Critical Thinking

The Science of Resilience

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Definition

"The whole problem with the world is that fools and fanatics are always so certain of themselves, but wiser people so full of doubts" – Bertrand Russell

Critical thinking is an approach to analysis and evaluation that emphasizes a more objective, scientific approach to understanding and forming a judgement to an issue, rather than an approach based on subjective bias and belief. It is a self-guided, intellectual process of intentionally conceptualizing, analyzing, applying, and evaluating information that has been gathered through reasoning, observation, learned experience, and communication (Paul et al., 1997). Critical thinking has been defined as a metacognitive process that consists of a number of skills (e.g., analysis, evaluation, and inference) and dispositions (e.g., open-mindedness, inquisitiveness and scepticism), that can be employed to develop a rational explanation, solution, or conclusion for a phenomenon, problem, or argument, with the open-mindedness to still be ready to entertain new evidence, and be surprised and humble enough to change said conclusion (Dwyer et al., 2014; Hare, 2003).

Ennis (1989, 1993, 2018) defines critical thinking as ''reasonable, reflective thinking focused on deciding what to believe or do'' (Ennis, 2018, p. 166), and states that there are eight key conceptions of critical thinking that ought to be incorporated across higher education curriculums:

- "Determine the relevance of information for evaluating an argument or conclusion
- Recognize flaws and inconsistencies in an argument
- Evaluate competing causal explanations
- Evaluate hypotheses for consistency with established facts
- Determine whether an artistic interpretation is supported by evidence contained in a work
- Recognize the salient features or themes in a work of art
- Evaluate the appropriateness of procedures for investigating a question of causation
- Evaluate data for consistency with established facts, hypotheses, or methods" (Ennis, 2018, p. 182)

Sullivan (2018) describes critical thinking as evidence-based reflection focused on truth, with a willingness to be open-minded, entertain various perspectives, and question those perspectives as well as one's own beliefs. Critical thinking is therefore associated with open-mindedness, although not completely open, as the idiom goes, "It pays to keep an open mind, but not so open your brains fall out" (Pennycook et al., 2015, p. 559). Critical thinking minds are not automatically accepting of information, and often search out additional evidence to verify the initial information, thereby making them less receptive of 'pseudo-profound BS' (Pennycook et al., 2015).

Critical thinking is similar to analytical thinking. Analytical thinking is the process of analyzing a complex topic or set of information and breaking it down into its basic parts or fundamental principles. Critical thinking is the process of carefully evaluating information and deciding how to best interpret it to come to a satisfactory explanation or judgement. While analytic thinking has a focus solely on the topic and how it can be broken down into more easily understandable parts, critical thinking often involves a more extensive open-mindedness that includes flexibility to alternate possibilities and thinking outside the box in considering how external sources of information relate to the issue (Swami et al., 2014). "Actively-open minded thinking includes the notion of flexibility, outward seeking of knowledge, and openness, which have been highlighted as cornerstones of critical thinking" (Swami et al., 2014, p. 574).

Paul et al. (1997) define critical thinking as "the ability and disposition to improve one's thinking by systematically subjecting it to intellectual self-assessment." In the literature, critical thinkers are not only those who apply such skills in one area of their life (e.g., school or work), but display this ability and disposition in every or most aspects of their life (e.g., as a citizen, parent, partner, worker, consumer, friend, or learner).

In their meta-analysis of critical thinking interventions, Abrami et al. (2008) state that educators aim to instill critical thinking not only in relation to their individual educational disciplines, but also for thinking about the "social, political, and ethical challenges of everyday life in a multifaceted increasingly complex world" (p. 1102). The authors argue that while being better critical thinkers as students has temporary advantages in academia, the crucial advantage in being a critical thinker is the ability to contribute more to society. Critical thinkers are more likely to develop into better functioning adults who are more able be successful parents, as they are more able to navigate the challenges of child-rearing and instill in their own children the importance of considering others' opinions and ways of being, thinking for themselves based on an analysis of the evidence, and embracing ambiguity in promoting democratic social harmony, rather than give into authoritarianism on the basis of emotionally-charged prejudice and dogmatic belief. Critical thinking, Abrami and colleagues argue, "sustains, builds, and perpetuates democracy" (Abrami et al., 2008, p. 1103).

Facione et al.'s (1998) American Philosophical Association Delphi panel report on critical thinking describes it as "purposeful, self-regulatory judgement which results in interpretation, analysis, evaluation, and inference, as well as explanation of the evidential, conceptual, methodological, criteriological, or contextual considerations upon which that judgement is based." The panel report also provides this high-profile definition of the ideal critical thinker, in that they are:

> habitually inquisitive, well-informed, trustful of reason, open-minded, flexible, fair-minded in evaluation, honest in facing personal biases, prudent in making judgments, willing to reconsider, clear about issues, orderly in complex matters, diligent in seeking relevant information, reasonable in the selection of criteria, focused in inquiry, and persistent in seeking [precise] results. (Facione, 1990, p. 3)

A commonality in definitions of critical thinking is that it takes effort in approaching one's thoughts, including in engaging with, critiquing, and explaining the reasons behind why one thinks a certain why. Critical thinking involves being open to listening to new ideas, open-mindedness toward criticism of one's own beliefs, and reflective skepticism (Celik et al., 2015).

The Delphi report identified the following 6 core critical thinking skills and 16 subskills or abilities for each (for an expert consensus description of each core skill, and questions to "fire up" each critical thinking skill see Facione's (2020) tables in Appendix A):

- Interpretation: Categorize; Decode significance; Clarify meaning
- Analysis: Examine ideas; Identify arguments; Identify reasons and claims
- Inference: Query evidence; Conjecture alternatives; Draw logically valid or justified conclusions
- Evaluation: Assess credibility of claims; Assess quality of arguments that were made using inductive or deductive reasoning
- Explanation: State results; Justify procedures; Present arguments
- Self-Regulation: Self-monitor; Self-correct

Hyslop-Margison (2003) argues that describing critical thinking as a standard transferable skill or basic set of problem-solving methods, and not taking into consideration a student's level of critical thinking abilities (i.e., skills and dispositions), means teachers run the risk of harming rather than helping their students. Instead, Hyslop-Margison argues that teachers ought to both model and accept that not every student will improve as critical thinkers during their time with them, as moving from ignorance to "epistemic enlightenment" requires ongoing scholarly effort. Rather than attempting to instill the metacognitive discourse of critical thinking on students, the author argues for "virtue epistemology" as a more useful teaching approach that still fosters dispositions, attitudes, and character traits designed to increase individuals' explanatory understanding, but removes the emphasis on teaching cognitive skills, problem-solving strategies, and abstract heuristic procedures.

Paul et al. (1997) claim that although critical thinking is a component of different learning tools, such as Bloom's taxonomy ((i.e. analysis, synthesis, evaluation) and Gardner's theory of multiple intelligences, the component should not be confused with the whole of critical thinking. Discussing teachers, Paul et al. (1997) state that knowing these concepts and individual critical thinking components within them (e.g., either questioning information courses, or analyzing multiple points of view) is not enough to say one comprehensively understands, practices, and is able to instruct others on the importance of critical thinking, nor have the ability to increase critical thinking in students. As such, their report states that most certified teachers have little understanding of what reasoning, assumptions, inferences, and implications are, and ought to have earlier instruction on the basics of reasoning. Consequently, prospective teachers may lack the reflective skills to be able to recognize that their own line of

thinking, including their assumptions, interpretations and conclusions, are influenced by their past disciplinary framework or viewpoint, e.g., in mathematics, biology, psychology, etc.

