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Metacognitive Education: Going Beyond Critical Thinking

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Critical thinking is one of the central aims of education, and many schools and universities have courses specifically devoted to critical thinking. Ennis (1989) defines critical thinking as "reasonable reflective thinking focused on deciding what to believe or do." There are of course many other definitions of critical thinking, but most of them emphasize the importance of rationality, clarity, analysis, and independence of thought. In a typical university course on critical thinking, students might study logic, argument analysis, basic scientific methodology, fallacies, and other related topics. They learn how to distinguish between good and bad reasoning, and use this knowledge to improve their own thinking.

As such, critical thinking necessarily involves a certain amount of "metacognition", or "thinking about thinking". The concept of metacognition started to gain prominence in developmental psychology around the 1970s (Flavell 1976). It is usually understood as having two components: knowledge about cognition, and the use of this knowledge in "self-regulation", which is the monitoring and control of cognition. Critical thinking must involve some amount of metacognition, since a critical thinker ought to be able to reflect upon the reasons for her beliefs, and take careful steps to ensure that her reasoning is correct. The main thesis of this paper is that the teaching of critical thinking should be

expanded and re-conceptualized as part of a broader educational program for enhancing metacognition. One of the most basic reasons for teaching critical thinking is to help students improve their decisions about what to believe or what to do. This paper argues that in order to better achieve this goal, we need to go beyond critical thinking. It involves teaching more about other aspects of cognition such as the psychology of learning and reasoning, and creative problem solving. We also need to help students gain better insight and control over their work habits and personality. This training in metacognition can improve the quality and effectiveness of thinking. It will in turn strengthen the learning of critical thinking and bring about more lasting cognitive gains.

The case for metacognition

A central argument for expanding the critical thinking curriculum has to do with the cognitive skills necessary for success in the modern world. First, globalization and technology have led to social upheavals, economic volatility, and global competition. Technical knowledge can become obsolete quickly. Linear and stable careers are becoming exceptions rather than the norm. The average U.S. citizen born in the latter baby boomer years (1957-64) would have had ten jobs by age forty (U.S. Department of Labor 2012). Critical thinking is of course more important than ever in this environment of accelerating changes. But it has to be supported by the motivation and ability to engage in lifelong learning. Metacognitive education can help students learn how to acquire new skills and expertise quickly and effectively.

Another facet of the modern economy is the high premium placed upon creativity. Nowadays, a good idea can leverage global capital and technology to achieve a worldwide impact never before possible. Consider Facebook, the popular social networking website. It began as an idea of an undergraduate student, but it reached one billion monthly active users in less than ten years. If Facebook were a country, it would be the third largest in the world after China and India. Its phenomenal success is a good reminder that we should never underestimate the power of a good idea. It also means companies and individuals must constantly adapt and innovate, in order to deal with new challenges and opportunities. But when it comes to innovation, it is artificial to separate critical thinking and creativity. They work intimately together in solving the complex problems in our personal and professional lives. Without creativity, critical thinking is impotent in changing the world. But creativity in turn requires critical thinking in testing and implementing ideas. Yet the teaching of critical thinking in universities is typically completely divorced from the topic of creativity. If we are serious about helping students become more effective thinkers, there should be a better integration of these two topics. Metacognitive education can help students become more adept at monitoring their own thinking and reasoning, and there is evidence that this will enhance creative problem solving (Hargrove 2012). Our students can increase their awareness of the heuristics for solving problems and try to internalize them. They can also find inspiration in the thinking processes and habits of creative people, and reflect upon the conditions that promote creativity.

However, it should be emphasized that the case for metacognition is not solely a response to new economic realities. Nor should it be seen as an attempt to turn universities into job training camps. Whatever projects we choose to engage in, the complexity of the modern

world has created tremendous opportunities and challenges. We live in a world beset with deep problems in politics and social justice, and the destruction of the environment is threatening our survival. Social progress depends in part on an informed citizenry being able to think about complicated issues critically and imaginatively, and to overcome parochial biases and prejudices. To help our students make better decisions and improve their reasoning, we need to equip them with a more versatile thinking toolkit. This requires taking into account recent research in education, cognitive science, social psychology, behavioral economics and related disciplines. This paper argues that a converging theme from these diverse fields is that metacognition plays a crucial role in improving thinking skills in the long run.

