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Metacognition and the intellectual skills of higher order

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ABSTRACT

The teaching and learning approaches which focus on memorization have no place in the "age of knowledge". The interest now is in training people to learn for life, solve complex problems, think creatively and critically, etc. The goal is to help students develop higher order thinking skills. After a literature review of metacognition theory, it is suggested that the teaching strategy known as "thinking aloud while solving problems" may help students develop higher order thinking skills.

INTRODUCTION

The argument and reason for passing from a memorizing teaching system to another that develops the intellectual abilities of higher order has different origins. Some people believe that it is a strategy from educational ideologues from occident to refrain the aggressive advance of the Chinese and Hindus academics, which educative system foments memorizing skill in a higher level than occident. According to this argument, the current educative system rewards the best grades and it is obtained by those who have the best skill to memorize. Admission tests of the best universities, in spite of their complexities, they continue being memoristic.

Apparently, this ideological consideration is not without influential followers in the educational literature. Trilling and Fadel (2009) in their important book: *Habilidades del siglo XXI* (abilities of the XXI century) suggest a similar position because their book starts with an anecdote that describes their meeting with a delegation of Chinese expert educators, in a high school of California. The Chinese experts were impressed because of the creativity and innovation from students and asked their American hosts to share their experiences, so they could implement an educative program that promote the development of creativity and innovation at their schools.

Perhaps the greatest reason to develop the intellectual skills of higher order is due to the same nature of the "knowledge age." Saving information in the memory loses relevance when this information is available through digital devices. Therefore, it is necessary to develop some other skills.

Currently, the school´s role, among other things, is to achieve the student develops learning and skills to solve complex and real life problems, so s/he knows how to cooperate, thinks critically, and communicates effectively, all this framed up in a society of constant changes.

Learning for life may involve, as suggested by The World Economic Forum (2016, p. 32), the training again in the index of abilities that someone already has, to increase his/her capacity of adaptation and employability, and about the educative system it should stop the educative practices of the XX century that prevents the progress of the talent nowadays. It must be propitiated the active pedagogy, focused on student which requires that student works in groups to solve problems and manage projects. In this regard, the Organization for Cooperation and Economic Development (2008) talks about the challenge of fostering learning for XXI century and says that this challenge "... must not be underestimate: certainly, it will not be achieved with the optimist expectation of the fact of repeating the necessity of changes, it is going to happen by magic" (p.10). The challenge which presents the "education for tomorrow" must be faced from different angles. In this article are presented some ideas taken from the literature of metacognition that could contribute with the development of the cognitive abilities that nowadays are required by students.

Deep learning

The first thing is to highlight that the goal of the educative system is accomplish students acquire a deep learning and that the strategies of teaching-learning should contribute with this. Marton and Saljo (1976), in their classic study about *Approches to Learning* say that according to the way that students solve tasks, can be classified in: *superficial, strategic, and deep*. Superficial and strategic students act with the premise of a memorized learning and their interest does not overcome their interest on simply answering the questions presented by the text or just accumulating a note. On the other hand, deep students seem to keep a kind of active dialogue with the text they are reading. They ask themselves about the relations of the different parts of the text, about the consistence and logic gaps that might be in text itself. Guiding students to a deep learning is complex. It must be taken into account some factors like student motivation and the design of the material.

With regard of motivation, Marton and Saljo indicate that it is reached when the texts provided to students that appeal to their interest. In other words, the bigger the relation of a text with the professional goals of the student is, the bigger his/her interest is to understand it. In the same way, the material they learn with must set questions that require analysis and reflection, more than the repetition of data. Then, the first thing that the educative system must take into account to propitiate a deep learning is make the student notice the utility of the material that is being studied and at the same time it requires a superior interaction with itself. The meaningful learning is reached when the student experiments with real life him/herself and not just receiving an abstract contemplation of it.

Metacognition

The literal meaning of the word metacognition based in its prefix *meta (beyond)* and its root *cognition (knowledge) is "beyond knowledge"*. However, the accepted meaning in the psychology field is more complex. The North American Psychologist from Stanford University, Flavell (1979), who stressed the word, he referred to the word itself like the act of reflection about the cognitive

process. Successively, he defined it as the monitoring of the cognitive process of first place, it is, other more basic cognitive processes. He also characterized it as the fact of "think about thinking".