Critical thinking is related but different to creative thinking (Baker & Rudd, 2001). Creativity is an important aspect of critical thinking, but not a necessary requirement. Within some disciplines, it is understood that some scenarios will require a degree of creativity and subjective decision making, but that a more objective methodology can be provided in terms of examples to follow. For example, nurses, doctors, paramedics, or First Aid responders are trained to be prepared for worst case scenarios, including in how to triage patients in multiple casualty scenarios. This requires the difficult decision of deciding which individual case will require the most and immediate attention, and which the least degree. Critical thinking and subjective judgement in this example, is strengthened through training that includes objective examples of similar scenarios.

The above is a good example of the need for supporting a disciplinary, academic, scientific, professional approach to a problem, while understanding and allowing for likelihood that the individual to execute their own decision-making skills in the likelihood they will need to make their own decision based on critical thinking. While structure is important and a necessary protective factor in strengthening resilience, so too are creativity and having the opportunity for individuals to make their own decisions.

Critical Thinking Disposition

A Delphi study reported 19 critical thinking dispositions of critical thinkers, or characteristics of individuals who are more apt to use critical thinking skills (Abrami et al., 2008). According to Bertrand Russell, possessing critical thinking skills is not enough to make one a critical thinker; these skills have to be practiced and honed into everyday behaviour through habitual effort (Hare, 2003). Just having the skill to think critically is not sufficient; a person needs to exercise those skills. The skills are translated into actual behaviours or habits. Some habits that are crucial in critical thinking are that of impartial inquiry, weighing evidence, trying to see things as they are, and living independently by one's own will and self-direction (Hare, 2003).

While habitual thinking is one of the problems that critical thinking addresses, learning and practicing these habits with a critical mindset can be beneficial in challenging automatic responses. In other words, Russell states that critical thinkers have to hone a "readiness" for critical thinking to counter automatic thoughts shaped by implicit biases (Hare, 2003). Different types of readiness include: "a readiness to admit new evidence against previous beliefs…; a readiness to discard hypotheses which have proved inadequate…; [and] a readiness to adapt oneself to the facts of the world" (Hare, 2003, p. 10). A major component of this critical thinking disposition and 'readiness' for Russell is the virtue of "truthfulness", which involves the desire to find out, and attempting to be correct in matters of belief.

Critical thinkers want *to know*, without tainting the truth with their own implicit biases. One key critical thinking disposition is the ongoing sense that humans think within a framework or perspective, and that all "thought and experience is based on assumptions" (Paul et al., 1997, p. 160). The disposition of being aware of one's own assumptions and biases is associated with being 'intellectually humble', which is necessary for considering alternative perspectives. As Hare (2003) says about open-mindedness, critical thinking involves a preparedness for the possibility of being surprised.

Self-regulation

One key critical thinking skill is self-regulation. Facione (2020) states that self-regulation is not only conscious effort, but the subconscious ability to monitor one's cognitive activities through the analytical practice of self-examination and self-correction. Self-regulation involves an evaluation of one's own inferential judgements with the aim of "questioning, confirming, validating, or correcting either one's reasoning or one's results" (Facione, 2020, p. 7). Self-examination and self-correction contribute to the ability to think critically not only about oneself, but about one's thoughts and actions in relation to certain events. This allows individuals to be able to examine their views on controversial topics while being sensitive to the possibility of influential personal biases and to notice when one's own ideas begin to overtake what is being said by another person. As an aspect of self-regulation, Facione (2020) says that critical thinking allows individuals to monitor how well they appear to be understanding what they are hearing, reading, learning, or experiencing, and acts as a reminder to themselves to be conscious of and separate personal opinions or assumptions from those of the author or speaker, to fact check and recalculate findings, to be mindful of one's purpose for learning, shift methods of inquiry, reconsider interpretations or judgements as new evidence arises, be cognizant of errors and revise answers, and change conclusions by realizing and accepting these misjudgements (Facione 2020).

While reflective thinking itself is separate from critical thinking, the two often intersect, as individuals with critical thinking dispositions tend to have higher levels of self-awareness and reflective thinking skills (Celik et al., 2015). Celik and colleagues also cite research into how critical thinking is also related to a sense of purpose in life and motivation (see also Rugutt and Chemosit, 2009), which are other key protective factors in resilience.

Cognitive Dissonance and Biases

Critical thinking promotes reflection on influential implicit biases through carefully examining how one's own background and upbringing has shaped their worldview. It allows for critique and reasoning before accepting the beliefs and arguments of others, including those of similar beliefs and backgrounds (Asimov, 1995). Cognitive biases are constructed patterns of thinking that have been shaped through social upbringing or genetics, and logical fallacies are deliberate or accidental "tricks of thought" based on flawed logic (Fallacy in Logic, 2020). Both

cognitive biases and logical fallacies are concerned with errors in reasoning. Biases occur because people's emotions and interest unconsciously affect with their reasoning. Correira and Festinger (2014) classify this phenomenon, or motivational biases, in three classes: *wishful thinking* (people beliefs are led by their desires); *aversive thinking* (people believe in something because of the anxiety for not believing); and *fretful thinking.* In some cases of wishful thinking, the argument may be or not be fallacious, however the argument based only on one's desire of an outcome is probably fallacious. This explains the relation between wishful thinking and confirmation bias (Correiea & Festinger, 2014).

Confirmation bias is a well-known form of implicit cognitive bias, in which people tend to like learning stuff that proves they were right all along. To challenge this with critical thinking, an important mental drill is to always ask after making a decision, "but what if I'm wrong?" Seriously inquiring into the 'what if' leads to an analytical break down of different aspects of the conclusion (e.g., "if this part is wrong, what can I do to improve it?"). Such a train of thought also leads to a greater focus on the implications. Even if the individual is satisfied with being right, by entertaining the possibility that they are wrong they can develop a back-up plan to have ready should things go wrong. Furthermore, the individual ought to be prepared to suppress their ego in the event that they have to admit to others that they were in fact wrong, in order to remedy the situation as soon as possible (Blair, 2012).

Aversive thinking people are anxious and therefore may get defensive when their thoughts are challenged. One of the most common forms of aversive thinking is rationalization, in which a person justifies an irrational thoughts or attitude by making up good reasons, instead of accepting the true reason. Individuals who rationalize commit a fallacy of misidentifying the cause. This happens when a person holds two or more cognitions that are inconsistent, and this inconstancy creates anxiety and discomfort. In more extreme cases, it leads to denial (Correira & Festinger, 2014).

The reflexive ability to examine one's own standpoint and biases, Paul et al. (1997) argue, is important for confronting and discussing moral issues and problems. Being unable to reason and reflect, prospective teachers not only lack critical thinking skills and the abilities to pass on such skills to their students, but worse, confidently believe they do. Ironically, when such uncomfortable moral problems arise, teachers in Paul et al.'s (1997) study were more likely to be unable to address the subjects in a removed and critical manner. Instead, such individuals tend to adopt standpoints of intellectual relativism, or the view that all answers sincerely believed and defended are equally good since, as far as they can see, there is no final way to intellectually assess competing answers other than by degree of active involvement in their defense (Paul et al., 1997).

Recognition that thought is heavily influenced and driven by emotion, no matter how much-self-regulatory effort is imposed on it, is crucial in thinking more critically, e.g., in considering the validity of another's perspective (Heinberg, 2018). What is seen as a fallacy sometimes is people's adaptive behaviour (Correira & Festinger, 2014). Recognizing this, as well

as other logical fallacies (Fleming, 2016), can contribute to strengthening social and ecological resilience through sound, reasoned application of practices (Heinberg, 2018).

Critical receptiveness, baloney detection and skepticism

Critical receptiveness is "one's willingness to listen, to entertain an idea, to receive a suggestion, rather than on doubt, reluctance, resistance and so on which are suggested by skepticism. But the receptiveness must be critical--it is not blind or unquestioning… Without a critical component, open-mindedness becomes indistinguishable from gullibility and credulity…" (Hare, 2002, p. 6). The opposite concept of critical receptiveness is reflective skepticism. A critical receptive person not only needs to be open-minded but also needs to be critical. Although emotions can cause close-mindedness, individuals who could feel and perceive one's and other people's emotion have the base of open-mindedness. They can be critical receptive when they apply critical thinking and reasoning in a situation (Hare, 2002).