A key insight of the metacognitive approach is that being a good thinker is not simply a matter of knowing the principles of correct reasoning. It has to be supported by an appropriate system of knowledge, skills and character traits. Nearly a century ago, John Dewey argued for the importance of teaching "reflective thinking", which is the examination of an idea "in light of the grounds that support it and the further conclusions to which it tends." (Dewey 1933, p.7) Reflective thinking is the precursor to what we now call critical thinking, and it includes a fair amount of logic. But interestingly, Dewey emphasized that theoretical knowledge is not sufficient for developing reflective thinking. Other personal qualities, such as being curious and open-minded, are also relevant if not more important:

> If we were compelled to make a choice between these personal attributes
> and knowledge about the principles of logical reasoning together with
> some degree of technical skill in manipulating special logical processes,

we should decide for the former. Fortunately no such choice has to be
made, because there is no opposition between personal attitudes and
logical processes. We only need to bear in mind that, with respect to the
aims of education, no separation can be made between impersonal,
abstract principles of logic and moral qualities of character. What is
needed is to weave them into unity (Dewey 1933, p.34).

More recent authors agree with Dewey that critical thinking requires not just knowledge but a range of thinking dispositions, motivations and attitudes. Langer (1989) argues for the importance of "mindfulness". The philosopher Richard Paul has urged that critical thinkers ought to develop "fair-mindedness" (Paul, Willsen and Binker 1993). Costa (1991) lists 15 "habits of mind", while Perkins, Jay, and Tishman (1993) offer seven key thinking dispositions:

1. To be broad and adventurous

2. Toward sustained intellectual activity

3. To clarify and seek understanding

4. To be planful and strategic

5. To be intellectually careful

6. To seek and evaluate reasons

7. To be metacognitive

Notice that metacognition is explicitly mentioned in this list as a thinking disposition, which is explained as follows:

the tendency to be aware of and monitor the flow of one's own thinking;

alertness to complex thinking situations; the ability to exercise control of

mental processes and to be reflective (Perkins, Jay, and Tishman, 1993,

pp. 148).

Halpern (1998) also includes metacognition in her four-part model of critical thinking

instruction, one of which is the teaching of "metacognitive monitoring". This includes for

example checking for accuracy, examining progress, and making appropriate decisions

about the allocation of time and mental effort in problem solving.

We agree there is a whole spectrum of attitudes and dispositions that are conducive to

critical thinking. We also firmly believe that metacognition enhances critical thinking

(see Magno (2010) for a review of the empirical evidence). Our approach builds upon

these observations but is different in at least three ways. First, we think metacognition

should not be conceived as just one among many thinking dispositions. Rather, it is a set

of higher-order cognitive skills and dispositions that help us acquire and regulate other

thinking dispositions. Thinking dispositions are often described as intellectual virtues.

Like their moral counterparts, putting special effort into one of them might mean less

cognitive resources for the rest. Metacognitive self-regulation helps us achieve a better

balance between these dispositions. Moreover, as Aristotle has pointed out, virtues lie

between excesses and deficiencies. Being careful is a good disposition, but being over-

cautious can be just as bad as being careless. It is good to have a plan and be reflective,

but it is also possible to over-deliberate. Given individual differences, we each have our

own pattern of excesses and deficiencies. Higher-order monitoring is needed to correct

and fine-tune our cognitive dispositions, and this is precisely a central function of metacognition.

The second distinctive feature of our approach concerns the role of knowledge in metacognition. Perkins, Jay, and Tishman (1993) and Halpern (1998) focus on the self-monitoring and self-regulatory aspect of metacognition, such as paying attention to our reasoning and tracking our progress. These dispositions are of course very important for critical and creative thinking. But we want to emphasize that these dispositions have to be supported by a suitable level of scientific knowledge about cognition. Reasoning itself is a cognitive process. There is a wealth of information from psychology and cognitive science about how reasoning might fail, and how it can be made more accurate and efficient. Recent research has found that our thinking processes and dispositions are very much affected by the quirks and biases of our cognitive architecture, often in surprising and unexpected ways (Kahneman 2011). For example, we ought to be aware of our own thinking, but we often over-estimate our abilities and underestimate our susceptibility to biases. Seeking more alternatives is a good habit of thought, but having too many choices can be counter-effective and leads to decision fatigue (Iyengar and Lepper 2000). Objectivity and fair-mindedness are admirable traits, but in some situations priming a sense of objectivity can actually increase discrimination (Uhlmann and Cohen 2007). What this means is that a careful, critical, and reflective attitude has its limitations. We can achieve a lot more when this attitude is combined with a suitable level of psychological literacy that helps us combat hard-to-detect biases and enhance the accuracy and effectiveness of our thinking.

