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ARTÍCULOS DE REVISIÓN

About the reflective thought also known as the critical thinking

Sobre el pensamiento reflexivo, también llamado pensamiento crítico

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Summary

This article deals with the concept of reflective thought or critical thinking from its initial formulation as an intellectual attitude to its current articulation as a third level of cognitive processing. Issues dealt with include critical thinking as a goal, as a cognitive process, as a part of dual cognitive processes, as a measurable disposition, as a measurable ability and as an educational task.

Key words: Reflective thought, critical thinking.

Resumen

Este artículo aborda el concepto de pensamiento reflexivo o crítico desde su formulación inicial como una actitud intelectual hasta su articulación actual como un tercer nivel de procesamiento cognitivo. Los temas tratados incluyen el pensamiento crítico como meta, como proceso cognitivo, como parte de procesos cognitivos duales, como disposición medible, como habilidad medible, y como tarea educativa.

Palabras clave: Pensamiento reflexivo, pensamiento crítico.

Demands from an increasingly competitive and globalized world include rational-reflective thought and, thus, nowadays organizations recruit senior management by taking into account its capacity to think with autonomy, objectivity and depth as well as the best universities assume that they do not only teach their students contents (engineering, administration, etc.) but also to think critically (Fisher, 2001). Even authoritarian institutions by excellence see reflective thought as expressed by the Head of the US Joint Chiefs of Staff when giving a speech to the officer class: "You will remember how you were inspired to think critically and question without fear, to look for radically different solutions and to express them without any inhibitions" (Mullen, 2009; cited by Facione, 2011). Critical thought as an educational goal occupies a place in US laws (U.S. Congress, 1994). This occurs because criticism is an indispensable previous step for scientific creation and; therefore, they are one of the supreme functions of intellectual life and they should be also one of the axes of university life together with technology reproduction (teaching of professions). If the university is limited to disclose technologies and makes no effort to teach students to think critically, a limited service is being offered to the society which will exclude scientific production and weaken professionals. Likewise, the university must assume as an objective the development of a competency like this because students need it to act as responsible citizens who are able to issue reasonable judgments of social and moral nature. In this article, I provide a review of the international literature existing in this sense, prepared by Peruvian educators and psychologists.

Critical Thinking as a Goal

The definitions of critical thinking vary from some wider and very diffuse ones to other which are more precise and specific. Sternberg (1986) defined it as processes, strategies and mental representations used by people to solve problems, make decisions and learn new concepts. Shortly afterwards, 46 philosophers, educators and social and physical scientists who were met for a Delphi task conceived ideal critical thinker as traditionally inquisitive, well-informed, reasoned, open-minded, flexible, balanced in evaluation, honest to face personal biases, prudent to make judgments, disposed to see things again, clear with respect of issues subject matter of discussion, organized with respect of complex issues, diligent in information search, reasonable to select criteria, focused on inquisition and persistent in the search of

results as precise as permitted by the nature of the subject and according to the circumstances (American Philosophical Association, 1990). These definitions are so general that they do not enable to make differences between critical thinking of general intelligence or certain personality features. In comparison, the US philosopher, educator and psychologist John Dewey developed a single essential idea when defining reflective thought as:

"The active, persistent, and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it, and the further conclusions to which it tends" (Dewey, 1909, cited by Fisher, 2001, p. 2).

This definition shows us that the essential concept is the attitude to not accept intuitions, beliefs or "truths" a priori but only after passing by a critical screening. The meaning of "active" in the definition of Dewey involves not just receiving ideas, storing and recovering them as well as communicating them but a process whereby a person thinks of himself, questions himself, finds relevant information by himself and reaches his own conclusions. Note that "persistent" and "careful" are opposed to "lazy", "automatic" and "impulsive". It is not just to jump into easy conclusions or to find solutions in fractions of a second, but to conduct necessary evaluations, as much time as they take. The most important part of the definition of Dewey is related to "grounds that support" a belief, and "further conclusions to which it tends". It means that the key is the quality of reasons to believe in something and the awareness of implications that our beliefs may have.