Critical thinking also allows one to recognize when one is being lied to, even if the person speaking to them does not intend to, based on a feeling of needing more or a greater scrutiny of the facts. A champion of scientific pursuit, reflective thinking, and human cooperation, Carl Sagan argued that critical thinking facilitates "baloney detection", or what more modern scholars describe as the ability to detect "bullshit" (Pennycook et al., 2015). More reflective, analytical individuals, who are better able to solve reasoning problems, are more likely to identify when more scrutiny is needed when presented with "pseudo-profound" baloney, or 'BS' (Pennycook et al., 2015). Understanding receptivity to bullshit is important, as research has shown that it tends to be associated with other beliefs that leave an individual vulnerable to exploitation or manipulation via a subversion of truth. Pennycook et al.'s (2015) four-part study found that individuals who were more receptive to bullshit, based on their tendency to rate ambiguous, meaningless statements as profound, were also less reflective, lower in cognitive ability (i.e., numeracy skills, and verbal and fluid intelligence), were more susceptible to conspiratorial ideation and ontological confusions, were more likely to endorse homeopathy and alternative medicine, and were more likely to hold religious and paranormal beliefs. Meanwhile, individuals who are doxastically closed, or have a closed belief system, will be unable to revise their beliefs, and therefore tend to be found throughout numerous faiths and religions (Boghossian, 2013). Having a doxastic openness cultivated through a philosophically examined life means not only being open to the possibility of being wrong in one's belief, but actively engaging with another person's belief in a manner that strengthens their argument against one's own. As Boghossian (2013) states, when encountering someone with a strong position, but poor argumentation skills, "we should provide people with arguments for their conclusions that are even better than the ones they've offered." This exercise can help to counter the cognitive biases (e.g., confirmation bias, the predisposition to believe in our own ideas) and brain tricks of thinking one is being open minded, when in fact they are not (Boghossian, 2013). It also models critical thinking dispositions and behaviours for the other individual.

Relationship to Resilience

While the ability to think more critically about complex issues can be psychologically troublesome, coping with this adversity can be improved through developing personal and psychological resilience through various factors. Although the individual may have not yet experienced the adversity, they nevertheless may need to adopt beneficial, protective resilient factors to 'bounce back' from the adverse effects of coming to the logical realization of the adverse situation to come. Such adaptations can allow the individual to maintain awareness and preparedness without succumbing to overblown worrying, outright pessimism, or apathy (Heinberg, 2018). Critical thinking is positively correlated with meaning making in life and life satisfaction (Celic et al., 2015).

While thinking 'too much', including about possible negative outcomes, can lead to feelings of vulnerability and negative thoughts in individuals high in neuroticism (Perkins et al., 2015), one large scale research study (n = 321,456) has shown that this ability also tends to be associated with lower mortality (Gale et al., 2017). When people are willing to embrace the uncomfortable and ambiguity of not knowing, rather than put it out of their mind, they are afforded more opportunities to do something about the situation. The willingness to examine, recognize and address one's own predispositions can assist in strengthening this critical thinking quality of entertaining uncomfortable scenarios and adopting any of a number of protective factors that can strengthen resilience (Heinberg, 2018).

Benitez and Canales (2013) write that a key aspect of resilience is an individual's ability to identify and solve problems in order to be able to overcome adversity, adapt, and grow from the experience. Critical thinking is necessary for developing individuals' analytical and decision-making skills that improve their resilience (Benitez & Canales, 2013). It is also associated with higher analytical ability and problem solving, judgement and decision making, professional/technical knowledge and expertise, and therefore increase the overall performance (Ejiogu et al., 2006). Kamali and Fahim (2011) found that critical thinker students have better resilience in facing difficulties with learning foreign languages. Critical thinking dispositions and skills also help to improve grades, as seen in a study of over 1100 college students showing that scores on a critical thinking skills test were significantly correlated with GPA (Facione, 2020). Reflective writing has also been shown to be positively associated with GPA, and critical thinking has been linked to cognitive ability and academic achievement (Kavenuke et al., 2020).

Critical thinking and creativity are essential for one's mental health and psychological well-being. Critical thinking and creativity improve one's ability to analyse, evaluate, compare and to be innovative. These abilities improve the locus of control. Individuals with better internal locus of control exhibit better coping strategies, and therefore tend to have better psychological regulation and well-being (Flor et al., 2012). Critical thinking is also crucial in problem solving. According to Kenyan philosophy, critical inquiry is crucial to make a fair

judgement and eliminate biases. One of the key factors in critical thinking is the ability to acknowledge the main issues and reasons behind them. Problems in the community can be solved by going to the roots of the problems and resolve them with fairness and justice (Presbey, 2004).

Critical thinkers are less susceptible to suggestions in a stressful situation. In adversities, they tend to question the reality, stressors, and demands they experienced, and make their decisions based on their assessment. They analyse multiple coping strategies and utilise the one that fits the situation. On the other hand, low self-esteem people tend to pre-occupied with distressing emotions when facing adversities, thus disengage from their previous goals under stress. They are highly susceptible to suggestions and prone to be compliant, therefore utilise dysfunctional coping strategies (e.g. avoidance coping, denial). Failure to activate critical thinking leads to utilisation of reactive coping in stressful situations (Gudjonsson, 1988; Gudjonsson & Sigurdssson, 2003).

Research by Tomczyk et al. (2018) found that, contrary to the stereotype, critical thinking is more prominent among young adults who are not employed, in formal education or training, particularly among those with vocational/professional experience. With the current economic situation, young adults are not always able to prevent themselves from becoming unemployed. They experience marginalization, mostly at the cultural level. However, sometimes they do have bigger motivations and goals in life that are translated in the way they make their decisions. They are also socially active. Valenzuela et al. (2011) discuss critical thinking's association with motivation, another protective resilient factor, stating that motivation is just as or more important than critical thinking dispositions [See our write-up on Motivation]. Reflective resilience, combined with critical thinking, individual assessment, and problem-solving strategies improves young adults' decision-making competence to navigate in their current situation (Tomczyk et al., 2018).

Various attributes influence resilience in children. Some of them are better at managing stress due to their disposition or temperament. Children who are flexible, hopeful, adaptable, and have inner locus of control are less vulnerable. Children who are critical, flexible, and creative are able to come up with various coping strategies and alternatives to their current situations. Critical thinking also helps them in making meanings about their situation and protects them from making simplistic meanings that are self-defeating (Boyden & Mann, 2005).

While critical thinking is associated with doubt (Mills, 2013), which has been associated with paranoia, critical thinking is also associated with positive wellbeing (Flor et al., 2012). The United States and Russia news sources have long been understood to be sensationalized fear-mongering information channels (Oates, 2006), and recent studies have shown the same route continues to be taken using online social media platforms. These campaigns not only aim to influence one's political preference; they do so through influencing one's resilience in terms of affecting one's sense of security, community, protection from discrimination, being able to make one's own decision, and the opportunity to develop a powerful identity. [See our write-

ups on Social Media, Protection from Discrimination, Opportunities to Make Decisions, and A Powerful Identity]**.** Improving self-regulation and critical thinking skills is not only important for strengthening an individual's resilience, but for their ability to partake in the political process to shape socioecological resilience, in terms of access to resources. The Interventions section below provides an example of how critical thinking skills can be improved through the use of social media.

However, we need to emphasize that while the majority of individuals have the cognitive faculties to question strongly held self-notions or common sense societal ways of being, some, simply put, lack these from the outset (e.g., some individuals with acute cognitive disabilities). Others may experience a greater difficulty in applying critical thinking as a result of negative physiological outcomes or accidents (e.g., individuals with fetal alcohol syndrome (Coggins et al., 1998)), or have suffered traumatic brain injuries that increase their difficulty applying critical thinking in decision making processes (Rios Freire et al., 2011).

