develop self-reflection skills and open-mindedness when sifting through the deluge of information. Moon (2002, 2006) and Brookfield (2005) note the student resistance to learning how to think critically as the media often only encourages memorizing trivia without necessarily engaging in any deep learning through critical thinking (Paul, 2012). Tsui (2002) points out that rather than teaching students "…what to think, perhaps we need to do more to teach them how to think" (p. 740). Postman (1985) notes that the focus on information, triviality, and entertainment conveyed through the media has influenced knowledge, thinking, and education. Students are being given more information in ways that are entertaining without necessarily engaging with the information or thinking critically about it through analysis and evaluation. One of Postman's (1985) *Amusing Ourselves to Death* book covers shows a family on a couch watching television without heads. This poignant cover outlines the importance that some forms of entertainment content are mindless facets of life including what may be learned in the classroom. Based on John Dewey's observations, Postman (1985) states: "content of a lesson is the least important thing about learning…the most important thing about [what] one learns is always something about *how* one learns" (p. 144). Entertainment and television-based learning happens, in many cases, without any reflection, analysis, or evaluation of information. This may create an opportunity for faculty members to use entertaining media content as a means for teaching critical thinking skills to directly confront the "Huxleyan warning" of a "cultural burlesque" (Postman, 1985, p. 155) and the issue of entertainment reducing us into "passivity and egoism [and truth being] drowned in a sea of irrelevance" (p. XIX). The challenge is to confront passive learning of information promoted by some forms of television, the Internet, and AI to facilitate active learning and effective thinking through careful analysis and evaluation. For example, applying analytic or evaluative questions in lectures when discussing readings, through written assignments, or on tests to entertainment such as films or media-based content integrated into course material. The challenge is taking a critical thinking approach and turning a disadvantage into an advantage; in other words, using disadvantages of certain types of entertainment and turning them into a pedagogical advantage by taking an educative approach. This is essentially analogous to a martial arts expert using the weight or force of a charging opponent and deflecting the momentum by flipping the opponent over them rather than absorbing their full impact. In practical terms, a film has entertainment value that many students may appreciate and find more understandable than ideas from readings and lectures. In this case, students could analyze and evaluate the film's characters based on the concepts from the readings or lecture. Also, there could be an analysis of AI outputs from programs such as ChatGPT or other AI to ensure accuracy,

precision and facts and going beyond taking it prima facie as automatically accurate, valid, or reliable information.

Third Issue

With the rise of AI, there is disagreement amongst academics regarding the challenges and the educational role of AI programs such as ChatGPT. While some point out the advantages of AI, others are still cautious and believe critical thinking is necessary to evaluate ChatGPT outputs (Plebani, 2023; Zhai, 2022, 2023). Spector and Ma (2019:9) note that critical thinking habits promote the development of human intelligence with the "…use of AI to help learners perform at a higher level making adjustments based on differences of learners. This is the notion with which we conclude the future lies in using AI to improve HI [Human Intelligence] and accommodating individual differences."

Zhai (2022, 2023) acknowledges that AI it cannot completely substitute for our creative thinking skills, discussing how "education must prioritize the cultivation of students' creativity and critical thinking skills to adeptly tackle and solve diverse problems in the environment, resources, economy, politics, and other areas of future life" (2023: 2). Exintaris et al (2023: 2977) notes the importance of critical thinking "[w]hen discussing limitations of ChatGPT for problem solving, students commented on its failures to deal with niche or complex problems, it not performing required steps such as evaluation while taking some redundant steps, and its "inability" [ChatGPT limitations]." Yu (2023: 10) points out how "teachers should also focus on cultivating students' critical thinking and innovation abilities to adapt to challenges in the field of artificial intelligence in the future."

Arguably, critical thinking can be used as a means for evaluating ChatGPT results and information. Emmert-Strib (2023) discusses the usefulness of ChatGPT that is informed by critical thinking principles of assessment and evaluation of the information produced by ChatGPT, viewing it as a research tool that may be helpful, but ultimately needs to be scrutinized. Rao (2005: 173) discusses the infusion of critical thinking into an AI engineering course, pointing out that "All education consists of transmitting to students two different things: (1) the subject matter or discipline content of the course ("what to think"), and (2) the correct way to understand and evaluate this subject matter ("how to think"). We do an excellent job of transmitting the content of our respective academic disciplines, but we often fail to teach students how to think effectively about the subject matter, that is, how to properly understand and evaluate it."