Dewey's conception was enriched after three decades when Edward Glaser defined critical thinking as: (a) an attitude to be disposed to consider problems and issues in a thinking fashion according to our experience, (b) the knowledge about the inquisition and logical reasoning methods and (c) a certain ability to apply these methods. Critical thinking requires a persistent effort to examine any belief or form of knowledge in the light of the grounds that support it, and the further conclusions to which it tends" (Glaser, 1941; cited by Fisher, 2001). Besides the elements common to Dewey's definition, here there is an emphasis on certain intellectual skills deemed to be needed. Another new element appears on the definition of Norris and Ennis (1989), the critical thinking is a reflective and reasonable thought focused on the

decision about what to believe in or make. Here the definition transcends the intellectual field to include also the most practical area of action and decision making. One more element was incorporated into the definition of Paul, Fisher, and Nosich (1993) critical thinking is a form of thinking – of any issue, content or problem – wherein the thinker improves his thought quality by taking charge skillfully of structures inherent to thought and imposing intellectual standards on them. In other words, critical thinking is achieved through a conscious improvement process by means of self-criticism related to the form of thinking of a person. As stated by Halpern (1998), when people think critically, they are evaluating the results of their mental processes. Finally, Fisher and Scriven (1997) concluded that critical thinking is a skillful and active interpretation and evaluation of observations and communications, information and arguments. Here we can see more completely the nature of the concept as an essential academic ability.

Even though there might be a universal agreement on the nature of critical thinking when the concept is maintained at a certain level of vagueness, disagreements appear as soon as more precision is attempted to be given there. Bailin, Case, Coombs, and Daniels (1999) wanted to harmonize several points of view by proposing a definition of critical thinking as a competency based on certain intellectual resources deemed necessary for preparing a valid judgment. To start, we do not talk about any type of thought but a thought which is addressed to a purpose or end, as to reply to a question, make a decision, design a plan or conduct a project. Secondly, thinking must meet certain standards of quality. To have a critical thinking, a person must be aware of the existence of such standards and make efforts to meet them even though he is unable to mention them verbally with great clarity. Evidently, the thing is not dichotomous, but a matter of degrees. According to Bailin et al. (1999), intellectual resources for critical thinking are: (a) background knowledge. A person can criticize something he knows a little bit, but he will not be able to think critically of a certain subject – i.e., by meeting standards of quality - unless he has a deep knowledge about it or the capacity to gather information of the case quickly, (b) operational knowledge about standards of good thinking. Each discipline (science, law, music, athletics, etc.) has standards that go beyond laws of logics and comprise standards of practical deliberation, argumentation, action plan development, standards governing judgments made in the course of actions and standards governing

the inquisition and justification in specific areas (e.g., psychological research). However, those standards do not tell the thinker what to do under a specific circumstance; they only provide the thinker with general rules that he will understand deeply only after their implementation in the practice and incorporating his experience, (c) knowledge about key critical concepts which enable to distinguish several types of products and intellectual processes. For example, confronted with a statement needing evaluation, the critical thinker shall recognize whether it is a value judgment, an empiric assertion, or a conceptual formulation, (d) heuristics (strategies, procedures for information or solution search). To evaluate a general principle, it is useful to look for counter-examples; to decide on a certain issue, preparing a list of pros and cons shall be practical, etc. The most useful heuristics are the most specific ones, (e) mental habits. These attitudes guide people to use intellectual resources to meet principles and standards of good thinking: respect for reason and truth, respect for products and high quality performance, inquisitive attitude, mental openness, commitment to pay attention to alternative points of view, courage to keep intellectual independency, respect for others in inquisition and deliberation processes, respect for legitimate intellectual authority and ethics in intellectual work.

Critical Thinking as a Cognitive Process

The definitions exposed in the foregoing section have a strong component of regulatory kind; therefore, it is difficult to distinguish among them some aspects of objective reality (how things are) of the desires of authors that things are in a certain way (how things must be). Experimental psychology of cognitive processes leads the issue to the scientific point of view, which implies distinguishing ideals from reality clearly. In this perspective, the scientific-politician and economist Herbert A. Simon went decisive steps which lead him to be awarded with the Nobel Prize in Economic Sciences in 1978 when he commenced to contrast at the middle of last century, the underlying rational model in economic science with the usual manner in which people make organizational and economic decisions. Classical and neo-classical economic theories assume that people are perfectly rational and make efforts to maximize economic achievements. Simon (1955, 1956) argued that human rationality is limited, imperfect and people look for satisfactory results not necessarily maximum or ideal ones. The studies