The third distinctive aspect of our approach is that the teaching of critical thinking is conceptualized as one component of metacognitive education, rather than the other way around. There is widespread agreement that critical thinking ought to be one of the central aims of education. But it is also hard to deny that there are many other cognitive skills that are desirable for our students. We have already argued for the importance of creativity and lifelong learning. Others might add that our students also need to enhance their social and cultural sensibilities, emotional intelligence, and leadership and self-management skills. Again, it is worth emphasizing that this is not just a matter of getting students ready for the workplace. It is simply a recognition that there is a multitude of skills that help us become successful at our projects, whatever they are. However, the cultivation of these skills is a lifelong process, depending on factors such as intelligence, upbringing, and personal effort. It is unrealistic to think our students can achieve their full cognitive potential with just a few years of university education. Ultimately, our students have to be responsible for their own learning and personal growth, taking into account their own unique circumstances. This implies putting critical thinking within a larger framework of higher-order cognitive skills that helps students embark on their lifelong journey of self-development. Such a framework will include basic competence in critical thinking and problem solving, an enhanced awareness of the importance of self-knowledge and positive personal habits, and the use of empirically validated methods to acquire new expertise and improve one's own performance. This is what metacognitive education is all about. As we shall see later in this paper, metacognitive competence not only enhances critical thinking. More generally, it is also linked to many positive outcomes in life, helping us attain achievements that go far beyond our IQ or innate talent. We shall now discuss the nature of metacognitive education in more details. In particular, we propose that the curriculum should include four main components:

1. Meta-conceptions – These are our core concepts about the nature and norms of high-level cognition. These concepts are of special importance because misunderstanding can prevent us from adopting the correct principles of thinking and learning.

2. General knowledge about cognition – This refers to more specific principles about cognition that can improve our thinking. They include: (a) Knowledge about good thinking skills, such as the principles of critical thinking, heuristics for creative thinking, problem-solving methods, and decision theory; (b) Scientific knowledge about psychological processes such as memory and reasoning, and how their performance might be affected by biases and other factors.

3. Meta self-knowledge – Having an accurate understanding of one's thinking skills and related dispositions, as opposed to general knowledge about cognition that applies to most people. Accurate self-understanding is important for knowing our strengths and weaknesses, and for identifying areas of improvement.

4. Self-regulation – How to monitor and control our cognitive processes and resources effectively, and develop cognitive dispositions and personality traits conducive to better thinking and learning, and other positive life outcomes.

We now discuss each of these four parts in turn.

Meta-conceptions

Misunderstanding the basic nature of thinking and learning can have detrimental trickle-down effects on everyday cognition. Some of these misconceptions pertain to critical thinking itself. For example, some people dislike critical thinking because they mistakenly believe it just means criticizing others all the time, which they regard as too destructive and confrontational; or they believe creativity is incompatible with critical thinking, because they think critical scrutiny will destroy new ideas before they are fully developed. A person with these views is probably less motivated to improve his or her critical thinking. Similarly, misconceptions about truth and values can also hinder reasoning. People who uncritically accept relativism about truth might not care about arguments and evidence. Or sometimes people end up with incoherent moral judgments because they confuse moral relativism with the view that right or wrong depends on the situation. In decision-making, it is not uncommon for people to think that a good decision is one that happens to have a favorable outcome. But if they fail to focus on the quality of the decision process itself, they are more likely to make bad decisions or to repeat past mistakes (Russo and Schoemaker 1990).

It is also important to have the right meta-conception about creativity. Creativity is often thought to be a matter of innate talent or a product of mysterious inspiration. But many people fail to realize that creativity in a given domain depends a lot on extensive knowledge and the development of expertise over a long period of time. Case studies and research in psychology have also documented the importance of intrinsic motivation, self-control and other personality traits (Ericsson and Lehmann 1996, Torrance 2002).

Having the right conception about creativity might turn out to be a crucial step in becoming more creative.