Beyond the classroom, there needs to be critical thinking pedagogy "portability," that includes citizenship, employment, and professional lives. When considering AI, it is essential that components of critical thinking such as analysis are necessary to evaluate ChatGPT outputs in areas of journalism, medicine, law, teaching and other occupations or professions (Ajevski et al, 2023; Exintaris et al, 2023; Murray, 2023; van den Berg & du Plessis, 2023; Tan et al, 2023). Ajevski et al (2023: 353) note that

"ChatGPT is likely to have a significant impact on both work and education, including legal careers and legal education, as it provides easily comprehensible answers to a variety of different questions very quickly." While AI is being used within legal careers, their work considers the potential impact in law schools, the legal profession, and how generative AI could be regulated and assessed. They discuss issues around integrity, copyright, and making sure law students and practicing lawyers assess AI such as ChatGPT, Google Bard, and other AI outputs. Murray (2023: 1) states: "I have previously written how the use of an AI system to perform legal research and draft legal briefs without supervision by the attorney can have disastrous consequences. This is because however clever and human-like an AI system can make itself appear through the words it generates, the system is only mimicking human language and human reasoning." Whether AI is producing legal document, magazine articles, or various media works, proper evaluative critical thinking is necessary.

Tan et al. (2023), discuss the potential benefits of AI as an artificial lawyer to promote access to justice through providing legal information, understanding the strengths of ChatGPT and JusticeBot, and the integration of legal tools for self-represented litigants. They also point out that the disadvantages of AI lacking precise legal information regarding landlord tenant cases. While AI can be an advantageous legal self-help tool, they argue that critical thinking is necessary to evaluate AI outputs in legal contexts by assessing language comprehension, accuracy, completeness, trustworthiness, harm issues (discriminatory information), and user-friendliness (Tan et al., 2023). I would argue that these critical thinking assessment criteria are useful to evaluate AI outputs to ensure they are valid and reliable. This point will be considered later in the article.

Overall, the development of independent critical thinking skills to scrutinize AI sources is essential, as ChatGPT, Google Bard, and other programs may end up doing the work and thinking for students such as writing, test taking, and other skills in professional areas.

Fourth Issue

Critical thinking is an essential skill that should continue past a student's post-secondary experience and contribute to their life-long learning (Terenzini et al., 1995). Halpern (1998) also points out the importance of critical thinking as a transferable skill beyond the post-secondary context. Citizenship may be the obvious place to apply critical thinking as an ongoing, transferable, and "portable" skill. Tsui (2002) notes that it is important for students to become "lifelong learners," and for them to have "higher order cognitive skills...to tackle a multitude of challenges that they are likely to face in their personal lives, careers, and duties as responsible citizens" (p. 740). Students need to apply their critical thinking skills in civic forums to become both local and cosmopolitan thinkers, analyzing social, political, and global issues. Brookfield (2005) notes that "at the heart of a strong participatory democracy is citizens' capacity to question the actions, justifications, and decisions of political

leaders, and their capacity to imagine alternatives to current structures and moralities…" (p. 49). Teaching critical thinking may help students to be more engaged citizens, rather than being mere observers, through experiential learning and activism inside and outside the classroom. This portable civic approach to critical thinking could take the form of possibly volunteering with various homeless shelters, poverty groups, environmental groups, animal rights groups, neighborhood associations, and anti-violence groups. It is also valuable to promote "ethical citizenship" associated with "thinking civically." (Kenedy & Nunes, 2012). Paul (2012) discusses this type of fair-minded skilled thinking, that I would argue is related to higher order thought (Kohlberg, 1981) in terms of mutual respect and universal moral thinking, as well as thinking about the other (Gilligan, 1982). The importance of ethics and critical thinking need to be considered to promote a positive contribution in the community as well as in careers beyond graduation connected to emotional intelligence (discussed below).