Improving

Abrami et al. (2015) describe Ennis's (1989) framework of approaches to improving critical thinking skills. The general approach involves teaching critical thinking skills and dispositions separately from presenting distinct subject matter for each. Following the end of WWII, the British philosopher and humanist, Bertrand Russell, wrote a 1951 article on the importance of critical thinking in the *New York Times*. He outlined "10 commandments" of critical thinking:

1. Do not feel absolutely certain of anything.
2. Do not think it worth while to produce belief by concealing evidence, for the evidence is sure to come to light.
3. Never try to discourage thinking, for you are sure to succeed.
4. When you meet with opposition, even if it should be from your husband or your children [or neighbour, wife, etc.], endeavor to overcome it by argument and not by authority, for a victory dependent upon authority is unreal and illusory.
5. Have no respect for the authority of others, for there are always contrary authorities to be found.
6. Do not use power to suppress opinions you think pernicious, for if you do the opinions will suppress you.
7. Do not fear to be eccentric in opinion, for every opinion now accepted was once eccentric.
8. Find more pleasure in intelligent dissent than in passive agreement, for, if you value intelligence as you should, the former implies a deeper agreement than the latter.
9. Be scrupulously truthful, even when truth is inconvenient, for it is more inconvenient when you try to conceal it.

10. Do not feel envious of the happiness of those who live in a fool's paradise, for only a fool will think that it is happiness. (Russell, 1951)

Facione (2020, p. 27) proposes the acronym IDEAS as a 5-step method to problem solving using critical thinking:

I = Identify the problem and set priorities (step 1)
D = Determine relevant information and deepen understanding (step 2)
E = Enumerate options and anticipate consequences (step 3)
A = Assess the situation and make a preliminary decision (step 4)
S = Scrutinize the process and self-correct as needed (step 5)

Education

Promoting critical thinking in children and youth is important, as although everyone tends to start out with a childlike wonder for discovery and a thirst for knowledge, which is what drives scientific advancement, this tends to decrease overtime (Hare, 2002). Regardless of the belief, whether religious, scientific, or otherwise, there is a natural temptation for the security, comfort and confidence that comes from holding onto close-minded belief. Hare (2002) writes that teachers have an important role to play in introducing students to the uneasy discomfort of uncertainty and keeping their thirst for wonder alive. Teachers can do this by actively reviewing their curriculums for bias and being an example of breaking through conventions by constantly trying new things, rather than repeating familiar, safe, and secure lesson plans (Hare, 2002). Hare writes that teachers must remember that they do not stop being students upon becoming teachers. They can still be confident in their answers but should not pretend to know when they do not, nor assume what they believe they know is beyond challenge, and they ought to maintain that sense of readiness to be surprised. Psychological studies have shown that educational interventions can improve critical thinking abilities and dispositions (Hitchcock, 2020).

Within an understanding of socioecological resilience in terms of policy and program development, educational reforms and interventions have to be developed with care. The responsibility for promoting and measuring critical thinking does not rest solely with educators, but with the political systems that fund these programs. One investigative report from the U.S. found that The National Assessment of Educational Progress (NAEP) measures critical thinking through "Historical Analysis and Interpretation" using multiple choice format (Strauss, 2017). While NAEP states that their approach requires students to still explain, weigh and judge current and past viewpoints, and defend generalizations with sound arguments, Strauss' (2017) study showed that students were only using their analytical skills to see which multiple choice answer logically connected with the other to make the most sense. In other words, they were not learning about critical thinking, but how to take tests.

Planning interventions to improve critical thinking in education is best done in solidarity with different social agents within the various structures of the socioecological framework. One report by the National Center for Policy Analysis showed that despite billions of dollars being invested, four federal education reform initiatives in the United States failed across multi-partisan presidencies (David, 2018). Reasons for these failures included states abandoning the programs due to disagreements with hidden small print mandates; the program's focus on having students pass tests rather than enrich their learning minds; setbacks due to unrealistic promises, expectations, and unexpected challenges; and concerns over costs and time spent on meeting the programs' standards through state testing. (David, 2018). While the author of the article reporting on this analytical report says the simple solution is to remove government intervention in education, another solution is improved communication and input across various sectors. Programs like this ought to be developed in tandem with all stakeholders for greatest efficacy in strengthening resilience, with a good first step being having an agreed upon shared definition of critical thinking.

Developing valid and reliable assessment strategies for teachers to be able to assess student's critical thinking skills as distinct from domain-specific knowledge or academic abilities (e.g., reading or writing) is crucial within any field of education. In such an analysis, teachers must pay attention not only to a student's ability to achieve correct responses, but also their ability to use critical thinking processes to attain those answers. Assessment measures (discussed in the next section below) must therefore be able to capture this accurately and reliably when conducting interventions to improve critical thinking skills (Facione, 1998).

The general approach in teaching critical thinking is done by teaching critical thinking abilities and disposition as a separate content. This general approach takes place in separate courses, instructional units, or as separate threads. Another approaches in teaching critical thinking is through the immersion approach, infusion approach, or the mixed approach which combined the general approach with either the infusion or immersion approaches.

The Immersion Approach

Ennis (1989) explains that in the immersion approach, critical thinking instructions are of the thought-provoking kind of subject matter instruction in which students do get deeply immersed in the subject, but in which general critical thinking principles are not made explicit. The immersion approach aims to foster a disposition of reflective skepticism. People who favor this approach believe that critical thinking is best taught as a disposition and attitude, which can be turned on and off as needed, not as a skill that people either have or not. Immersionists view the steps in critical thinking as implicit and not specific, that is, each person has their own way of thinking. The goal in the immersive approach is to teach in a way that a person can define their task as thinking about ideas, not simply learning or memorising (Gray, 1993). Gray (1993) lists some methods to help in achieving this goal: (a) providing ideas to think about; (b) providing model of thoughts implicitly, such as using class demonstrations to trigger mutual

thought; (c) providing techniques that foster thought, for example by teaching students to make their own questions; (d) holding discussion meetings where people engage in some dialog about an idea; (e) and testing and grading to reward their thoughts. Frasca (2001) argues that non-traditional immersive methods like theatre and video games can also be used to strengthen critical thinking skills through alternate side-taking, adopting a 'spectator' position, and development of consciousness-raising characters.

The Infusion Approach

In the infusion approach, "general principles of critical thinking dispositions and abilities are made explicit" (Ennis, 1989, p. 5). One of the examples of the infusion approach is Activating Children's Thinking Skills (ACTS; McGuinness et al., 1997). Dewey and Bento (2010) explains that this methodology "delineates the thinking skills of critical thinking, creative thinking, searching for meaning, problem solving, and decision-making with metacognition at the core of all these processes" (p. 330). ACTS thinking framework includes different types of thinking (McGuinness et al., 2007): "pattern-making through analysing wholes and parts, noting similarities and differences (Searching for Meaning); making predictions and justifying conclusions, reasoning about cause and effect (Critical Thinking); generating ideas and possibilities, seeing multiple perspectives (Creative Thinking); solving problems and evaluating solutions (Problem-Solving); weighing up pros and cons, and making decisions (Decision-Making)" (p. 110).

Interventions

Activating Children's Thinking Skills (ACTS)

In this intervention, 134 teachers were trained in the ACTS framework and metacognitive approaches for teaching (Dewey & Bento, 2010). The target of the intervention was children age 8-11. Dewey and Bento (2010) examine children's cognitive ability after a two-year period of the ACTS intervention. The participants, 404 children within 7 years 6 months and 9 years 8 months, were divided into experimental or waiting list control group. They found that ACTS intervention increases children's overall cognitive ability.