showed that people based their decisions on limited information despite more information could be used. When announcing the Nobel prize winner, I was a visiting researcher at the University of Toronto and – distracting me from my doctoral thesis work – I spent several months to show work motivation models worst predicted labor behavior while more information was supposed to be held by the worker when making decisions (León, 1979); thereafter, in the thesis, I evidenced that positive information processing is more differentiated than negative information processing (León, 1981). The following relevant Nobel Prize in Economic Sciences in this sense was awarded in 2002 to psychologist Daniel Kahneman who, together with Amos Tversky, developed a study on heuristics privileged by the people and their usual biases in information processing. For example, Tversky and Kahneman (1971) gave a simple statistical problem to the psychologists who participated in the congresses: "Let's imagine you have run an experiment on 20 subjects and a significant result was obtained which confirmed your theory ($z = 2.23$, $p < .05$, two-tailed). Now you have the opportunity to work with an additional group of 10 subjects. What do you think is the probability to obtain significant results, in a one-tailed test, separately for this group?" The majority of answers gave a probability equal to .85, despite the actual probability was of .48. This was due to the fact that psychologists assumed that the second sample would replicate the results obtained with the first one. However, it could only occur if the two samples would have been large enough; psychologists did not take into account that the second sample was even smaller than the first one. Upon conducting other studies with similar results, Tversky and Kahneman (1971); cited in Kahneman, 2002, concluded that people have strong intuitions regarding random sampling; these intuitions are wrong in essential aspects; and those intuitions are shared by ingenuous subjects and trained scientists. People see a sample randomly derived from a population as highly representative, i.e., similar to the population in all essential characteristics. Consequently, people expect these two samples derived from a particular population are more similar between each other and in respect of the population in comparison to the predictions given by statistical theory, at least for small samples.

As remembered by Kahneman (2002) in a discourse given at the ceremony for receiving the Nobel Prize, he and Tversky discovered that judgment biases – which, by definition, are not at random but systematic –

are mainly seen in information recovery processes. Of course, a main issue is information accessibility – how easy certain mental contents appear in our minds. Why some thoughts are more accessible than others? Accessibility is determined by physical properties – such as size, distance and decibels – and more abstract properties, such as similarity, causal propensity, surprise factor, affective valence and state of mind. In intuitive judgments there is no uncertainty or doubt. In an emergency, the firefighter does not lose time assessing different possibilities: the "right" answer appears as obvious according to his experience. Another determining factor is adjustment. The same information shall have different answers depending on the framework in which it appears. It is more probable that a cancer patient accepts a surgery if he is told that survival probability is of .90 than if he is told that death probability among subjects undergoing surgery is of .10. In attribute replacement heuristic, the subject facilitates decisions by giving an answer based on an attribute evoked by the situation but which is not an actual part of the problem, so that he may make a mistake as a result thereof. When maintaining the order of the following two questions: first "How happy are you with your life in general?" and then "How many dates have you had for the last month?", answer correlation is closer to zero. However, correlation increases to .66 when the order of questions is reverted because the one related to dates evokes an affectively charged evaluation which influences the answer of the second question.

However, these biases may be corrected if the person makes more effort to think of. Let's consider the following problem: "A bat and a ball cost $1.10 in total. The bat costs $1 more than the ball. How much is the ball?" My first answer, as the one given by 50% of students in Princeton and 56% in Michigan, was 10 cents. Since Kahneman said it was an incorrect answer, I tried to solve the problem with my wife at lunch, but we were interrupted. Just the following day I gave the matter some more thought until finding a solution. What was the difference between my initial answer and the last one? The first one was intuitive, immediate, without hesitating, something that suddenly appeared. The second one was a result of a deliberate, controlled, slow and dedicated reasoning. My daughter, despite being an economist, also failed her first answer but, when I told her it was wrong, she applied an equation and solve the matter in a half minute. Here we can see the nature of intuitive judgment, deliberate reasoning and expertise role.

Critical Thinking as a Part of Dual Cognitive Processes

The dual processing concept refers to the coexistence of two modes of processing information that Kahnemam (2002) summarized as in figure 1.