Beyond this, the portable aspects of critical thinking need to be considered in terms of what ten Dam and Volman (2004) see as a "citizenship competence" in civic life and helping students become active learners and community members in their everyday life. It is the post-secondary transition of critical thinking that is first facilitated in the classroom and then in the outside world. The point of portable critical thinking is to encourage autonomous evaluation of issues and controversies. Paul (2011) discusses how the "…nature of professional and everyday life increasingly demands critical thinking…the cost of generating a growing mass of uncritical thinkers as workers and citizens is staggering" (p. 19). He views critical thinking as an essential skill in teaching and learning as well as in all aspects of everyday life. With the rise and prominence of AI, it is especially necessary to encourage critical thinking skills to scrutinize AI legal, academic, journalistic, and other content.

The need for critical thinking skills will be considered in terms of a lack of these skills in new graduates, as noted by employers (e.g., through CERI surveys). While faculty members claim that critical thinking is one of the most important goals of an undergraduate education (Bok, 2006; Paul, 2011), many undergraduates do not significantly increase their higher order thinking skills and often leave with the same skill they arrived with in their first year (Arum & Roksa, 2011, Grayson and Kenedy, 2018; Grayson et al, 2019). The challenge is that students are not graduating with portable critical thinking skills, and employers want to hire students who are able to think critically and independently as "life-long learners" (Bok, 2005).

Overall, these four discrepancies need to be addressed in an updated framework that considers the importance of critical thinking and the centrality in post-secondary education. Having a framework that addresses these discrepancies and the recent challenge of AI is essential, as many are questioning why it is worth getting a post-secondary education. AI now adds another reason when considering a post-secondary education when artificial intelligence can do the work for you.

Defining Critical Thinking: Concepts and Frameworks in the Era of AI

This is a practical overview of critical thinking definitions, taxonomies, and frameworks reviewed in order to examine common elements and differences. Defining critical thinking is important, as definitions influence pedagogy and assessments (McMillan, 1987). The definitions of critical thinking vary, but there seem to be commonalities that are associated with Bloom's revised taxonomy. Often critical thinking includes analysis, evaluation, and sometimes creative thinking (Chaffee, 2012; Paul, 2011, 2012; Paul & Elder, 2006; Ruggiero, 2012). Dewey (1916) noted that "thinking is a process of inquiry, of looking into things, of investigating" (p. 173). He viewed "critical thinking as being a combination of a suspension of judgment and healthy skepticism" (Simpson & Courtney, 2002, p. 91).

Paul (2011) notes that critical thinking dates back to Socrates' (470-399 BCE) who said we are not critical thinkers by "nature" and that our thinking is deeply flawed. Paul discusses the key influence of Socratic thought as being associated with intellectual integrity and empathy. Paul (2012) states that critical thinking is based on the ability to "analyze and assess our thinking and the thinking of others […] through working to systematically improve the quality of our thinking, to raise the problem to the level of conscious realization" (p. 6). According to Paul and Elder (2006), critical thinking "…has three dimensions: an analytic, an evaluative, and a creative component" (p. XX). Paul (2011) is very clear about mapping critical thinking and guiding students to think critically. He notes that critical thinking should be taught explicitly; can be seen as global across disciplines; should be systematically integrated into courses and curriculum; and is Socratic in terms of being "fair-minded with integrity and empathy; and is open and understandable, using ordinary language…" (p. 13).

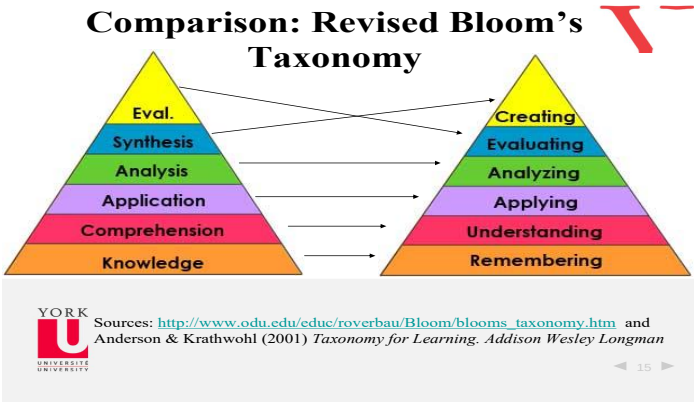
Generally, the common elements that many critical thinking frameworks and definitions have are a focus on assessing, evaluating, and analyzing ideas, facts, and information. Some authors provide taxonomies and definitions; others primarily offer definitions that are associated with pedagogy and do not have developed taxonomies. The central purpose of this section is to make the reader aware of the possible ways of viewing critical thinking as a theoretical construct that can be applied to teaching critical thinking pedagogy.