Our meta-conceptions about learning can directly affect our actual learning and problem-solving skills. Most teachers are familiar with students who are more interested in knowing the correct answers than the methods used to arrive at those answers. Low-aptitude students in particular often place little value on careful reasoning in problem solving, and are less likely to engage in detailed analysis (Lochhead et al. 1980). Research by Carol Dweck on mindsets confirms the importance of meta-conception in learning (Dweck 1986, Dweck and Elliott 1983). According to Dweck, individuals with a "growth mindset" are those who think of intelligence as a malleable attribute that can be improved through effort. These individuals are more likely to persist through adversity and achieve success compared with those who adopt a "fixed mindset", seeing intelligence as an inborn and static trait. The latter group is more ready to give up when they encounter setbacks in solving problems. But research suggests that mindsets can be changed. Students can improve their academic performance when they are taught that intellectual skills can be acquired and enhanced through effort and in overcoming challenges. This line of research is also relevant for the teaching of critical thinking. It is very important for students to understand that their intellectual capacities could be improved well beyond the bounds of their IQ or innate endowment.

According to social psychologists, our interpretation of stress and anxiety (e.g. as fear or excitement) can also affect our performance in solving problems. In a recent study, students who were told that anxiety can improve performance ended up with better scores at a mock Graduate Record Examination (GRE) mathematics test. Furthermore, the effect

persisted in that these students on average performed about 8% better than controls in the subsequent official GRE mathematics test, and they reported being more confident of their performance and less worried about their anxiety (Jamieson et al. 2010). This is a dramatic illustration of the power of meta-conception. Interestingly, the intervention had no significant effect on either the mock or official GRE verbal score. One hypothesis is that the positive construal of anxiety serves to improve executive functions that involve planning and elaborate computation, which are more important for mathematical reasoning than verbal retrieval tasks. If this is correct, it seems plausible that critical thinking under demanding conditions will exhibit a similar response given its heavy reliance on executive functions.

General knowledge about cognition

Metacognitive education stresses the importance of acquiring knowledge about cognition in becoming a better thinker. We have seen how meta-conception affects critical thinking and cognitive performance. Another main component of knowledge concerns the principles governing good reasoning. They include the standard curriculum of critical thinking courses, such as the rules of logic and scientific reasoning. But as we have argued earlier, critical thinking does not work on its own. We need our creative imagination to come up with arguments, alternative explanations, and counterexamples. In trying to solve complex problems, critical analysis and creativity complement each other. Given that metacognitive education is about effective and useful cognition, the curriculum will include not just critical thinking, but also topics such as heuristics in creative thinking, and problem solving methodology.

There is of course no algorithm for creativity. But many creative individuals seem to make use of similar heuristics and thinking habits. So students might conceivably benefit by incorporating them into their own repertoire. For example, using creative problem solving often follows a cyclical process, starting with extensive research and collection of data. This is followed by intensive analysis involving activities such as re-framing the problem, finding connections and patterns, and exploring alternatives. At this stage there are heuristics for problem solving that might be applied, such as those discussed in Pólya (1945). A subsequent incubation period of relaxation or sleep might then facilitate the emergence of new ideas. If so, the ideas can be tested and improved upon. If not, the whole process can be repeated until the problem is solved (Young 1975). Of course, this technique does not always deliver results, and some people might benefit from a different working pattern. But it is still worth teaching because it raises awareness that creativity is an extended process involving preparation, effort and knowledge. Students can fine-tune a routine that suits them best based on the technique.

Another aspect of creativity that might be emphasized concerns the growing trend in modern society towards collective problem solving. For example, academic and industrial R&D processes are increasingly team-based. Team-authored papers generally receive more citations, and play an increasing role in high-impact research and the filing of patents. This is not just a trend in the natural sciences. It can also be observed in the social sciences and humanities (Wuchty et al. 2007). But the curricula of many university courses on critical thinking are often "individualist", focusing on the knowledge and skills that a single thinker ought to possess. It is worth reminding our students of the increasingly social dimension of knowledge production. Exploiting the help of social

networks and learning from the best people around us can boost our problem solving ability. However, at the same time we also need to be vigilant against the dangers of conformity and groupthink.

Conformity and groupthink are examples of thinking traps that we should avoid. Thinking traps include fallacies, and examples include overgeneralization, false dilemma, begging the question, or inappropriate appeal to authority, to name just a few. The topic of fallacy is discussed in almost all critical thinking courses. Philosophers often classify fallacious thinking using semantic or logical categories such as ambiguity, inconsistency, or lack of justification. But failures in critical thinking can also come from psychological dispositions and contextual influences. These cognitive biases are usually prevalent and persistent, affecting our minds in subtle and even unconscious ways. The teaching of critical thinking can become richer and more practically relevant if we expand the topic of fallacy to incorporate related research from psychology and cognitive science.