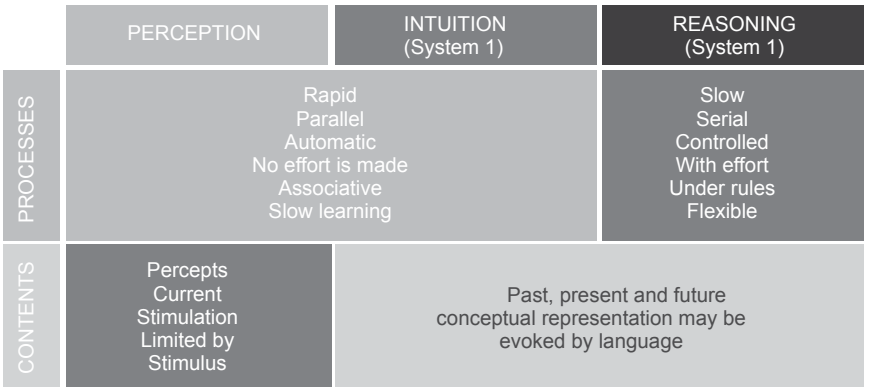


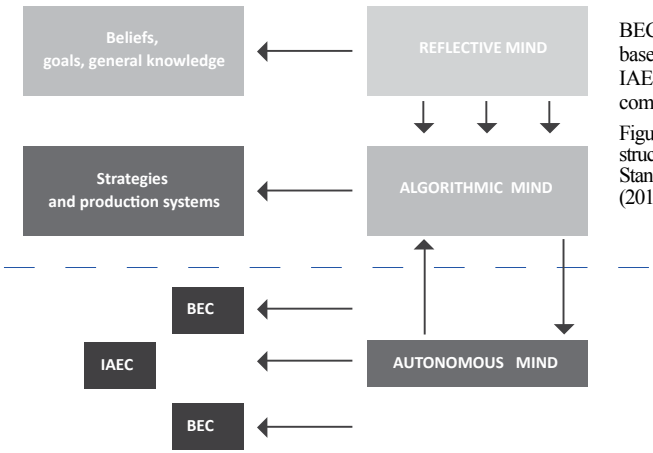
Figure 1. Differentiation of two information processing systems.(Extracted from Kahneman, 2002, p. 451)

Table 1.
Names assigned to dual cognitive processing components

Authors	Intuition	Reasoning
Schneider & Schiffrin (1977)	Automatic	Controlled
Chaiken (1980)	Heuristic	Systematic
Fodor (1983)	Modular input	High cognition
Evans (1989)	Heuristic	Analytical
Reber (1993)	Implicit	Explicit
Epstein (1994)	Experiential	Rational
Hammond (1996)	Intuitive	Analytical
Stanovich (1999)	System 1	System 2
Smith & DeCoster (2000)	Associative	Based on rules
Nisbett et al. (2001)	Holistic	Analytical
Wilson (2002)	Subconscious	Conscious
Strack & Deutsch (2004)	Impulsive	Reflective
Toates (2006)	Limited to stimulus	High order
Stanovich & Stanovich (2010)	Algorithmic mind	Reflective mind

Table 1 offers used names to make differences between them. Perceptual and intuitive processing of figure 1 prevails in daily life. The question posed by researchers is: "When or under what circumstances deliberate reasoning

stepped in?" Stanovich (1999) and Stanovich and West (2002) proposed names system 1 and system 2 to refer to two forms of cognitive processing and assumed that system 2 is in charge of monitoring quality both of mental operations and evident behaviors. I retook the bat and ball problem because I knew my first answer was incorrect. If I would not know that, it is probable that my system 2 would have activated, inducing me thus to verify the quality of my first answer by the sum of the solution (ball = 10 cents) and logical conclusion of my formulation (bat = $1.10) to find out that the total would be $1.20 not $1.10. Just then I would have tried to find a better solution. Kahneman and Frederick (2002) suggested monitoring is generally lax enough and enables that many erroneous intuitive judgments be expressed. Stanovich and Stanovich (2010) synthesized the most recent evidence by conceiving a three-partite cognitive processing (figure 2). Autonomous mind has access to encapsulated information acquired by the specie via evolution as well as specific knowledge obtained individually through over-learning and practice (e.g., climbing stairs). Processes are autonomous, of quick and mandatory execution when the mechanism is activated, and do not need conscious attention.



BEC: Encapsulated knowledge base
IAEC: Learned and closely compiled information

Figure 2. Knowledge structures according to Stanovich and Stanovich (2010).

The algorithmic mind (equal to intuitive judgment in Kahneman scheme), under the executive control of a person, has access to micro-strategies related to several cognitive operations and rules of the production system to make sequences for thoughts and behaviors. Algorithmic mind privileges efficiency, but operates under world models of individuals; thus, we can reach irrational conclusions or decisions if assumptions are

erroneous (for example, assuming that a small sample is representative). The reflective mind has the function to refrain algorithmic function when necessary and redirect it under an assumption repositioning. When this occurs, cognitive processes become relatively slow and costly operations consumers because now they have to work with hypothetical reasoning and cognitive simulation. When doing so, we create temporary models of the world and test imaginarily our actions in this modeled world. This requires us to be able to distinguish our favorite representations from the reality of the ones we need to imagine in order to assess our actions in a wider and more objective context including alternative actions. That is, while cognitive processes of algorithmic nature are only purported to maximize efficiency, the ones of reflective mind reconsider algorithms by looking for rationality. For example, a professor from Universidad Católica del Perú was invited to participate in an English team to study well-being feeling. He understood English answers obtained through questionnaires did not tell a whole history, so he resorted to the emic approach of anthropologists to define basic concepts from ingenuous verbalizations of the people, and just then he submitted these concepts to a rigorous verification through factor analysis (Yamamoto & Feijoo, 2007).