YES! Intervention

The Youth Empowerment Strategies (YES!) program is a photovoice program designed to create opportunities for youth to experience participation and self-determination (voice and choice), competence (self-efficacy) and to enact power and control (Wilson et al., 2007). The program is designed to engage youth as critical thinkers and problem solvers and to create opportunities for civic engagement with other youths. Target youths are those that are underserved and between the ages of 9-12 years old. Participants meet in groups for 90 minutes weekly after school for approximately 25 sessions.

The YES! Curriculum is divided into 8 topics (Wilson et al., 2008):

- *Group formation* in which the groups work on team building activities and establish group norms
- *Photography* in which the groups are taught photography (using the camera, practicing photography) with assignments involving photographing object from multiple angles. Storyboarding, or telling stories using photos are introduced in the eighth week. The story consists of telling about the picture, what they felt about the picture, what have happened before the picture was taken, why it happened and what would happen next and in the future. This topic aims to teach causality. The assignment is to capture various contrasting attributes (eg. quiet/loud, safe/unsafe, clean/dirty) in their school environment
- *Photovoice* which aims to deepening participants' level of thinking about cause and effects of different attributes. Participants are asked to "capture images representing things at school that made students feel happy, healthy, or safe (assets) or feel unhappy, unhealthy, or unsafe (issues)" (Wilson et al., 2007, p. 246). Students who have difficulty in writing are assisted and received dictation. The group members then read aloud their *freewrites* and discuss the assets and issues identified. After the picture discussion is done, they are asked to identify issues and assets that are not photographed
- *Community organizing strategies* in which the groups use decision-making strategies to decide potential social actions topic. The facilitator helps them identifying the cost, importance, and feasibility of each topics to narrow them down to one project
- *Engaging the group in social action* which is done in all sessions. Participants engage in social action with the group
- *Engaging the community in social action* which is done when participants engage in social action with the school community

Wilson et al., (2008) found that the degree of empowerment may depend on the level of effort from the group members and some external factors. While not formally evaluated, Wilson et al. (2007) argue that photovoice projects such as YES! are useful insofar as they provide participants with opportunities to experience engagement in and control over their environments.

Community Service Learning

Service-learning is done by combining community service with academic learning. Sedlak et al. (2003) found that service-learning fosters self-confidence, self-esteem, and self-reflection in nursing students. It also strengthened their ties to the community and provided new insights to the classroom material. Critical thinking is fostered through active participation in the services. Seldak et al. (2003) examines 94 nursing students' critical thinking before and

after the experience and found that both professional and community perspective are improved after service-learning experience.

Outdoor Programs

In assessing the impact of outdoor programs on the resilience of at-risk children, Ungar, Dumond, and McDonald (2005) state that "there is a remarkable similarity between the anticipated outcomes from outdoor adventure programming and characteristics of resilient individuals" (p. 325). In citing Rutter et al (1999), the authors list self-esteem and self-efficacy through experiences of coping successfully with stress and opening up positive opportunities for change and growth as protective mechanisms related to resilience. While other mechanisms are also noted these most clearly relate to opportunities to make decisions for oneself and can be evidence in the two programs assessed by the authors.

The two programs assessed are Winter Treasures and Choices Wilderness Programming. Winter Treasures is an earth-education program run through school-community collaboration and students are trained in leadership responsibilities. The program is organized around an experiential one-day excursion to a large urban parkland, followed by a series of classroom activities. After the pre-trip activities, the children went out for a one-day excursion, in which they played outdoor or did a storyline ("the children explore the natural world and learn about the concept of habitat in a natural community" (Warner & Dumond, 2004, p. 27). Ungar et al. (2005) highlight that the meaningful responsibility given to participants through the experience was influenced by how the school environment they returned to promoted or constrained further growth.

The Choices Wilderness Program targets youth who are harmfully engaged with drugs, alcohol, and/ or gambling and is an introduction to wilderness adventure as a form of treatment. The program is comprised of a 3-day wilderness trip during which participants are encouraged to come up with rules which they believe are necessary for communal living. While different in their approach and design, the authors note that both programs provide "opportunities for the development and demonstration of new competencies, problem-solving, autonomy, helpfulness and other positive attributes associated with resilience" (Ungar et al., 2005, p. 331).

Inquiry Learning Strategy

Magnussen et al. (2000) examine inquiry-based learning (IBL) as a flexible methodology in teaching problem solving and critical-thinking ability. Inquiry-based learning is a method that "incorporate principles of systems theory as well as the deductive model and supported different collaboration models for disciplinary discussion and interdisciplinary teamwork" (Magnussen et al., 2000, p. 361).

Magnussen et al. (2010) analyse IBL in nursing curriculum by evaluating groups, each consisted of 8 to 10 students. A tutor was available provide content expertise. The tutorial focused on a client's situation. The cases were revealed in a sequential manner to imitate a real clinical situation. Students were asked to discuss the information available, separated relevant and irrelevant data to formulate and tested hypotheses. A group tutor kept the discussion on tract and encouraged students to explore all relevant issues. Once students identified all information about the case (learning issues), they divided the issues and started on individual research. At the next session, students discussed about what they had learned during their research and whether their previous hypotheses are supported. A group tutor was present to enhance students' discussion, exploration and problem-solving strategies. Written summaries were made as a conclusion. Magnussen et al. (2000) found that IBL improves critical-thinking skills in students with low initial critical thinking score.

Social Media to Enhance Critical Thinking

Reeves & Crowther (2019) examined interventions developed by the Centre of Child Protection that promote critical thinking skills and digital resilience in young people for the appropriate and safe use of online technologies. The particular concern is in protecting young people from online grooming, sexual exploitation, radicalisation, and extremism.

They used simulations "Lottie" on child sexual exploitation and "Zak" on radicalisation to encourage young people to think critically when analysing complex social problems. The simulations were run through different social media platforms where young adults could see and learn about "Lottie's" and "Zak's" engagement in social media. These simulations were based upon research and real cases; sensory simulation; challenges to find some information; and assessment based upon feedback. The intervention improves young people's knowledge about internet safety, their awareness of grooming, and teachers' own training (Reeves & Crowther, 2019).

Lutzke et al. (2019) examined an intervention to improve critical thinking in identifying fake news on social media. They provided participants with six Facebook posts about climate change (three fake and three real news) and gave them a series of guidelines for evaluating news: "(1) Do I recognize the news organization that posted the story?; (2) Does the information in the post seem believable?; (3) Is the post written in a style that I expect from a professional news organization?; and (4) Is the post politically motivated?" (p. 101964). The participants were also provided with the enhanced guidelines, for which they are asked to rate the importance of each guidelines (on 1-10 scale) in terms of the usefulness in helping them to evaluate the credibility of the news. From the study, Lutzke et al. (2019) found that participants, even the doubters of climate change, who read both the simple and enhanced guidelines were less likely to trust climate news. The effect sizes are small, however participants' trust, like and share ratings for real news stayed the same. Another factor that

influences a person's view on fake news is level of domain-specific knowledge and a positive view toward social media (Lutzke et al., 2019).

Critical Thinking Through Case Studies

Case study can be used as pedagogical tool to teach critical thinking. Pomykalski (2010) found that analysing case studies encourages students' active engagement and improves critical discussions in class and in written assignments. The cases used in case study are based on real life scenarios, have supporting data that can be analysed, and have a problem or question that needs to be solved. Case studies can be done in groups or individually, although working in group enhance brainstorming. Case studies increase students' active learning and ability to identify dilemmas, other people's intentions and feelings. They also promote problem-solving , professional thinking, active learning and increase students' engagement in class (Popil, 2010).

The ARDESOS Program and the DIAPROVE Methodology

Saiz and Rivas analyse two new techniques in improving critical thinking: the ARDESOS program (2011) and DIAPROVE methodology (2016).

