LOGIC and KNOWLEDGE
The role of logic in the process of teaching

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In logical literature is common to appeal to the so-called "intuition" in order to legitimate the acceptance or rejection of some inferences. However, the meaning of the term intuition is not univocal. For example, some philosophers of logic signed up in the rationalistic tradition, believe in the existence of a set of logical principles that are universals and imposed because they have an evident character. These principles would exist in the mind either in a conscious or unconscious form. Others philosophers, from a more pragmatist point of view, state there are pre-systematic logical intuitions in the natural language which we can find in spontaneous people's answers. Some of these logical intuitions agree with valid logical inferences but others logical inferences offer resistance. So, for that philosophers, most of the logical systems consist in formal constructions from such intuitions. Furthermore, the set of natural language intuitions becomes a kind of "empiric test" to prove the logical system adequation.

In the present time, cognitive psychology offers an approach to these problems without requesting support of any kind of intuition. Indeed, most of the cognitive psychologists are interested in analyzing the process of knowledge construction, in particular the deduction process such as it is shown in deductive inferences studied by logic.

There are several different constructivist approaches. Perhaps the issues that most radically divide the investigators in this area concern the role of logical systems in human deductive reasoning. There are approaches that are against the introduction of models to describe human logical thinking. On the contrary, most of investigators introduce logical or mental models to describe the underlying capacity of reasoning. But, all of them agree in describing the logical capacities and abilities of people in terms of *competence* and *performance* or *competence* and *procedures.* But their views diverge when they investigate problems about the specific nature, origin and development of logical competence.

Obviously, the proposed explanation differ according to the type of answer given to those problems. But beyond the differences between them, most of the empiric investigations share fundamental characteristics of human logical competence. In this paper, we will use the expression *natural logic* as synonymous of *logical competence.*

We embrace the perspective of biological functionalism. According to Willis Overton (in *Competence and Procedures: Constraints on the Development of Logical Reasoning* 1990), all human being in their initial state is an organized system of biological activity. This system is itself differentiated into systems and subsystems, but it is initially undifferentiated with respect to psychological process. Now on, this process leads to more complex forms by means of successive differentiations and integrations produced by their interrelations with the world. These forms are characterized by their capacity to produce "representations" or "concepts." This process continues and finally achieves a complete system of logical competence and logical procedures making possible the construction of logical necessity of deductive reasoning.

From this perspective, we can say that (i) the people logical competence is the condition of possibility of all kind of knowledge, (ii) it organizes and structures our knowledge about the world, (iii) it is the genesis of logic science and (iv) science logic is able to build models to describe ordinary logical competence.

Although from different perspectives most of the cognitive psychologists agree on logical competence or natural logic is condition of possibility of formal logic. Also, we believe that they would also coincide in granting the following general characteristics about adult natural logic: 1) all natural inferences have a deductive simpler structure than usual deductive chains of formal logic; 2) in natural logic, people often accepts inferences that re "erroneous" from a logical point of view; and 3) natural inferences always occur inside significant context and inference acceptance or rejection are closely related with the truth value of its sentences and with word's meaning. Furthermore, recent investigations show that people inferential skills is developed according to their situations of life, that this capacity increases in direct relationship with the possessed information on the topic, and that logical competence also participates in integration processes of available information.

At this moment, we want to carry out the following questions: 1) What is the role of logic in general teaching process ? 2) What consequences the previous results have for

teaching logical concepts? and 3) How must the teacher select appropriate tools in order to use them in the process of teaching logic?.

The answer of the first question is conditioned by the role of logical structures in process of organizing knowledge that we have mentioned before. So, the role of logic in learning process will be perfecting and enlarging logical competence and developing people's abilities of correctly reasoning. The answer to the second question leads to several previous questions. On one hand it will be necessary to carry out a critical analysis about the form in which logic is trained in first years of learning process. Traditionally, logic was presented as the part of philosophy devoted to study the "laws of thought" and it was reduced to Aristotelian syllogistic. This situation changed later and at the moment, only are imparted mathematical logic contents by means of mechanical procedures. However, both didactic approach are similar: both believe in the existence of fundamental logical knowledge that it is necessary to transmit without keeping in mind people's logical competence and the role of logic in knowledge construction.

Specialists in didactics, in particular those that are devoted to didactics of mathematical, say that, even in teaching mathematics, student have a previous and ordinary mathematical knowledge. In the case of logic, this "previous and ordinary knowledge" is people natural logic or people logical competence. Very often, this natural logic becomes an authentic didactic obstacle for the teaching of certain logical topics, for example the crucial concept of deduction. When we want to think about the concept of deduction in a classroom, students generally reject that in a valid reasoning was possible to infer a true conclusion from false premises, in spite of having deductive abilities that qualify them for making theorem demonstrations. In many cases, the students will break some "erroneous" inferences of their natural logic in order to incorporate new correct thinking strategies. So, is the professor who must create *didactic situations* that overcome didactic obstacles and must favor the construction of new structures and new logical abilities by means of *reflective abstraction*. We think that this is a more or less paradoxical process: human logical competence or natural logic is the genesis of logical science, but at the same time, to learn the last implies to break the first.

The third question implies at least to think about two questions. On one hand, the role playing by mechanical procedures or algorithms (or computer machines) in logic

learning process, and for the other, what different tools are possible to use in order to achieve a successful learning-teaching process of logic.