There have not been recent or significant changes to critical thinking taxonomies, theory, or definitions. The last update of Bloom's (1956) taxonomy was Anderson and Krathwohl's (2001) revised taxonomy of critical thinking (See Diagram 1). Most definitions of critical thinking highlight the importance of analysis and some type of evaluation (Brookfield, 1987; Facione, 1990; Halpern, 1997; Paul, 2011, 2012; Paul & Elder, 2011; Ruggiero, 1989, 2009, 2012). While there may be disagreements about the aspects of critical thinking and related definitions, most of them include the following themes: exploring and analyzing multiple perspectives and interpretations,

examining and evaluating evidence, promoting self-reflection, and drawing conclusions (Dunn, Halonen, & Smith, 2008).

Bloom's (1956) work is often cited as being the foremost influential taxonomy on critical thinking. As noted, Anderson and Krathwohl (2001) updated Bloom's (1956) original work, placing "create" at the top of the pyramid or hierarchy. They integrated "synthesis" in the 1956 model into "create" in the 2001 update, as well as moving evaluation from the top of the original hierarchy to the second spot under creating. This revised cognitive taxonomy includes an ordering from the basic to the more complex forms of thinking: remembering, understanding, applying, analyzing, evaluating, and creating. The revised taxonomy has been used for faculty development at many colleges and universities, where faculty members have created academic tasks highlighting different cognitive levels within the taxonomy. The focus has shifted toward differentiating between cognitive tasks that are proposed to be sequential in nature.

Diagram 1 Comparison: Bloom's Revised Taxonomy



A New Critical Thinking Paradigm: Affective or Emotional intelligence and Creative Thinking

Is there a better model of critical thinking? Are the current taxonomies, definitions, and models of critical thinking adequate? Is the potential paradigm shift located within the inclusion of expanding the analytic into the emotional? Brookfield (2005) points out that "…critical thinking elevates a Western form of cognitive, rational knowing above other forms of comprehension…there is little attention paid to affect, emotion, spirituality, or holistic modes of being and knowing" (p. 56). Elder (1997) has noted the connection between critical thinking and emotional intelligence. Since then, there has been limited literature that has expanded on this connection. Combining emotional intelligence with critical thinking seems contradictory or diametric to any type of thinking. The closest change or shift seems to be creative thinking and the inclusion of some type of emotional intelligence. Paul (2012) notes the affective dimension of critical thinking involving the role of emotions and feelings,

highlighting everything from thinking independently, to fair-mindedness, to developing intellectual humility, courage, good faith or integrity, and other important dimensions (see Paul, 2012, pp 11-12). This connection to emotional intelligence and a full explanation of the model will be discussed in future work.

Kenedy's Model of Cyclical Critical Thinking

This model is based on Bloom's Polygon (see Diagram 2) and viewing it beyond a polygon and more of a circular framework, moving away from Bloom's and Anderson and Krathwohl's static pyramid. The polygon suggests a direction that is more of a dynamic cyclical view of critical thinking connected to task-oriented questions and activities. When considering critical thinking, there seems to be a more fluid process involving increasing analytic complexity (see Diagram 1 left side). The model presented (see Diagram 3) includes creativity, and cyclically moves through re-thinking knowledge or ideas innovatively and possibly reworking them or our understanding of the critical thinking process. Re-thinking can also result in reflecting on ideas to examine and evaluate information or knowledge to develop a more in-depth understanding or altering knowledge in terms of a paradigm shift (Kuhn, 1962). It also includes the possibility of creatively using emotional intelligence and empathy to consider ethical and other issues that transcend rationality considering the Weberian concept verstehen or "understanding" a person's perspective (Tucker, 1965). Going a step further, it is an empathetic understanding of a person's actions that may take a creative approach to ethical concerns beyond rationality, related to emotional intelligence and critical thinking.