ARDESOS stands for *argumentation, decision, solving of problems in daily situations*. It aims to initiate critical thinking by teaching three main skills related to critical thinking: reasoning, problem solving and decision-making. The intervention is based on "a lot of practice, interdomain practice, and tasks based on daily situation, together with biases or distortions". In example 1, Saiz and Rivaz (2011) provided a daily activity that triggers arguments to defend one's point of view, and the positions and decisions they made. Argumentation is part of and reflects human's reasoning. Example 2 and 3 provided samples of daily activities that stimulate real problem solving and decision-making tasks. Example 2 gave a common problem to trigger problem solving strategies while example 3 focused on the options of solution and the best probability for the situation. The ARDESOS program also fosters motivational aspects related to critical thinking: utility and interest. The ARDESOS program tackles biases and fallacies by making participants aware of them and familiarizing them in the thinking process.

The ARDESOS program is implemented for 6 weeks in a classroom for a 55-60 hours period, over four months. Sessions are held twice a week, for one and a half hour. Participants are divided into 4 groups. The activities are: argumentation (4 weeks), conditional and analogical reasoning (4 weeks), explanation and casuality (4 weeks) and decision-making (4 weeks) (Saiz & Rivaz, 2016).

DIAPROVE stands for *diagnosis*, *prognosis*, and *verification*. Diagnosis is done by discovering important facts to improve reasonings. DIAPROVE is inserted into the ARDESOS program by fostering "development of observational powers, the combined use of facts and

deduction, and efficacious management of disconfirmation procedures or the ruling out of hypotheses" (Saiz & Rivaz, 2006, p. 20).

Zaiz and Rivaz (2006) found that both the ARDESOS program and DIAPROVE methodology are effective in improving critical thinking. However, the efficacy in practical reasoning among people who did the ARDESOS program is higher compare to the ones that did the ARDESOS with DIAPROVE methodology.

Argument Mapping

Twardy (2004) analysed the Reason! Approach to critical thinking and the Reason!Able software. The Reason! method uses argument mapping to draw and rearrange arguments and reasonings layout based on new considerations. An argument map is "a two-dimensional representation of argument structure" (Twardy, 2004). The software helps to map claims and reasons in boxes and rearrange them easily.

The Reason! approach involves analysing arguments and producing them. For checking the argument structure, the students have Dr. Neil's "helping rules" (Twardy, 2004):

- For every independent reason, every meaningful term in conclusion must appear in each reason.
- "Every meaningful term in one premise of a reason must appear at least once in another premise of that reason, or in the conclusion" (p. 100).

Arguments that were reconstructed are evaluated by students. The software helps students to evaluate reasons based on the following grounds: necessary truth, expert opinion, eyewitness testimony, common knowledge, personal experience and considered opinion.

Every week, students came to electronic classrooms and worked in groups. Each module has a set of practices exercises and a set of exercises for homework (6 questions, requires 5-10 hours of work). Each module also has an in-class exam. "The goal is both to provide plenty of practice and plenty of feedback" (Twardy, 2004, p. 106). Twardy (2004) found that argument mapping works in helping students understand arguments structures, and therefore helps them to think more clearly.

Dwayer et al. (2012) examined argument mapping method using the Rationale AM software. In week 1, students completed pre-testing questionnaire. The course began in week 2 where they attended classes 1 and 2 for introduction to critical thinking. In week 3, they identified and analysed structures of arguments and evaluated the strengths and weaknesses of each argument. Week 4 and 5 focused on evaluation; in week 4, students were trained to evaluate and recognize imbalances, omissions and biases in arguments, while in week 5 they had to evaluate type of sources, the relevance of propositions to the central claim, the logical strength and the balance of evidence of an argument. In week 6, students were taught about

inferences and in week 7, they were taught about reflective judgement. At the end of the course, students were asked to complete another questionnaire.

Dwayer et al. (2012) found that overall critical thinking ability improved after the intervention. However, they found that students' learning motivation and need for cognition did not change after the argument mapping intervention.

Visual Thinking Strategies

Visual thinking strategies (VTS) has been used to teach critical thinking in classroom setting and medical school (Reilly et al., 2005). Housen (2002) states that VTS is "an art-viewing program originally designed to develop aesthetic understanding: the range of thoughts and feelings that occur when looking at art' (p. 99). It utilises paintings and photographic details to trigger meaning making of the object through observations and reasonings. The VTS method is described below:

- "All students have the opportunity to express their opinions about the artistic piece.
- Students all receive positive affirmation for their contributions in the form of paraphrasing and pointing by the facilitator.
- Students learn to value each other's comments as means of viewing the art for multiple meanings.
- The facilitator maintains neutrality but shows interest in each comment.
- Each participant comment is acknowledged.
- The facilitator points as people talk, seeking to confirm understanding but also keeping eyes on the image.
- Teachers encourage active participation.
- Instructors continually point at the painting, maintaining the group's focus on the art piece in front of them." (Reilly et al., 2005, p. 251)

The facilitator of the VTS discussion then asked questions to engage participants in a discussion and to point out that there are various points of view that may be similar or different (Reilly et al., 2005). Typical questions that are asked by the facilitator are:

- "What's going on in this picture?
- What do you see that makes you say that?
- What else can you find?" (Reilly et al., 2005, p. 251)

Reilly et al. (2005) explored the effectiveness of VTS in medical education and found that incorporating VTS improves empathy, awareness, sensitivity, and analytical thinking. Housen (2002) found that critical thinking taught by VTS transfers across social context. VTS influences critical thinking in two ways: by giving a person the opportunity to practice reasonings and by increasing a person's observation and speculation ability.

Assessment

Watson-Glaser Critical Thinking Appraisal II (Watson-Glasser II; Watson & Glasser, 1980)

- 40-item
- A critical thinking test often used in educational and workplace settings that analyzes five sections (Wells, 2018, p. 242):
    - Inference: The ability to derive logical conclusions from premises of varied approaches.
    - Recognition of Assumptions: The ability to recognize assumptions and presuppositions implicit in the approaches.
    - Deductions: The ability to judge whether propositions made by the approaches can be logically drawn from evidence.
    - Interpretation: The ability to judge whether the conclusions and arguments made by the approaches can be logically drawn.
    - Evaluation of Arguments: The ability to distinguish relevant, strong, and weak arguments
- 5-point Likert (Definitely true, probably true, insufficient data, probably false, definitely false)
- Coefficient alpha = .81 (Watson & Glaser, 1994).
    - Often used in job hiring and performance assessments. Other similar forms of critical thinking tests include: the GMAT and the SHL Critical Reasoning Test.

California Critical Thinking Disposition Inventory (CCTDI; Facione, 1990; 2020)

- 75-item, forced-choice, 6-point adjective checklist (1 = strongly agree, 6 = strongly disagree).
- Max score = 450; Min score = 75; scores less than 250 deemed deficient in critical thinking disposition
- Subscales: truth-seeking, open-mindedness, analyticity, systematicity, confidence, inquisitiveness, maturity
- Cronbach alpha = .92 overall; .60 to .78 on the subscales
- Walsh et al. (2007) state that their 1997 study found Cronbach alpha scores for the subscales ranging from .57 to .78, with an overall Cronbach alpha of .91, and their 2007 study reported subscale ranges of .53 to .84, with an overall Cronbach alpha score of .91.
- See Appendix B for a less robust measure, the Critical Thinking Mindset Self-Rating Form (Facione, 2020)

California Critical Thinking Skills Test (CCTST; Facione, 1990, 2013)

- 34-item

- A measure of core reasoning skills in undergraduate, graduate, or comparable population groups. Has been shown to predict critical thinking skill strength in problem situations and has been used internationally.
- Measures include: Overall Reasoning Skills, Analysis, Interpretation, Evaluation, Explanation, Inference, Deduction, Induction and Numeracy
- Internal consistency measured by the Kuder Richardson -20 (KR-20) score. "The Kuder-Richardson -20 is the comparable statistic to Cronbach's alpha used for dichotomously scored instruments and scales. For an instrument with multidimensional scales, a KR-20 above .70 indicates a high level of internal consistency" (Facione, 2013, p. 48).
- Price: N/A – 'Request Price Quote' at bottom of page: https://www.insightassessment.com/article/california-critical-thinking-skills-test-cctst-2#