The definitions and latter uses of metacognition have remained quite close to the original meaning assigned by Flavell. Then, metacognition is understood as:

- "The act of thinking, planning and controlling thinking" (Girash, 2014)
- "The ability of reflecting, understanding, and controlling learning and the fact of being aware of our steps and strategies during solving a problem" (Ferreiro, 2012, p.253).
- "The self-knowledge that a person has about his/her cognitive processes, the characteristics and exigencies of the situations and tasks to solve, and the strategies that can unfold to manage efficiently their execution by themselves" (Escanero, Soria and Gonzales-Haro, 2008, p. 4).
- "A series of operations, activities and cognitive functions carried out by a person through an internalized set of intellectual mechanisms that allow him/her gather, produce and evaluate information, which make possible the person to know, control and self-regulate his/her own intellectual operation". (Arredondo, 2007, p.74).
- "Awareness or analysis about learning or thinking process" (Merriam-Webster, 2014).

These definitions have in common that metacognition is manifested when the person has awareness about his/her own thinking and adjusts it to problem solving or wanted tasks. In this sense, Brown (1978) states that the metacognitive processes are used to decide which process or cognitive processes are necessary to do a task.

Metacognition and Learning

Flavell (1979) asserted that metacognition would produce a high interest. In fact, the theory of metacognition has been strengthened through investigations from different subjects, some of them include: educative psychology, learning science, computer science, artificial intelligence, cognitive psychology, the interaction between humans and computers, educative technology, engineering, mathematics education, education sciences, teaching education and literacy (Azevedo and Aleven, 2013).

Metacognition has received a lot of acceptation in the educative literature. It is said that constructive paradigm of education has contributed with this. Among the examples that are noted about the incursion of metacognition in the educative process are: Bloom`s taxonomy, in which his revised version included the category *metacognitive Knowledge* to the original version (Anderson et al, 2001). Likewise, the influential report PISA (Report of the International Program for Students Evaluation) decided to include in 2009 the metacognitive abilities on reading comprehension exercises.

Metacognition facilitates the aware use of learning strategies and has been considered as a very relevant prognosticator of learning (Veenman, Wilhelm, y Beishuizen, 2004). A person with well-developed metacognitive abilities can look for the best solution to a problem or a task, which in turn, will help him/her take the best decision. In addition, metacognitive awareness will allow him/her think over the process of thinking, think and learn from mistakes. Thereon, Pintrich (2010) points that those students who know different types of strategies to learn, think and problems

shooting have more probabilities to apply them. In this same sense, ÖZ (2005) expresses that skillful students in metacognitive self-awareness are more strategic and work better than students who do not have this ability. As for Winne and Hadwin (1998) they state that metacognitive ability is shown at the moment of studying or solving tasks out of the classroom; from their perspective, studying is a way of self-controlled learning. The former is in agreement with Klimenko and Alvarez (2009. p.19) when they say that metacognition implies:

> A higher level of knowledge, it is knowing about the making. It allows the subject to learn to plan, administrate and manage his/her own learning and the processes of problem solving, through the election, usage, modification and evaluation of the appropriate cognitive strategies.

Metacognition implies to have awareness of the strong and weak points of our own intellectual operation, as well as the types of errors of reasoning that we do. This implies, according to Nickerson (1984, quoted by Arredondo, 2006), that metacognitive awareness would help us take advantage of our strength, compensate our weaknesses and avoid our more common serious errors.

In this same regard, Arredondo (2007) asserts that metacognition allows identifying the correct intellectual processes for every task: save time and errors (p. 77). For example, “when a student faces a problem s/he comprehends it belongs to an unknown topic for her/him, that the way in which the problem is set hinders its comprehension and at the moment to realize a graphic, for example, it will help her/him understand it better” (Kilomenko and Alvares, p. 18).

Metacognition facilitates learning as far “it allows the subject to learn to plan, administrate and manage his own learning and the processes of problem solving, through the election, usage, modification and evaluation of the appropriate cognitive strategies” (Kilomenko and Alvarez, p. 18).

Through metacognitive strategies, students:

> Learn to organize their study activities and know their own particularities about their memory capacity, attention etc. their respective forms to process information or learning styles, the characteristics of the different tasks and type of available information (Kilomenko and Alvarez, p. 19).

According to Escanero, Soria and Gonzales-Haro (2008, p. 4), metacognitive strategies ensure the managing of learning process about the base of reflection and control, orientation, planning, and supervision (when it is pertinent). This is the so-called self-managed learning. Then, the use of metacognitive strategies supposes: a) know what we have to do, b) know how to do it and c) control it while it is performed.

