THE IMPORTANCE OF QUESTIONING IN THE UNDERGRADUATION PROGRAM AND UNIVERSITIES

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Abstract. *This paper reaches towards understanding the importance of questioning in undergraduation programs and universities. This approach argues against the role that answering assumes nowadays and in benefits of the importance of questioning in the undergraduation programs. In doing so, this paper advocate that any educational process related to universities and, in particular, engineering programs to be successful requires dynamic interaction between students and professors. This papers states that questioning is an active-reactive process that leads to doubts. If doubts are understood as a way to reach a research behavior, experienced professors teaching their students should guide them how to question by themselves, as well. In turn, research can be seen as the way to which leads to knowledge. Thus, those who learn this process are taught not only the knowledge yet how to acquire mechanisms of reasoning, judgment abilities, critical sense, critical argumentation, only to mention few. In this sense, questioning is one powerful mechanisms to reach the main goal of universities and engineering undergraduation programs, that is, learn how to think.*

Keywords: *Education, Undergraduation, Learning, Teaching*

1. INTRODUCTION

Four parameters for the future of the education in the XXI siècle were established by the International Committee for Education from UNESCO [1]. These parameters involves learn to learn, to do, to be, and to be social. In order to achieve these parameters it is well known that the distinct learning and teaching styles must be taken into account [2]. Successful learning is directly associated to the ability, prior preparation of the student as are the instructor's teaching style adopted in class. The main learning styles and teaching styles can be categorized as presented in Table 1.

This paper addresses the importance of learning how to make questions in contrast to learn how to answer questions as it is worth nowadays in universities and undergraduation programs, in general, and in engineering programs, in particular. When compared to learn to think in terms of inference mechanism and reasoning, knowledge acquisition assumes a limited importance in the engineering or any other undergraduation program since the latter serves only as a database to practice the mechanisms of reasoning and critical argumentation.

There is a myriad of philosophical concepts and theories for achieving a successful educational process. This paper states that questioning is an active-reactive process that assumes an important aspect in the educational process when one is interested in knowing the origin and causes of the subjects. In this sense, students should be taught to think; create critical mechanisms upon database that they are going to face off and work in. Further, this active-reactive process supplies a dynamic interaction between students and professors such that both classes and learning are attractive.

In order to achieve the proposed approach it is assumed that logic is able to represent the human mind process, embracing knowledge construction and mental reasoning process. The importance of questioning arises when either part of the premises is vacancy or the inference mechanism is object of not being valid. This condition is designed by teachers that intentionally propose questions or let a vacancy in the concepts and definitions used in the logical mechanism. Teachers can also accomplish that by inciting students to come up their proper experiences and previous knowledge to fulfill those opening spaces in the logical reasoning. If there is not such a previous knowledge, teachers may also contribute and stimulate students to overcome this deficiency by additional study. In this sense, teachers should be able to promote

Table 1. Dimensions of Learning and Teaching Styles [2]

Learning Styles		**Teaching Styles**	
Perception	- Sensory - Intuitive	Content	- Concrete - Abstract
Input	- Visual - Auditory	Presentation	- Visual - Verbal
Organization	- Inductive - Deductive	Organization	- Inductive - Deductive
Processing	- Active - Reflective	Students Participation	Active Passive
Understanding	- Sequential - Global	Perspective	- Sequential - Global

students to raise pertinent questions according to the context in which it is inserted in. This complex set of activities is a way to attract the attention of students by creating a space for doubt, curiosity etc., then, giving the students the opportunity to participate in the educational process.

2. LOGIC IN THE EDUCATION PROCESS

Humans may be characterized as a matter of knowledge and reasoning. An alternative for modeling the human knowledge is by propositions (also denominate assertive, statement, affirmation) in the form P = $< x_1$ is $M >$ to represent the human descriptions of nature phenomena. In turn, an alternative to represent reasoning and the human mental behavior is to employ logic (mapping) that allows obtaining a feasible conclusion, Q, deduced from a collection of premises, P_n, composed by a set of IF <premise> THEN <conclusion>, equivalent to linguistic expressions, i.e., a conditional proposition (Fig. 1). A simplified perspective excerpt from [3] [5] describing the fundamental elements that may be employed to describe humans is presented next.