Critical Thinking Disposition Scale (EMI; Ricketts & Rudd, 2005)

- 33-item
- 5-point Likert
- EMI stands for the three subscales: Engagement (12-item), Cognitive Maturity (10-item), and Innovativeness (11-item)
    - Engagement measures students' predisposition to look for opportunities to use reasoning, their ability to anticipate situations that require reasoning, and their confidence in their ability to reason (Cronbach's alpha = .89)
    - Cognitive Maturity measures students' awareness of the complexity of real problems, their predisposition to entertain other points of view, and the awareness of their and others' cognitive biases and predispositions (Cronbach's alpha = .75)
    - Innovativeness measures students' tendency to be intellectually curious and desire truth (Cronbach's alpha = .79)

The Critical Thinking Dispositions Scale (CTDS; Sosu, 2013; Appendix C)

- 11 items and 2 sub-dimensions: critical open-minded and reflective skepticism The critical openness reflects the "tendency to be actively open to new ideas, critical in evaluating these ideas and modifying ones thinking in light of convincing evidence" (Sosu, 2013, p. 115). The reflective skepticism shows "the tendency to learn from ones' past experiences and be questioning of evidence" (Sosu, 2013, p. 115)
- Cronbach alphas: .81
- 5-point Likert scale (1 = totally disagree, and 5 = totally agree)
- The total score for openness scale ranges from 7 to 35 (7-21 low; 22-28 moderate; 29-35 high) and the total score for reflective scepticism ranges from 4-20 (4-12 low; 13-16 moderate; and 17-20 high)

Critical Thinking Motivation Scale (CTMS; Valenzuela et al., 2011; Appendix D)

- 19-item
- A measure for the study of the relationship between the components of motivation and critical thinking. Participants record their level of agreement or disagreement with statements regarding their expectations about thinking in a critical or rigorous way (expectancy), and the value (value) of thinking this way. The 'value' category is further split into subcategories of attainment, utility value, intrinsic or interest value, and cost
- 6-point Likert scale (agree / disagree)
- Cronbach alphas:
    - Utility = .849
    - Interest = .760
    - Cost = .800
    - Attainment = .832
    - Expectancy = .732

The Revised Critical Thinking Scale (Hwang et al., 2010)

- A 15-item scales with 3 subscales: assumption, evaluation, induction
- 4-point Likert scale (1 = *not relevant, clear or appropriate* to 4 = *relevant, clear, or appropriate*)

Actively Open-Minded Thinking scale (AOT; Stanovich & West, 2008; Janssen et al., 2020)

- 41-item from six subscales: flexible thinking, openness values, dogmatism, categorical thinking, belief identification and counterfactual thinking
- 6-point Likert scale (6 = *agree strongly,* 5= *agree moderately,* 4 = *agree slightly,* 3 = *disagree slightly,* 2 = *disagree moderately*, 1 = *disagree strongly*)
- Cronbach alpha = .84

PENCRISAL Critical Thinking Test (Rivas & Saiz, 2012)

- 35 items from five factors: deductive, inductive, practical reasoning, decision-making, and problem solving
- Open-format items; participants have to respond by adding a justification for their answer. The quality of the response is rated as:
    - "0 points: when the answer given as a solution to the problem is incorrect; 1 point: when only the solution is correct, but not properly reasoned (identifies and demonstrates understanding of the fundamental concepts); 2 points: when, as well as giving the correct answer, the subject justifies or explains why (where he or she makes use of more complex processes involving real production mechanisms)." (Rivas & Saiz, 2012)
- The value range is between 0-70
- Used in a Spanish population
- Cronbach alpha = .632

Critical Thinking Toolkit (CriTT; Stupple et al., 2017; Appendix E)

- A measure of students' attitudes and beliefs about critical thinking
- 27-items describing: confidence in critical thinking, valuing critical thinking, and misconceptions
- 10-Likert scale ranging from *strongly disagree* to *strongly agree*
- Cronbach alpha:
    - Factor 1 (confidence in critical thinking): .92
    - Factor 2 (valuing critical thinking): .79
    - Factor 3 (misconceptions): .60

The Bullshit Receptivity Scale (BSR; Pennycook et al., 2015)

- Pennycook et al. developed this scale to measure individuals' receptivity to "pseudo-profound bullshit statements" (PPBS). The statements taken from two internet sources are a collection of profound-sounding buzzwords designed without concern for meaning, yet due to their syntactic structure have the appearance of conveying or communicating something profound. E.g., "Wholeness quiets infinite phenomena", "Hidden meaning transforms unparalleled abstract beauty."
- Subjects use a 5-point scale to measure how profound statements are (1= Not at all profound, 2 = somewhat profound, 3 = fairly profound, 4 = definitely profound, 5 = very profound). A high score indicates receptivity toward bullshit.
- Cronbach alpha = .82

Need for Closure Scale (Kruglanski et al., 1993)

- 42-item
- 7-point Likert (totally disagree; totally agree)
- Measures the need for closure as defined by five different facets: preference for order (.76), preference for predictability (.76), decisiveness (.75), discomfort with ambiguity (.60) and close-mindedness (.58).
- Has received cross-cultural validation
- Cronbach alpha = .83. (See individual subscale alphas above)

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Appendix A: Core Critical Thinking Skills & Questions

Facione (2020, p. 9)

Core Critical Thinking Skills		
SKILL	**Experts' Consensus Description**	**Subskill**
Interpretation	"To comprehend and express the meaning or significance of a wide variety of experiences, situations, data, events, judgments, conventions, beliefs, rules, procedures, or criteria"	Categorize Decode significance Clarify meaning
Analysis	"To identify the intended and actual inferential relationships among statements, questions, concepts, descriptions, or other forms of representation intended to express belief, judgment, experiences, reasons, information, or opinions"	Examine ideas Identify arguments Identify reasons and claims
Inference	"To identify and secure elements needed to draw reasonable conclusions; to form conjectures and hypotheses; to consider relevant information and to reduce the consequences flowing from data, statements, principles, evidence, judgments, beliefs, opinions, concepts, descriptions, questions, or other forms of representation"	Query evidence Conjecture alternatives Draw logically valid or justified conclusions
Evaluation	"To assess the credibility of statements or other representations that are accounts or descriptions of a person's perception, experience, situation, judgment, belief, or opinion; and to assess the logical strength of the actual or intended inferential relationships among statements, descriptions, questions, or other forms of representation"	Assess credibility of claims Assess quality of arguments that were made using inductive or deductive reasoning
Explanation	"To state and to justify that reasoning in terms of the evidential, conceptual, methodological, criteriological, and contextual considerations upon which one's results were based; and to present one's reasoning in the form of cogent arguments"	State results Justify procedures Present arguments
Self-Regulation	"Self-consciously to monitor one's cognitive activities, the elements used in those activities, and the results educed, particularly by applying skills in analysis, and evaluation to one's own inferential judgments with a view toward questioning, confirming, validating, or correcting either one's reasoning or one's results"	Self-monitor Self-correct

Source: APA Report: *Expert Consensus Statement on Critical Thinking*. (ERIC ED 315 423)

Questions to Fire Up Our Critical Thinking Skills (Facione, p. 8).