For Bransford et al (2004), metacognitive approach in teaching can make students take the control of their learning. He adds that it explains itself because of the fact that metacognition allows them to set their learning goals and manage their attainment. He continuous saying in his investigation that children can learn, among other things, to predict their own results, explain themselves to improve their comprehension, take notes about the things that they do not comprehend, activate the previous knowledge, plan with advance and know how to dedicate time and memory.

In this context, Celina Arredundo (2006) says that metacognition also consists of being concentrated in the activity that is currently being done, it is, maintain attention focused on the problem and

avoid distraction from outsider and insider factors that are not related to that business: outsider noise, irrelevant ideas, behavior of people; everything with the purpose of using the resources and correct intellectual processes.

White, Frederiksen and Collins (2008) say that metacognition contributes to the creation of scientific communities inside the classroom. This is because metacognition encourages students to know nature and the practices of scientific investigation. In addition, White et al, say that metacognitive knowledge allows them to see themselves as capable learner, which affects in his/her learning as for his/her motivation to learn, too. In relation to this, Perkins and Grotzer (1997) say that some training programs have been designed to increase intelligence, especially for students of poor performance, based on metacognition.

Similarly, adults and children generally have poor knowledge how their mind work and how to learn. That is, they have an incomplete knowledge about their own metacognitive processes (memory, leaning, planning, ability to solve problems and processes of taking decisions) (Graesser, 2009).

In summary, many investigations have shown that, when a learner faces a difficult or new task, only metacognitive abilities contribute to the initial process of learning (Veenman, Wilhelm, y Beishuizen, 2004).

Teaching to think metacognitively

It is consider an axiom that when students make to university studies, already know to learn. However, actually it is shown the opposite: students know little about learning strategies and especially, about the appropriate strategies in relation to their styles of learning in the field of studies. Which is interesting is that many studies have addressed to the relation between learning strategies and academic success they aim to metacognitive strategies as a possible way for academic success. There exist many strategies whose purpose is that students become aware of the reasoning that they use to solve problems, however, here the study will focus in the metacognitive strategy known as: “thinking aloud”.

Think out loud to solve a problem

The objective of this strategy is to make visible what is invisible: the thinking process, for example, when you want to let students know the metacognitive process of his/her teacher in the comprehension of a reading, the teacher offers “evidence of ideas, knowledge and experiences that come to mind when you hear the title, comments on the topic, the author’s name or when reviewing the text” (Nadal et al, 2006) (, p.68). In this regard, Hacker (1998, p.43) points out that the verbalization or the written explanation on how to solve a problem has a positive effect on the acquisition of knowledge. In the same way, Chiu and Chi (2014) have investigated the effect of the self-explanation (through the verbalization of every step during the problem solving) and have found that the students with more robust learning usually use this strategy with more frequency. Also, Schunk (1994) expresses that the verbalization allows the decrease of errors committed when solving a task.

Schellings and Broekkamp (2011) carried out a study on the application of strategies of thinking aloud. For this study they trained the participants about thinking aloud during the achievement of a task. First, it was explained to them what the complete procedure was about; then, they were

given a reading. The students were asked to speak out loud any thought that arises about the reading. This form of verbalizing the thought was practiced in two ways previously: first, one asked them to do a knot and second, to read a text on the human behavior. In both cases they were stimulated to think out aloud during the execution of the tasks.

The task the participants carried out after having being trained consisted of solving selection exercises based on a reading. When they were underlining parts of the text without verbalizing, the assistant of the examination asked them to keep on thinking aloud (example: what are you thinking now? keep on thinking aloud). They were not asked about the reason of their selection since the task was consisting only in verbalizing the thought.

A model of instruction based on strategies of thinking aloud was designed by Whimbey, Lochhead and Narode (2013, 7th ed.) and outlined in their book *problem solving and comprehension* (Resolution of problems and Understanding). The authors propose that it is possible to teach students to solve complex problems (which require high capacity of analysis and concentration) through the method they called “thinking aloud in pairs during the resolution of problems”.

The method is to assign the role of listening to one of two peers while the other solves the problem out loud. The student who solves the problem must focus only on solving the problem and verbalize his/her ideas; on the other hand, the student who has the role of listener should be attentive and to ask questions that could help clarify the conclusions makes by his/her peer. In addition, the student listening must avoid giving clues or solve the problem. The authors recommend that each student should be assigned the role of listener and problem solver in different problems but never in the same problem.