The human reasoning mechanism, associated to the study of logic, is related to the validity of the argument. As stated in a previous work [5], an *argument* is defined upon a set of finite sequence of P_n propositions for $n \geq 1$, i.e., $P_1, P_2, \ldots, P_n$, that presents as consequent a final proposition, Q, and may be represented by the following expression:

$$P_1, P_2, \ldots, P_n \Rightarrow Q \ . \tag{1}$$

The set of antecedent propositions, $P_1, P_2, \ldots, P_n$, and the final proposition, Q, are also known, respectively, as the *premises* and the *conclusion* of the argument. In this sense, an argument as given in (1) is valid if and only if there is a

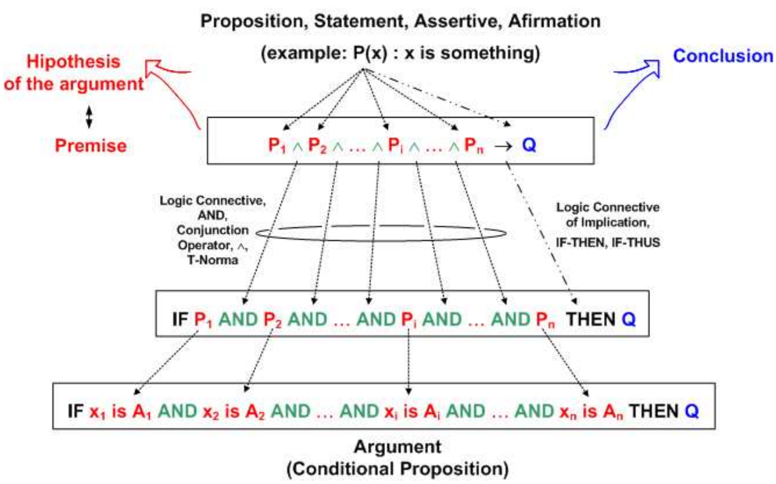
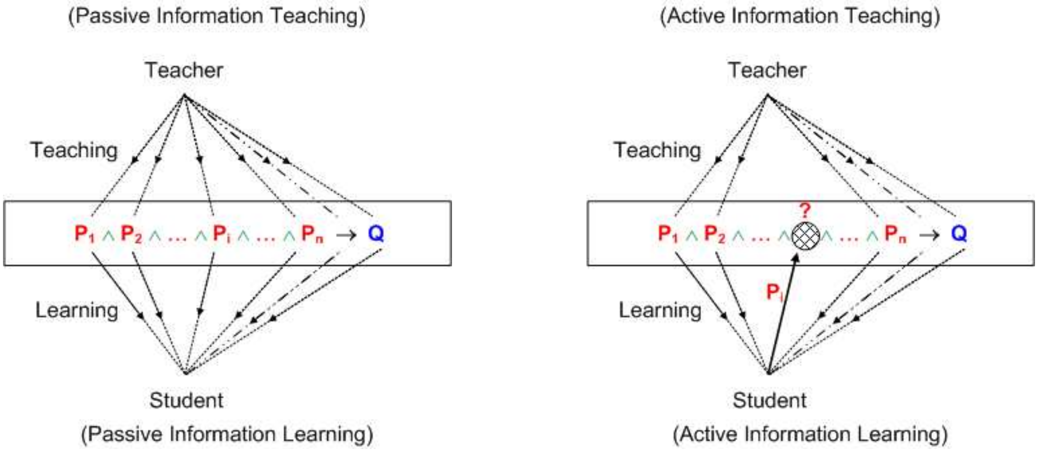


Figure 1. Logic nature of mind [4][3].