Questions to Fire Up Our Critical Thinking Skills	
Interpretation	• What does this mean? • What's happening? • How should we understand that (e.g., what he or she just said)? • What is the best way to characterize/categorize/classify this? • In this context, what was intended by saying/doing that? • How can we make sense out of this (experience, feeling, or statement)?
Analysis	• Please tell us again your reasons for making that claim. • What is your conclusion/What is it that you are claiming? • Why do you think that? • What are the arguments pro and con? • What assumptions must we make to accept that conclusion? • What is your basis for saying that?
Inference	• Given what we know so far, what conclusions can we draw? • Given what we know so far, what can we rule out? • What does this evidence imply? • If we abandoned/accepted that assumption, how would things change? • What additional information do we need to resolve this question? • If we believed these things, what would they imply for us going forward? • What are the consequences of doing things that way? • What are some alternatives we haven't yet explored? • Let's consider each option and see where it takes us. • Are there any undesirable consequences that we can and should foresee?
Evaluation	• How credible is that claim? • Why do we think we can trust what this person claims? • How strong are those arguments? • Do we have our facts right? • How confident can we be in our conclusion, given what we now know?
Explanation	• What were the specific findings/results of the investigation? • Please tell us how you conducted that analysis. • How did you come to that interpretation? • Please take us through your reasoning one more time. • Why do you think that (was the right answer/was the solution)? • How would you explain why this particular decision was made?
Self-Regulation	• Our position on this issue is still too vague; can we be more precise? • How good was our methodology, and how well did we follow it? • Is there a way we can reconcile these two apparently conflicting conclusions? • How good is our evidence? • OK, before we commit, what are we missing? • I'm finding some of our definitions a little confusing; can we revisit what we mean by certain things before making any final decisions?

Source: © 2014 User Manual for the *California Critical Thinking Skills Test*, published by Insight Assessment.

Appendix B: The Critical Thinking Mindset Self-Rating Form

Facione (2020, p. 14)

Critical Thinking Mindset Self-Rating Form

Answer yes or no to each. Can I *name any specific instances over the past two days* when I:

1. was courageous enough to ask tough questions about some of my longest held and most cherished beliefs?
2. backed away from questions that might undercut some of my longest held and most cherished beliefs?
3. showed tolerance toward the beliefs, ideas, or opinions of someone with whom I disagreed?
4. tried to find information to build up my side of an argument but not the other side?
5. tried to think ahead and anticipate the consequences of various options?
6. laughed at what other people said and made fun of their beliefs, values, opinion, or points of views?
7. made a serious effort to be analytical about the foreseeable outcomes of my decisions?
8. manipulated information to suit my own purposes?
9. encouraged peers not to dismiss out of hand the opinions and ideas other people offered?
10. acted with disregard for the possible adverse consequences of my choices?
11. organized for myself a thoughtfully systematic approach to a question or issue?
12. jumped in and tried to solve a problem without first thinking about how to approach it?
13. approached a challenging problem with confidence that I could think it through?
14. instead of working through a question for myself, took the easy way out and asked someone else for the answer?
15. read a report, newspaper, or book chapter or watched the world news or a documentary just to learn something new?
16. put zero effort into learning something new until I saw the immediate utility in doing so?
17. showed how strong I was by being willing to honestly reconsider a decision?
18. showed how strong I was by refusing to change my mind?
19. attended to variations in circumstances, contexts, and situations in coming to a decision?
20. refused to reconsider my position on an issue in light of differences in context, situations, or circumstances?

If you have described yourself honestly, this self-rating form can offer a rough estimate of what you think your overall disposition toward critical thinking has been in the past two days.

Give yourself 5 points for every "Yes" on odd numbered items and for every "No" on even numbered items. If your total is 70 or above, you are rating your disposition toward critical thinking over the past two days as generally positive. Scores of 50 or lower indicate a self-rating that is averse or hostile toward critical thinking over the past two days. Scores between 50 and 70 show that you would rate yourself as displaying an ambivalent or mixed overall disposition toward critical thinking over the past two days.

Interpret results on this tool cautiously. At best this tool offers only a rough approximation with regard to a brief moment in time. Other tools are more refined, such as the *California Critical Thinking Disposition Inventory*, which gives results for each of the seven critical thinking habits of mind.

For a fuller and more robust measure of critical thinking dispositions see the California Critical Thinking Disposition Inventory (CCTDI) by Facione and Facione, published in 1992, by Insight Assessment.

Appendix C: Critical Thinking Disposition Scale

Sosu (2013)

Critical Openness
I usually try to think about the bigger picture during a discussion
I often use new ideas to shape (modify) the way I do things
I use more than one source to find out information for myself
I am often on the lookout for new ideas
I sometimes find a good argument that challenges some of my firmly held beliefs
It's important to understand other people's viewpoint on an issue
It is important to justify the choices I make
Reflective Scepticism
I often re-evaluate my experiences so that I can learn from them
I usually check the credibility of the source of information before making judgements
I usually think about the wider implications of a decision before taking action
I often think about my actions to see whether I could improve them

Appendix D: Critical Thinking Motivation Scale items

Valenzuela (2011)

Table 1. **Items of Critical Thinking Motivation Scale (CTMS)**

Expectancy
Concerning reasoning correctly, I am better than most of my peers.
I feel capable of understanding everything related to thinking in a rigorous way.
I am able to learn how to think in a rigorous way.
I am able to learn how to reason correctly better than most of my peers.
Task value
Attainment.
For me it is important to learn how to reason correctly.
For me it is important to be good at reasoning.
For me it is important to use my intellectual skills correctly.
For me it is important to be good at solving problems.
Utility value
Thinking critically will help me to become a good professional.
Thinking critically will be useful for my future.
Thinking critically is useful in everyday life.
Thinking critically is useful for other subjects and courses.
Intrinsic/interest value
I like to reason properly before deciding about something.
I like to learn things that will improve my way of thinking.
I like thinking critically.
I like to reason in a rigorous manner.
Cost
If I have a problem that requires me to reason in a critical way, I am disposed to sacrifice the time that I would otherwise have devoted to other things.
I am disposed to sacrifice quite a lot of time and effort in order to improve my way of reasoning.
It is worth investing time and efforts to acquire and use critical thinking.

Appendix E: The Critical Thinking Toolkit

Stupple et al. (2017)

	10 (strongly agree)	9	8	7	6	5	4	3	2	1 (Strongly disagree)
1. I can detect the use of inappropriate emotional language in scientific arguments										
2. I have a well-defined goal in mind when I am critical										
3. I can identify the structure of arguments without being distracted by their content										
4. Critically thinking is particularly important in psychology [or insert name of discipline]										
5. Critical thinking is essential in higher education										
6. When there is a very strong relationship between two variables we can claim that one causes the other										
7. Critical thinking develops as you progress through your degree										
8. I can express my critical thinking well in my written work										
9. You cannot get a good degree without good critical thinking skills										
10. I prefer to do things where there is a quick answer										
11. I have a focused and systematic way of thinking										
12. All relevant information should be presented in lecture slides										
13. Generally I am a good critical thinker										
14. I do well in assessments that ask for critical evaluation										
15. I think critically while working on my assignments										
16. All my lecturers expect me to think critically										
17. I know how to approach complex issues in a variety of ways										

18. I will get higher grades if I think critically										
19. I have the ability to judge the value of new information or evidence presented to me										
20. I can evaluate the arguments of others well										
21. Critical thinking is when you describe what is wrong with something										
22. I am good at weighing up both sides of an argument										
23. I can identify analogies between theories										
24. When designing experiments I can readily eliminate extraneous variables										
25. I think critically while reading										
26. I can rephrase the arguments of others in my own words easily										
27. I think critically in lectures										

Scoring key

Factor 1 - Confidence in Critical Thinking 1, 2, 3, 8, 11, 13, 14, 15, 17, 19, 20, 22, 23, 24, 25, 26, 27

Factor 2 - Valuing Critical Thinking 4, 5, 7, 9, 16, 18

Factor 3 - Misconceptions 6, 10, 12, 21

R2

For more information about R2 or to discover how you can bring the program to your organization, business or educational setting, please contact us.

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