Take for example confirmation bias, the tendency to selectively recall information and interpret evidence in a way that conforms to our pre-existing beliefs. It can lead to over-confidence, also a widespread bias. We end up with an inaccurate picture of our capacities, and our opinions become less objective because we do not pay enough attention to consider alternatives and counter evidence. Systematic and deliberate effort is needed to mitigate the effects of these biases, and it is not just a matter of knowing the rules of logic.

It is worth noting that cognitive biases can occur even when no logical fallacy is being committed. For example, racial or gender biases are sometimes unconscious and hard to

detect, even among people who sincerely affirm liberal and egalitarian values. Even the price tag on a bottle of wine can influence our subjective evaluation of its taste (Plassmann et al. 2008). There are also framing effects where the choice of words can unconsciously distort our memory and decision-making. For example, when asked whether the tallest redwood tree in the world is higher than one thousand feet, subjects tend to give inflated estimates "anchored" around the arbitrary figure mentioned in the question (Kahneman 2011). In another experiment, subjects who participated in a prisoner's dilemma game called "Wall Street Game" behaved much more selfishly than participants in a "Community Game", even though the two games were exactly the same (Liberman et al. 2004)! These are dramatic examples that illustrate the powerful but subtle effect of language on our minds.

It is of course impossible to be completely immune to these influences. Our susceptibility to many of these biases seems uncorrelated to cognitive ability. But in some cases, knowing more about them can help us become more resistant to their influence (Stanovich and West 2008). Teaching about these biases therefore has pedagogical value, and might offer some protection against manipulative attempts in marketing and politics. It also improves strategic thinking where we need to take into account other people's sub-optimal decisions. More generally, we can use such knowledge to design better public policies that nudge people toward better decisions (Thaler and Sunstein 2008).

Cognitive biases provide an important source of information about the architecture of the mind. In cognitive science, many authors have proposed some form of dual-process model of higher cognition (see Evans, J. 2008, Kahneman 2011). They make a distinction between psychological processes that are fast, automatic, and unconscious, and those that

are slow, deliberate, but conscious. The two groups of processes are often known as System 1 and System 2 respectively. System 1 includes innate skills and automatic reactions that we share with other animals, and is crucial for survival. It serves us well most of the time, but the danger is that it can also lead to unreliable intuitions and rash decisions, in situations where careful analysis is required. This is particularly likely to happen when we are not paying attention, or are tired, emotional, or under stress. The engagement of System 2 to override default responses requires deliberate effort and reflection, and is crucial for metacognition. Interesting, a recent study suggests that this readiness for reflection (as measured by what is known as "The Cognitive Reflection Test") is a better predictor of the ability to combat classic cognitive biases compared with measures of cognitive ability, thinking dispositions, and executive functioning (Toplak, West, and Stanoich 2011).

The delineation between the Systems 1 and 2 is not uncontroversial. Some researchers have even argued that in some situations relying on intuitions rather than deliberate reasoning can lead to more satisfactory decision outcomes (Dijksterhuis, et al. 2006). But being aware of the divergent sources of our judgments can help us find ways to improve their accuracy and become more alert to potential lapses. For example, one might adopt the strategy of not making drastic decisions when being emotional. Or one might decide as a rule not to follow one's intuitions whenever there is a feeling of uncertainty or anxiety. It is also useful to keep a record of our decisions to explore the effectiveness of different thinking strategies. Teaching about the psychology of reasoning and biases offers a more comprehensive picture of rationality, helping students fine-tune and self-correct their thinking.

Meta self-knowledge

Accurate self-knowledge is essential in order to control and improve our thinking. But psychologists have found that in many areas people tend to over-estimate their abilities. For example, they think they are more likely than their peers to get a higher salary or have a gifted child, but less likely to divorce or have a drinking problem (Weinstein 1980). Similarly, the vast majority of drivers believe they drive better than average (Svenson 1981). This "above-average effect" also applies to business managers (Larwood and Whittaker 1977) and football players (Felson 1981). It also extends to college students when they are asked to rank their logical reasoning skills, knowledge of English grammar, and ability to recognize humor (Kruger and Dunning 1999). Furthermore, comparative studies suggest that over-confidence is prevalent across many different cultures (Yates et. al. 1998, Chen et. al. 2007).