(a) (b)

Figure 2. Information Learning/Teaching Process.

correspondence to a *conditional proposition*,

$$P_1 \wedge P_2 \wedge \ldots \wedge P_n \rightarrow Q \ , \tag{2}$$

that is tautological. The consequent, or conclusion, is also known as *associate conditional proposition*) for the given argument.

The antecedent of the rule in (2) is a conjunction of the P_n premises. All conditional propositions correspond to a composed proposition whose premises are further aggregate by a logic connective of conjunction, $\wedge$, which, in turn, are related to the linguistic conjunction, “AND”. The conclusion is obtained by the logic connective of implication, $\rightarrow$, that, in turn, is related to a linguistic implication, “IF-THEN”. In this way, the argument in (2) may also be described by the following linguistic expression:

$$\text{IF } P_1 \text{ AND } P_2 \text{ AND } \ldots \text{ AND } P_n \text{ THEN } Q \ . \tag{3}$$

An important characteristic that must be detached is that each proposition, P_i, parts only one input universe of discourse. The amount of P_n propositions is related to the dimensionality, n, of the argument and so of the human thinking or reasoning. Thus, each proposition, P_i, assumes a representation $\langle x_i \text{ is } A_i \rangle$, where, x is an element of the input universe of discourse, X, i.e., $X = \{x = A \mid x \in X\}$. The proposition, Q, assumes a representation $\langle y \text{ is } B \rangle$, where, y is an element of the input universe of discourse, Y, i.e., $Y = \{y = B \mid y \in X\}$. Thus, the expression in (3) may be, finally, represented as:

$$\text{IF } \langle x_1 \text{ is } A_{1j_1} \rangle \text{ AND } \langle x_2 \text{ is } A_{2j_2} \rangle \text{ AND } \ldots \text{ AND } \langle x_n \text{ is } A_{nj_n} \rangle \text{ THEN } \langle y \text{ is } B \rangle \ . \tag{4}$$

Thus, a concept that assumes an important role in the logic is the *conditional proposition* since it allows to that the human knowledge may be represented as a set of rules of the type IF ⟨input is A⟩ THEN ⟨output is B⟩. The input universe of discourse may be multidimensional, i.e., X_j, $j = 1, \ldots, n$. In this case, the propositions, $\langle x_i \text{ is } A_i \rangle$ and $\langle y \text{ is } B \rangle$, are represented by points in their respective universe of discourse.

Finding out the premises and the mechanisms of inference in any matter should be the main paradigm and goal assumed in an undergraduation and educational process.

As previously presented, logic is a mechanism for finding out a rigorous and formal reasoning upon true statements and of internal coherence that is equivalent to scientific demonstration (scientific certainty); base of the mechanisms used to build *universal* knowledge. In this sense, it fits the inherent goal of education process in the *university* due to its intent in representing all categories of knowledge within *universe*, regardless of the field in which it is inserted in.

When the matter of interest is to prepare students in distinct aspects of professional life, the university and, in particular, engineering undergraduation course seems to follow a reverse direction to what they had proposed to. Mostly, professors transmit their knowledge by using passive mechanisms as its main instrument of work such as conventional or digital slides, transparencies, black-boxes and so on. In doing so, students are inserted in a system to behave in a passive manner, as well, as depicted in Fig. 2(a).

There is no interaction and dynamics on the learning process in which both teachers and students are passive in the educational process. Teachers present to their students the whole set of concepts and definitions as propositions, P_i, that latter will compose the inference reasoning. The passive learning/teaching process also involves the reasoning mechanism based on those previous concepts and definitions, be it directly or indirectly passed to the students.