However, my lecture should leave no erroneous idea that everything is solved with Stanovich and Stanovich (2010) scheme. Evans (2008) concluded that existing evidence regarding the concept of dual processing clearly points out the presence of two cognitive mechanisms, but differentiation of two processes is very far from being achieved in full. How much conscience is in each process? system 1 processes have been considered pre-conscious, implicit, automatic, of low-effort, rapid, of high capacity, default format, holistic, and perceptual and system 2 processes have been considered conscious, explicit, controlled, of high effort, slow, of low capacity, inhibitory, analytical and reflective. It seems to be appropriate to conceive system 2 as a form of thought under control of intentional level, supported by sub-conscious processes of system 1 that provide percepts, memories, etc. It also seems that the most promissory way is to operationalize conscience concept by considering that the thought of system 2 needs access to a limited capacity working memory central

system, which does not occur with system 1. We are aware in a certain time of what is represented in working memory, wherein conscious thought flows sequentially. But this is a clearly insufficient scientific assertion, because it does not cover the entire conscience subject. A second issue is evolutionary stage. We could make differences between systems 1 and 2 in terms of being evolutionarily old versus the new ones, evolutionary rationality versus individual rationality, shared with animals versus humans only, non-verbal versus language-related and modular cognition versus independent cognition of specific dominium. In this context, we should consider emotional intelligence as previous to critical thought. I doubt effort I put to successfully solve the bat and ball problem helps me to solve items of MSCEIT (Mayer-Salovey-Caruso Emotional Intelligence Test) related to emotions reflected in faces or abstract paintings. Kanazawa (2010) considers it as previous to the development of abstract intelligence; while emotional intelligence would have evolved during the first 100,000 years that Homo s. sapiens spent in tropical savannah of Sub-Saharan Africa, the abstract one would have appeared just when facing evolutionarily new problems when going out from there around 60,000 years ago. However, abstract intelligence is also distinguished from critical thinking and evolutionary psychologists have difficulties to admit dual cognitive processes. Evans and Stanovich (2013) identified five critics to dual processing concept: (a) theoreticians of dual processing have offered multiple and vague definitions, (b) attribute conglomerates proposed are not well aligned, (c) there are no discrete steps from a system to another but a cognitive style continuum, (d) simples processes may report apparently dual phenomena, (e) dual processing evidence is ambiguous and not convincing. All these critics have something of truth, but they can be refused with arguments that would go beyond the space disposed of by this article.

Critical Thinking as a Measurable Disposition

However, how can critical thinking be different from intelligence? It is evident that difference is radical when the first one is conceived as an attitude, disposition or cognitive style. Disposition to critical thinking has been distinguished from the ability to think critically because a person can enhance his ability to think critically and, however, not to be motivated to use such an ability (Ennis, 1994). Among the best studied dispositions to think are curiosity (Maw & Magoon, 1971), the need for cognitive closure

(Kruglanski, 1990), and need for cognition (Cacioppo & Petty, 1982). Perkins, Jay, and Tishman (1993) reviewed the literature on disposition to think critically and identified seven clearly differentiable features: (a) disposition to be wide and adventurer, (b) disposition to divagate, identify problems and research, (c) disposition to construct explanations and understand, (d) disposition to make plans and be strategic, (e) disposition to be intellectually careful, (f) disposition to look for and assess reasons, (g) disposition to be meta-cognitive, i.e., be aware of own intellectual processes. Facione and Facione (1992) defined the disposition to think critically as an internal motivation to be used in order to face problems and make decisions; they compared students' disposition scores (based on self-reports on the frequency of certain behaviors and the strength of beliefs in certain types of thought) with the performance in a critical thinking ability test and found a significant correlation between the two measures (.67). This shows that a 45% performance variation in the test is explained by the variation in disposition to think critically. A factor analysis applied to the items of California Critical Thinking Disposition Inventory gave seven internally consistent dispositions according to Cronbach's α coefficient: to be inquisitive, systematic, judicious, analytical, seeker of the truth, open-minded, and reason-based (Facione, Facione, & Giancarlo, 1996). Therefore, research works confirm the existence of certain dispositions to think critically as measurable features which have influence on the performance as a critical thinker, even though they do not ensure the possession of abilities aimed at critical thinking.

Perkins and Ritchhart (2004) proposed a more complex alternative when they proposed a triadic composition of critical thinking including three elements: sensitivity, inclination and ability. Sensitivity is related to if a person sees some occasions on current flow of events that might require to think of, for example, noticing an unjustified causal inference, a rush generalization, a limiting assumption to be challenged, or a provocative problem to be solved. Inclination is referred to if the person is disposed to make efforts to think of the subject, either due to curiosity, personal relevance of the subject, mental habits, etc. Ability is referred to the capacity to effectively think of the subject on a sustainable basis.