The model highlights a non-hierarchical type (unlike Bloom's taxonomy and Anderson and Krathwohl's revised taxonomy) of critical thinking and working with knowledge as higher level thinking skills including analysis, evaluation, and creatively engaging with course content and other information. This framework considers a critical thinking process that is cyclical, creatively rethinking possibilities and reexamining information in original ways that may result in a paradigm shift considering verstehen.

The cycle begins with thinking or re-thinking information. The model promotes active learning, viewing knowledge as higher level learning. Part of active learning is not only engagement but also thinking independently to be able to assess and evaluate knowledge to draw conclusions based on evidence. This cyclical model of critical thinking focuses on the production of knowledge as the highest goal of critical thinking in terms of creation and (re)thinking, based on analysis, synthesis, and evaluation. The point here is to move toward a paradigm shift through creative re-thinking and new or modified ideas. In this model, the definition of critical thinking, as noted above, is based on reflective thinking that is focused on interpreting, analyzing, critiquing, synthesizing, and evaluating information, arguments, and experiences with a set of reflective attitudes, skills, and abilities to guide thoughts, beliefs, emotions, and actions (Bloom, 1956; Paul & Elder, 2006, 2012; Ruggiero,

1989, 2009). Beyond analysis and evaluation, critical thinking also has a creative component, which promotes thinking to formulate original ideas (Anderson & Krathwohl, 2001; Krathwohl, 2002; Paul, 2011, 2012; Paul & Elder, 2006; Ruggiero, 2012). The outcome of this model is a way of understanding the learning cycle and critical thinking as ongoing and involving rethinking facts, information, concepts, and ideas.

Thinking, in the first three parts of the cycle, highlights applying critical thinking skills of focusing on the learning process through understanding information or content. Comprehension involves acquiring a rudimentary understanding of concepts, ideas, facts, or information to grasp basic ideas. This first step highlights recognition of concepts and definitions related to facts and information. Description is being able to explain information and convey it to others; it is the ability to show some understanding of the concepts or ideas in terms of explaining or discussing information. There is also the expectation of interpreting information and summarizing it clearly. Application is the process of taking an idea, thought, or way of thinking and being able to apply it to various contexts or scenarios; this may include classification of information, preparing or reporting information in various contexts. These first three parts of the critical thinking cycle are stages before analysis necessary to analyze ideas, contexts, or ways of viewing the world. There needs to be a foundation of understanding before analysis can take place. These foundational aspects of critical thinking, once understood, allow for analytical and deeper thinking.

The next four parts of analytical thinking is being able to analyze facts, information, and concepts, and draw inferences and conclusions. Analysis is a more advanced stage of learning that depends on a basic understanding of facts and information to interpret the information in your own words. Synthesis brings together many facts and various types of information, as well as being able to combine ideas and concepts into various frameworks. It is also being able to compare and contrast concepts and notions. This may include reorganizing ideas, revising them, and designing frameworks. Evaluation is one of the highest forms of thinking and is based on making judgments and evaluating information or facts. Evaluations or judgments may be based on a deeper critique of ideas or facts that could lead to recommendations for future re-evaluations or re-examination of information. For instance, judges interpret, evaluate, analyze and synthesize ideas and arguments. Creation is introducing new ideas as a result of deep analysis, synthesis, and evaluation. Through the process of re-evaluating and re-examining ideas, concepts, or theories new ideas may emerge (Anderson & Krathwohl, 2001),. There may be new and possibly original ways of looking at or thinking through ideas, as well as creating new frameworks or paradigm shifts (Kuhn, 1962). These are original ways of examining or looking at ideas, such as the shift artistically from realist art to impressionist art, it could be ethical ideas based on emotional intelligence, or verstehen as a creative approach to empathetic knowledge and a deeper understanding. It is a new way of looking at ways of thinking, such as Einstein's theory of relativity or other scientific breakthroughs, involving

analysis, synthesis, evaluation, and critique to create ideas or revolutionize thought about a subject area. Krathwohl (2002) notes that creative thinking is about putting together elements in a novel form to create an original product or idea.