Other teaching model based on thinking aloud procedures has been proposed by Meichenbaum and Biemiller (1998). The authors reflect the cognitive model of thinking aloud should be carried out while running a task that are equally visible in nature such as when it comes to understand a passage of a text or when writing an essay. Thinking out loud, the authors continue, can be used to describe the steps required to solve a problem as well as to highlight the importance that each one of these steps.

This model of thinking aloud can take two forms: self-questioning (through questions such as: what information do I need? have I reviewed the answer I gave the problem or task?) and statements that guide instructions to follow (my first step is..., this is not the answer I expected, I have to double check the step I took, etc.). According to the authors, the teacher can model thinking aloud when it outlines important information and makes plans (I want to see if I understand what I have to do), access prior knowledge (what do I know about this topic?), self-monitor (does what I’m doing make sense?), seeks for help (what do I need to know?), and self-reinforces (I did not do it all, but I did my best. This is a complex task). The authors also express that there are circumstances in which this model of thinking aloud is not desirable, for example, when the task is too simple. Similarly, the teacher should avoid convey the idea that its model of problem solving is the only correct (Meichenbaum and Biemiller 1998. p.128)

The self-explanation is effective insofar as it enables the identification of gaps in the understanding of the material to study and previous knowledge that the student possesses. Generally, we are not aware of our thinking patterns and should teach us to be. Then, the task of the facilitator is

providing learning tasks which stimulate the oral or written self-explanation, or provide problems with several explanations so the function of the student is to find the correct explanation.

The Feedback and the Mistake

The feedback plays a very important role motivationally so the students use the metacognitive strategies. The beginner must be sure that the metacognitive awareness facilitates deep learning. Specially, when one asks him to think metacognitively, s/he should be given immediate feedback. Namely the feedback will have to take the role of the traditional behaviorist of informing him about her/his level of current learning and what it should or might be the case (Sadler, 1989), only this way it will be able to take the next step, improve her/her metacognitive skill and see its utility. In the long term, the difficulty that raises the reflection and the analysis of what s/he learns will increase her/his learning significantly. The literature abounds in supporting the notion of that what is more difficult to learn has more virtues than defects since it facilitates the retention and the transference (Bjork, 1994). From this perspective, the error also plays the most important role in learning[1].

Transferability

On transferability and the application of metacognitive ability it could be speculated that everything depends on the context. If the student does not perceive the need to implement his/her capacity for analysis to solve a task and rather, s/he could instead, resort on the use of rote learning, s/he will opt for the last one. If the environment doesn't demand eternal metacognitive vigilance, this one will not exist.

However, the student, metacognitively skillful, can transfer this ability to solve problems of different areas of knowledge[2] (Bransford et al., 1999). This is because an expert student, as opposed to a non-expert student, has an extensive repertoire of strategies s/he can use to solve difficult problems. Citing *How People Learn*, it is demonstrated that students transfer their metacognitive skills to new learning situations without the influence of the guides or prompts used in experimental studies.

In any case, a way of making students aware of the different courses of action that can be taken to solve a problem or different learning strategies that they can choose from to achieve learning, is presenting them these strategies. If they only know one way to learn, they will be aware only of this one. However, if an attitudinal change really has happened regarding the mental habits, students will take the initiative on their own to gain insight deep in what is presented.

CONCLUSION

According to the veracity of what we understand by metacognition, it is stated as "observable" evidence that the ability to analyze and reflect on a learning task is greater than the mere act of memorizing. Both can be expressed to solve a problem, or write a reflective diary. A typical multiple choice exercise can become an effective metacognitive tool if we add an item that asks the student to justify his/her answer. Similarly, a reflective journal may collect information about the type of reasoning used by the student to solve a task.

1. It is important to highlight that successful teaching and learning methodologies based on error have been designed. A special case is the "productive failure" from Kapur y Bielaczyc (2012).

2. Sternberg (2001) defends a contrary theory and poses that the metacognitive ability depends heavily on the field of study. An individual may be metacognitively skilled in chemistry, but that does not empower him to be metacognitively skilled in Literature.

The metacognitive strategy known as "thinking aloud" can contribute to the development of at least two skills of the twenty-first century: learning for life and learn to solve problems. First, because it allows one being aware of the learning process; second, because it evidences the types of errors that can be committed to solve a problem. Generally, it facilitates a dynamic interaction and a deep focus on what is learned. It is a didactic tool if it is planned effectively since it permits the mobilization of mental resources of higher order.

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