A key concept in cognitive schemes of Stanovich and Stanovich (2010) and Kahneman (2002) is to think of by abstaining from own beliefs and

attitudes regarding the subject, and the question that arises out is if there is a disposition of such a nature that may be measurable and general, i.e., that spreads beyond specific thematic domains. Cognitive process per se is well-established; from Piaget (1926, 1972; cited by Stanovich and West, 1997) it is known that one's beliefs make a bias on judgments so that good thinking requires decontextualization (Baron, 1991, 1995). Stanovich and West (1997) prepared a questionnaire of disposition to think critically including sub-scales on flexible thought (e.g., the more time you think of a subject, it is more probable that you solve it), openness to ideas (e.g., philosophical issues make me feel bored), openness to values (e.g., social laws and policies must change to reflect a changing world), absolutism (e.g., it is better to believe in a religion than feeling confused with doubts), dogmatism (e.g., it is necessary to restrict freedom to certain political groups), categorical thought (e.g., there are two kinds of people in the world: good and bad ones), superstitious thought (e.g., number 13 means bad luck), counterfactual thought (e.g., my thoughts would not be different if I had been raised by different parents), result bias (measured by a complex item), and social desirability (e.g., I do not gossip about others' business) which was adjusted by principal component analysis. Active disposition to open-minded thinking measured like this was significantly related to the capacity to assess situations by abstaining from own previous beliefs. The latter was measured with an intra-subject experimental methodology creatively designed by Stanovich and West (1997). This one and other research works (e.g., Sá, Stanovich, & West, 1999; Sá, Kelley, Ho, & Stanovich, 2005; Stanovich & West, 1998) have shown the existence of individual differences in respect of disposition to think critically which are consistent and that disposition influences people's intellectual behavior.

Critical Thinking as a Measurable Ability

Does the ability to think critically also exist as a feature, i.e., as a consistent variable making differences between individuals through situations? How can we distinguish it from intelligence or general cognitive ability? Figure 3 contributes to understanding the subject as a scientific issue. Specific components of ability to think critically (small ellipses within the ellipsis comprising it in figure 3) have been compared with intelligence. One of them is the already seen capacity to decontextualize, that is, to think with

independency of previous beliefs on a certain subject, which frequently make a bias on the judgment. The other is the capacity to get over the gambler's fallacy, that is, the tendency to think that probability to win is increased if a person has lost many successive times. The other is the disjunctive reasoning ability, defined as a tendency to consider all possible states of the world to decide on options or choose a solution. Let's imagine one must choose between options A and B and event X may occur or not in the future. If one prefers A not B, when X occurs and also when X does not occur, uncertainty on X occurrence must not affect the preference for A. However, people frequently say if there is uncertainty about X, no decision can be made as to A or B or even B may be preferred; this occurs because there is no disjunctive reasoning. Toplak and Stanovich (2002) designed nine reasoning tasks and gave them to 125 students. Optimal performance in all tasks needed disjunctive reasoning. Only in three tasks performance depended on general cognitive ability or individual's intelligence; it was more dependent on the disposition to think critically. It was also shown that intelligence or general cognitive ability is very far from explaining entirely the capacity to get over the gambler's fallacy (Toplak, Sorge, Benoit, West, & Stanovich, 2010).

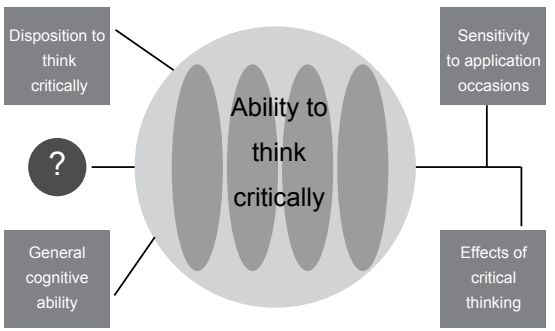


Figure 3. A scheme on relations between critical thinking features

However, this capacity or disjunctive reasoning only represents in part critical thinking as a general entity (the ellipsis comprising the others). Is there an ability to think critically as a consistent aptitude that goes beyond its components? Facione (1990b) tried to capture global entity by developing California Critical Ability Test and summing all partial scores of its five components: analysis, assessment, inference, deductive and inductive reasoning. The 34 items were created from a Delphi consensus of university professors about the five components; the range of internal consistency

coefficients goes from .78 to .84. One decade ago, the Watson-Glaser Critical Thinking Appraisal Test had been developed in Texas with sections such as induction, assumption identification, deduction, judging if a conclusion is a consequence that goes beyond a doubt, and argument evaluation. Older is the Inquisitive Ability Test developed in Australia. Others were summarized by Ennis (2001). However, the most popular is Halpern Critical Thinking Assessment, marketed by Schuhfried VTS in Austria and Lafayette Instrument Company in the USA as a test for application of critical thinking to daily life validated in several countries. I think it has two defects: confuses too much critical thinking with general intellectual abilities and, on the other hand, is focused too much on research subject.