Re-thinking ideas is part of the notion of the paradigm shift (Kuhn, 1962). As a result of the critical thinking cycle, there is the possibility of new ideas that revolutionize thinking and create a new paradigm, ethics, or artistic ways of re-examining past and future knowledge. The new framework becomes the basis for knowledge and will impact comprehension, description, and application. It will also influence analysis, synthesis, and evaluation of ideas. In short, it could be argued that the highest level of critical thinking is creation and re-thinking ideas, which, as a process, goes beyond conventional logic, science, or accepted academic thought and allows for re-examination and possibly original ideas. Independent evaluations beyond ideological perspectives are vital to engage in independent critical thinking. The re-thinking process may also result in a deeper understanding through verstehen that may include emotional and ethical understanding.

Arguably, the highest level of thinking involves considering what others have not thought was possible or was even considered impossible. It is being open to all possibilities, regardless of how improbable or unrealistic they may be. This type of thinking focuses on the unthinkable, in terms of creative problem-solving that questions current knowledge, practices, art, and other established thinking and can create a paradigm shift. To teach critical thinking, a teaching model may include Dynamic Purposeful Learning and Cognitive Apprenticeship that will be considered in the conclusions.

Diagram 2 Bloom's Polygon of Critical Thinking

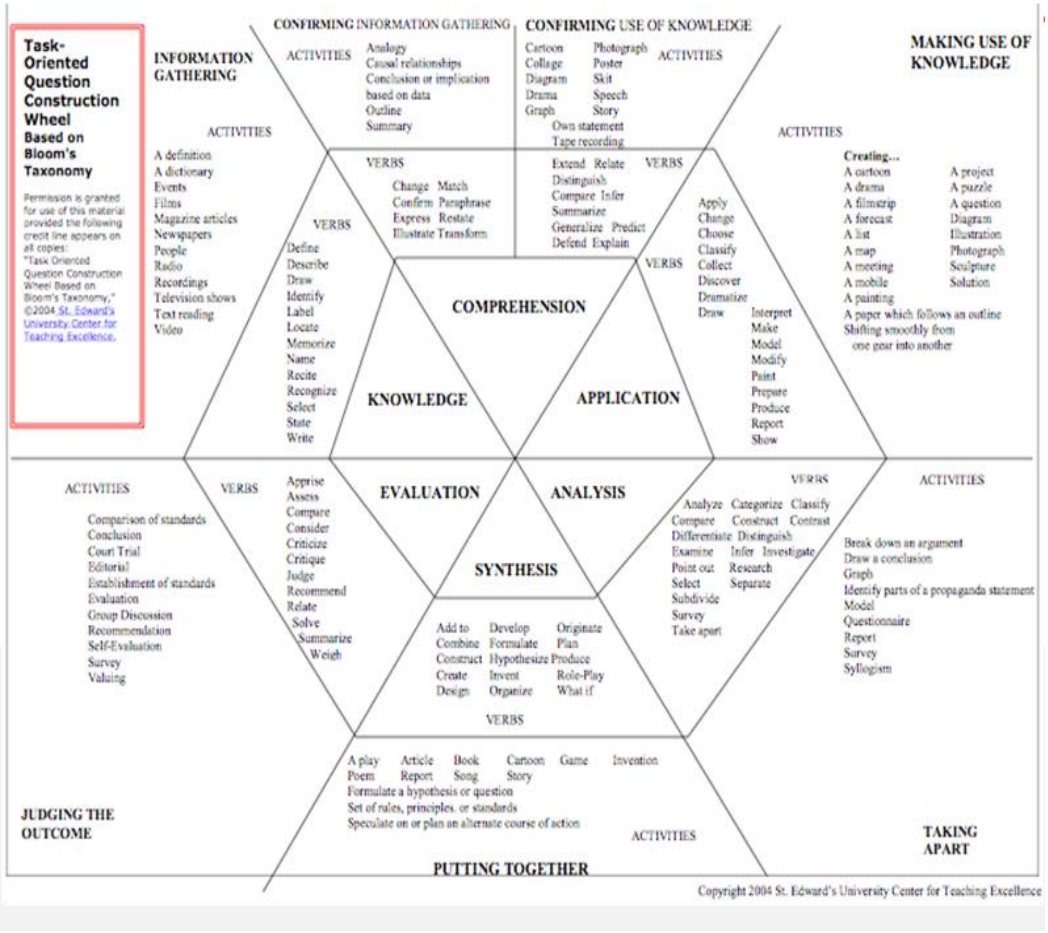
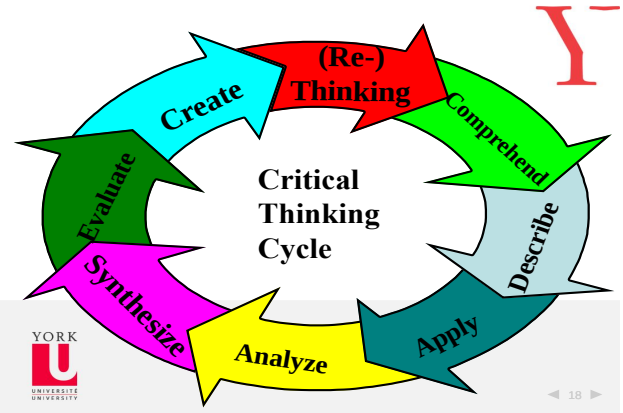