Of course, self-confidence helps sustain a positive self-image, and motivates us to overcome obstacles. But over-confidence can hinder self-improvement by blocking insight into our own weaknesses. To deal with this problem, it is crucial to calibrate self-appraisals using objective measurements, accurate comparative information and corrective feedback. It might also be useful to keep a journal of our successes and failures for periodic review. It is important to emphasize this aspect of metacognitive monitoring in the teaching of critical thinking as well.

People's optimistic perception of themselves can make them evaluate their own actions more favorably, which can lead to disagreements and conflicts. Because we are often

unconscious of the biases operating in our own judgments, we tend to see ourselves as objective and fair-minded. But when other people disagree, we judge them to be irrational or motivated by self-interest. This differential recognition of bias in others but not in ourselves is known as "the bias blind spot". It seems to be a particularly irrepressible bias, and one unfortunate consequence is that if we regard our adversaries as irrational, we are more likely to confront them and resort to more aggressive means (see the review by Pronin 2008). An awareness of this problem might help us become more charitable and improve inter-personal understanding.

Self-regulation

In the metacognition literature, self-regulation refers to the capacity to monitor and control our own cognitive processes. Typically it involves setting up goals, applying and reflecting on the strategies for achieving those goals, monitoring our progress and making necessary adjustments. Self-regulation is surely crucial for critical thinking. A critical thinker understands the importance of clarity and truth, and takes careful steps to achieve those objectives. Deliberate effort is needed to analyze ideas systematically and to avoid rash judgments. Furthermore, good critical thinkers will try to obtain better insight into their own thinking, and find ways to improve their thinking skills even further.

Beyond critical thinking, self-regulation provides the discipline necessary for acquiring expertise in domains where there are learnable regularities. This requires intensive and deliberate training taking corrective feedback into account. Strong motivation and discipline are essential in order to endure repetitive exercises over a long period of time.

In many cases, daily practice for a whole decade is necessary to achieve world-class performance. This seems to be true across diverse domains, whether it is chess, mathematics, dance, sports, or musical performance (Ericsson and Lehmann 1996).

There are of course individual differences in self-regulation, linking to differences in personality. The five-factor model of personality in psychology describes variation across five dimensions: neuroticism, extraversion, openness, agreeableness, and conscientiousness (Costa and McCrae 1992). Conscientiousness involves being responsible, careful, systematic, and hardworking. There is now a huge body of data pointing to the benefits of conscientiousness. Among the five factors, it is the best predictor of academic performance in high school and college, independent of cognitive ability. It is also the best predictor for self-regulation in undergraduate students (Fein and Klein 2011). Outside of academic performance, conscientiousness predicts physical and mental health, longevity, (lack of) criminal convictions, marital stability, income, leadership, job performance and occupational attainment. Many of these effects can be separated from other variables such as socioeconomic status and education (Moffitt et al. 2011, Roberts et al. 2012).

Grit is a related personality trait that has also received a lot of attention recently. Compared with conscientiousness, grit places greater emphasis on persistence and effort, resilience in overcoming hardship, and the ability to stick to long-term goals despite setbacks. It seems to be a common trait among exceptionally creative and successful people according to some extensive case studies (Miles 1926). Grit presupposes self-regulation, and is highly correlated with conscientiousness (but not IQ). Grit predicts educational attainment, undergraduate grade point average, retention in college, over and

above IQ and conscientiousness. In fact, grit can propel less intelligent individuals to excel and become more successful than their more gifted counterparts (Duckworth et al. 2007).

It is interesting to note that when Dewey (1933) argued for "reflective thinking" in education, he characterized it partly as thinking that involves "care" and "persistence", which correspond closely to conscientiousness and grit. University education should do more to help students understand the importance of these traits. As discussed earlier, cognitive skills often require extensive, structured, deliberate practice over a long period of time. Self-regulation in the form of conscientiousness and grit can surely help. Many authors are worried about universities failing to help students improve their thinking. One large-scale study in the US involving more than two thousand students at twenty four universities showed that 45% of students failed to improve their critical thinking significantly during their first two years of college, while 36% still showed no gains after four years (Arum and Roksa 2011). Not surprisingly, the study also found that students who took courses with more reading and writing showed higher rates of learning (see also Dollinger et al. 2007). If universities are serious about improving critical thinking, one of the many things they should do is to rebuild a learning culture that values and rewards hard work and persistence. The enhancement of critical thinking is thus intimately related to metacognitive education.