The conception approach of Frederick Cognitive Reflection Test (2005) is different from all existing critical thinking tests; he defined test contents from cognitive research works on decontextualization, disjunctive reasoning, etc. The test consists of three items only, characterized by their design to contain errors in absence of critical thinking; these items often induce people to give an answer that seems to be logical but is wrong and then the subject only hits the target if the error is noticed and continues looking for a solution. The relation between score obtained in the Cognitive Reflection Test and a series of experimental tasks used in heuristic and bias research has not been consistent at all (Frederick, 2005; Cokely & Kelley, 2009; Campitelli & Lebollita, 2009; Oechssler, Roider, & Schmitz, 2009; Obrecht, Chapman, & Gelman, 2010; Koehler & James, 2010), but Toplak, West, and Stanovich (2011) have shown that it is a powerful performance predictor in a wide range of heuristic and bias tasks (13 test), more powerful than general cognitive ability or disposition to think critically. In the terms of Figure 3, Toplak et al. (2011) showed that the test (comprising the ellipsis measured by three items) had a substantial correlation with complex cognitive ability but, at the same time, it was a strong determining factor in heuristic and bias tasks (comprised ellipses) notwithstanding such a relation or the relation with the disposition to think critically. That is, there would be something more than the disposition to think critically and the complex cognitive ability in the ability to think critically. It is more clearly conceptual if we make a difference between two types of intelligence defined by Cattell (1963). Cattell's fluent intelligence concept would correspond to Kahneman's intuitive judgment and Stanovich's algorithmic processes while crystallized intelligence, which

results from the individual's intellectual evolution, would approach to the concept of critical thinking and reflective mind.

What is critical thinking for? What effects does it produce? According to Kitadamo and Kurtz (2007), the academic and personal benefits of critical thinking are well-established because students who may reason critically obtain better grades and they are more required in the labor market; however, it is unclear if the evidence supporting this conclusion excluded intelligence influence. More recently, Frederick (2005) used this test to predict decisions about receiving a prize immediately versus receiving a bigger prize later. Students with more critical thinking were more disposed to wait when temporary framework was relatively short (e.g., $3400 this month or $3800 the next month; $100 now or $140 the next month), but there were no differences with the ones of lesser critical thinking when temporary framework was bigger (e.g., $100 now or $1100 in 10 years; $9 now or $100 in 10 years). That is, the critical thinker is more likely to achieve more economic victories; exception for long terms is explained because within the bigger term factors out of control of the decision maker intervene (interest rate, inflation rate, etc.). Frederick (2005) also found out men present more levels of critical thinking than women, despite not seeing gender differences in general intelligence. This may help to explain the most significant differences between scientific achievements of men and women.

Sensitivity to situations requiring critical thinking has been studied by Perkins and Ritchhart (2004) who, for example, proposed a situation to primary students wherein Mrs. Pérez told her daughter they had to immediately moved to a another city because the company where she worked at was moving its offices and her daughter felt frustrated because she was going to lose her friends. Children were simply asked for what they thought about that situation, creating thus an opportunity to spontaneously question the implicit assumption that immediate moving was imperative. In general, research on critical thinking is recent (not more than 40 years) and it is particularly incipient within the area of sensitivity.

Critical Thinking as an Educational Task

Can you learn how to think critically? Facione (1990a) showed evidence that students at the beginning of a university course of critical thinking in 1990 presented less ability than those students who had finished the same course in 1989; other studies, with better experimental control, confirmed positive findings in the same Californian university. There is so much literature on education of critical thinking among students of several courses, such as nursing (Angel, Duffey, & Belyea, 2000; Facione & Facione, 1996), psychology (Tynjälä, 1998), pharmacology (Allen & Bond, 2001), computer science (Twardy, 2005), militia (Fischer, Spiker, & Riedel, 2009), language clinics (Kamhi, 2011), and others reporting significant effects of educational interventions on the ability to think critically, even though they have methodological weaknesses.