Diagram 3 Kenedy's Model of Cyclical Critical Thinking



Discussion and Summary

In the era of AI, critical thinking has become even more relevant. With the introduction of ChatGPT, Google Bard, and other AI applications, it is even more necessary to consider a cyclical model of critical thinking and address the four challenges noted above. I argue that critical thinking is based on becoming an active learner that is an engaged independent and effective thinker examining all information including ChatGPT and other AI sources. I have argued that critical thinking pedagogy should also promote "portability," into citizenship such as voting, engaging in everyday information-based online multimedia literacy including AI, as well as in a person's employment and professional lives. Artificial intelligence is one of the latest challenges, as it offers many positive breakthroughs requiring analytic scrutiny such as research, writing papers, legal briefs, medical imaging, and diagnosis, and replacing us as actors, images, voices, and other human mimicry that may impact copyright and other legal and ethical areas of our lives.

Post-secondary learning and writing promotes authorship as students learn ideas and incorporate them into their own understanding. Writing your own work in terms of authorship may be a creative act when marshalling information, quotes, and reworking them into a new way of viewing the information. This includes evaluating and scrutinizing ChatGPT and other AI outputs. Tan et al. (2023: 4-5) provides evaluative criteria for critically assessing Chat GPT outputs considering language comprehension, accuracy, completeness, trustworthiness, harm, and user friendliness. The latest challenge of AI is scrutinizing if the language outputs are "clear and understandable." Is the AI output accurate, correct, or up to date? Is the information complete, including all relevant and necessary information? Is the AI information trustworthy, from reputable sources, and reliable? Is the AI information toxic, offensive, dangerous, or violating privacy information? Finally, is the information user-friendly and easy to use? These guidelines for using AI may be helpful to critically evaluate outputs.

Conclusion

More work is necessary to understand the inconsistencies and discrepancies noted in the literature related to critical thinking pedagogy and conceptualizations related to critical thinking in the era of AI. Through a review of critical thinking definitions and frameworks, Kenedy's cyclical model of critical thinking is introduced as one way of analytically evaluating AI outputs with the caveat of more work being necessary to establish a future approach and research to creatively rethinking the impact of AI. Connected to this approach would be future consideration of Kenedy's model of Dynamic Purposeful Learning, Cognitive Apprenticeship, and other pedagogical models promoting critical thinking related to AI. Future publications will explore the connection between critical thinking and emotional intelligence, outline models offering faculty members guides to bridging the gap between general and deeper learning associated with critical thinking and AI. The presentation of a pedagogical

model would also include critical skills course material, critical thinking syllabi, assignments, critical thinking related to AI, and evaluation tools supporting a pedagogical critical thinking model in the era of AI.

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