Of course, it is an open question to what extent we are able to change our personality. But there seem to be plenty of strategies to improve self-control, such as preempting or reappraising an undesirable option, or other methods such as distancing and distraction (Goldin et al. 2008, McGonigal 2011). By increasing self-control, one might indirectly

strengthen conscientiousness. In the academic context, conscientious self-regulated learning has been reported to correlate with academic success (Kitsantas, Winsler and Huie 2008, Zimmerman and Schunk 2008). Self-regulated learners are self-aware and take responsibility for their own learning processes. They are motivated to seek out the information and skills they need to acquire, and they take active steps to plan and monitor their learning. There is evidence that explicitly teaching students metacognitive learning strategies that include self-regulation can succeed in raising their grade point averages and graduation rates (Tuckman and Kennedy, 2011).

Conclusion and further discussion

Different sources of theoretical perspectives and empirical evidence have converged on the importance of metacognition in the form of disciplined self-regulation supported by self-understanding and knowledge of psychology. It enhances learning, critical thinking, creativity, and academic and career success. There are therefore good reasons to expand the teaching of critical thinking in this direction. In this final section we address two potential reservations.

First of all, there might be a worry about mixing critical thinking with psychology. The teaching of critical thinking often includes a fair amount of logic, broadly conceived. This might include the rules of deductive logic, inductive inferences, and scientific confirmation. But these principles are usually taken to be *a priori*, fundamentally different from the empirical *a posteriori* theories in much of metacognition, such as the

science of cognitive biases and personality traits. It might be thought that these two sets of theories should not be taught together since they belong to different disciplines.

However, as Dewey has observed, thinking well is not exhausted by knowledge about logic. If there are other important factors that contribute to good thinking, they should also be included into our teaching regardless of disciplinary boundaries. Take medical education as an analogy. The discipline of human physiology is indeed distinct from psychology, risk management, counseling, and ethics. But nobody should deny that the latter topics are also important in training doctors. Similarly, critical thinking is only part of what we ought to know to be an effective thinker. We teach logic because we think it helps students avoid errors in reasoning and make better judgments. Nonetheless, from a pedagogical point of view, it is just as useful to know about the psychology of biases and the importance of self-regulation. By explicitly introducing metacognition into the curriculum, our students acquire a broader perspective about the different factors that contribute to good thinking. This interdisciplinary approach gives them a more solid foundation to acquire other cognitive skills and improve themselves in the long run.

This raises a more practical reservation about metacognitive education. Critical thinking already covers a lot of topics. Teachers of critical thinking inevitably have to decide which topics to include and which to leave out because of limited class time. For example, how much of formal logic should be taught? How useful are Venn diagrams and Aristotelian syllogisms? Metacognition is even more wide-ranging, including diverse topics about creativity, cognitive science, social psychology, and so on. One might wonder whether it is realistic or even desirable for a single course to address all these topics. There is the risk of superficial coverage leading to poor results.

This is a legitimate concern, but the present proposal is not that we abandon courses in critical thinking immediately and start teaching metacognition instead. Rather, the suggestion is that the development of metacognitive competence ought to be an explicit aim of education, and the time is ripe to consider how critical thinking fits within this larger framework. But there is no reason why we should shoehorn every topic related to metacognition into one single course. Some of the points discussed, such as the effect of interpreting anxiety in a positive light, or strategies for improving self-control, are perhaps more appropriate in a learning component designed to impart "soft-skills". Creativity and problem-solving heuristics can perhaps be discussed within discipline-specific courses. Certainly we need more research on how best to teach metacognition. But the university curriculum as a whole should convey a clear message of its importance. There should be appropriate coordination to ensure adequate support and incentives to build a learning culture that centers upon metacognition.

In any case, metacognition ought to be given a more prominent place in the teaching of critical thinking itself. As far as teaching methodology is concerned, critical thinking courses can make more extensive use of problem-based learning instead of lectures to familiarize students with self-regulated learning. As for content, students can learn more about the psychological factors that affect our reasoning, and find out how to mitigate the effects of cognitive biases. They should understand that thinking skills go beyond raw intelligence, and that conscientious effort and good personal habits can help us maximize our potential. We also need accurate self-understanding, and take corrective actions in response to feedback. It is a cliché that our students need to learn how to think. It is also a commonplace observation that many of them fail to do so. Hopefully, by thinking more

about learning, and about the nature of the thinking process itself, our students will end up becoming better thinkers.

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