The interaction among students has been considered as an essential element of education in critical thinking. Paul (1992) argued that students learn better when their thinking involves an extended interchange of points of view or reference frameworks; for example, focused discussions, seminars conducted by the students themselves, learning based on problems, and academic controversy method. Tsui (1999) assessed specific educational techniques and reported that the best results were obtained with protocols designed to elicit active attributes of meaning by students; these courses put an emphasis on inquisition; courses that used professors' comments about students' dissertations; courses including critical analysis on manuscripts; and courses replacing multiple choice tests by essays. Tsui (1999) also noted that, notwithstanding specific efforts to improve critical thinking of students, regular courses of mathematics, sciences, language and others improved students' critical thinking. Probably this reflects pedagogical wisdom of professors teaching these courses. Abrami, Bernard, Borokhovski, Wade, Surkes, et al. (2008) have reviewed these interventions. Bigger study limitations are related to the absence of efforts to evaluate transferability of learning to the "real" world, i.e., that world outside the classroom, even though there are some exceptions. Lehman and Nisbett (1990) examined spontaneous transfer of selected abilities of critical thinking to non artificial environments. It was done by calling students at their homes many months after the end of course and posing to them some new questions that supposedly

form part of a survey. Students gave their answers by making use of the abilities acquired during the course. Halpern (1998) cites other exceptions.

The most ambitious educational approach on this area is probably Halpern's approach (1998), which is based on four pillars. The first one is the development of an ethics of critical thinking, without which the student cannot progress. Students must understand and be prepared to assume the essential characteristic of critical thinking, that is, mental effort. Secondly, specific abilities to teach must include understanding how can a cause be established, recognition and critics of assumptions, analysis of mean-purpose relations, reasoning supporting conclusions, assessment of degrees of probability and uncertainty, incorporation of isolated data into a bigger framework, and the use of analogies to solve problems. Thirdly, learning must be designed to optimize transfer, beginning with the sensitivity strengthening to recognize situations requiring critical thinking. To this effect, professors must take into account that the meaning of something is just a network of concepts to which that thing is related. Learning environment must approach meaning networks operating in the extra-classroom ecology. Finally, education on critical thinking must have a meta-cognitive element, that is, an element that leads to self-consciousness and strengths planning function guiding the use of thinking resources. To this purpose, the student should be helped to make processes explicit which in general occur implicitly.

In contrast to highly theoretical directives of Halpern (1998), the best educational projects I found in this literature dealt with very specific techniques of critical thinking improvement. Interested in promoting competences that students need to participate responsibly and appropriately in a democratic society, Fritjers, Ten Dam, and Rijlaarsdam (2008) assumed that, instead of focusing on purely logical problems, teaching should be charged with values, because otherwise it would lack ecological validity (from generalization to real environments). Academic courses on which students' reasoning is expected are usually full of implicit values. Authors designed a methodology that may be implemented to any substantive course and applied it to environmental issues in a Dutch secondary education biology course. The technique was dialogical learning that is, based on dialogues. Compared with more conventional lessons, dialogical lessons caused more positive effects on critical thinking and quality of students' value orientation. Another

study that called my attention was one developed by Quitadamo and Kurtz (2007), which had also to do with biology. In this case, researchers were interested in strengthening scientific critical thinking of US undergraduate students and used a writing technique. Writing is frequently used in tests as an alternative to multiple choice questionnaires to evaluate students' knowledge, but it has a potential as a critical thinking since it demands the individual to make ideas explicit and evaluates and chooses mechanisms to make its discourse effective. However, writing studies as a mean to improve critical thinking were full of methodological deficiencies (Daempfle, 2002). In this first day of classes, students of the study conducted by Quitadano and Kurtz assigned to writing treatment were informed that their lab assignments would be evaluated through cooperative essays instead of traditional rapid questions and they were given weekly assignments to be developed in three or four-member groups. The results were evaluated in comparison to a control group and in the context of multiple co-variables. The group under writing treatment substantially improved their critical thinking while the control group showed no changes. The main study limitation is probably short-term tests. For example, nurses are trained in critical thinking, but the impact of trainings at the level of care received by patients is not evaluated (Fesler-Birch, 2000). Another problem to be solved is generalization of ability to think critically from an area to another. It is certain that a reader knows somebody whose judgment in a professional area is respected and, however, he/she gets surprised about this individual's deficiencies of critical thinking in another area. Nobody has any doubt about critical abilities of Linus Pauling in chemical issues, but this individual who was awarded the Nobel Prize twice was a devout believer in vitamin C mega-dose efficacy in cancer treatment despite of contrary evidence produced in this regard.

Conclusions

The subject of critical thinking continues to be a challenge for psychologists and educators around the world. The Peruvian university should abandon rhetoric dealing with this subject and assume it as an explicit research objective and an experimental strategy for educational programs.

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