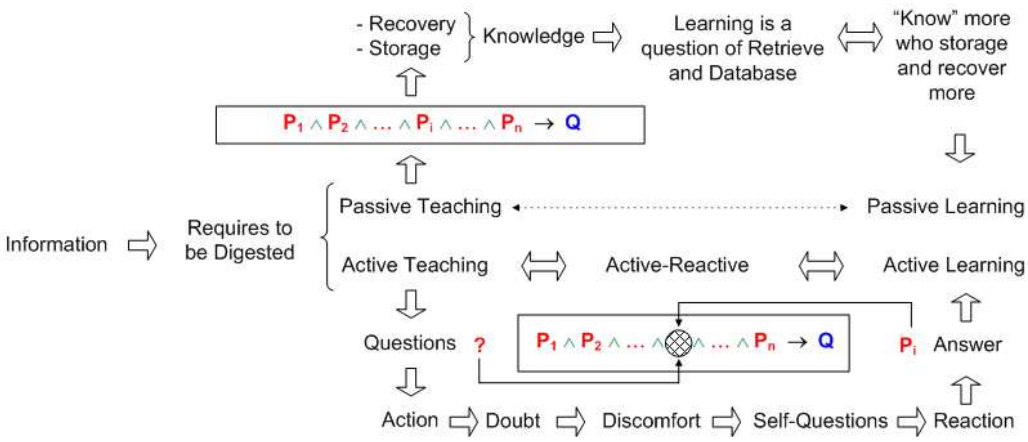


Figure 3. Questioning in the education in learning process.

Since all knowledge is previously digested by teachers that believe they are working in benefits of the students, these are not required to struggle to build up new concepts and definitions or, at least, find out these ones in the existing literature. Even difficult exercises attained to students are inserted in the ordinary context of classes and books presenting no effort, thus, for them to leave behind the safe knowledge and environment and get ahead, by challenging the established a certain set of knowledge by arguing against them.

This teaching approach is, then, characterized by professors teaching students how to answer questions instead of teaching them how to ask pertinent questions and, also important, which sort of questions should be questioned in what, here, is named active educational process Fig. 2(b). The set of *what, why, who, when, where* and *how* questions are barely touchable.

The importances that qualification tests assume for approval into the set of students and professors as well as the apprehension with the answer that will be obtained exemplify it. In this sense, it seems that there is more interest with tests (get approved) instead of learning. Moreover, this mechanism is used in a manner that will usually satisfy the inquirer, for instance, not worried if the answer is superficial or in-depth, thus, dealing with the inquirer as solely an enquirer. In this context, students go to universities to create a database of knowledge instead of acquiring reasoning mechanisms, judgment abilities, or critical sense; that is, to learn how to think and, in particular, to think scientifically. Actually, for attaining such a kind of knowledge, it may even not be necessary goes to classes since it may be acquired through various manners. Passive learning/active becomes a question of storage (database) and retrieves information, that is, know more who storage and recover more.

If professors inserted in this process, for one side, may not realize that the educational environment and their initial or main goals have been impoverished, for the other side, students are not prepared to understand their role in the educational process yet. Students learn only to look up just for answers in the presence of a questionnaire or when professors conduct questions. In contrary, they should be alert of never being comfortable in any set of knowledge, be it refuting all the concepts and definitions already established, be it contesting and arguing against renouncing them, in the same manner.

While in the passive information learning and teaching process students stay always in the idle state for getting their answers being confirmed by professors without paying attention to the doubts that would come up, in the active information learning and teaching process students look through the whole subject also in a (re)active process. Since doubts can be understood as the fuel that incites to research, and this one may be viewed as the way that leads to knowledge, students should be stimulate to question and not be afraid of actions or consequences that stop most of them to go through. When facing off their doubts students are encouraged to examine what can be accept as representing the reality all around, and what is true, real.

Learning how to think and so, being able to acquire reasoning mechanisms, judgment abilities, or critical sense, can only be achieved by active learning process Fig. 2(b). The active learning process may be carried out when the teacher asks students about a specific definition or concept not lectured yet. Another manner to achieve that is by inducing students in finding out in advance elements to help building the whole knowledge. This activity corresponds in intentionally opening a hiatus, vacancy in the inference mechanism in (1) (2) (3) or (4). For instance, expression in (4) would be rewritten as:

$$\text{IF } \langle x_1 \text{ is } A_{1j_1}\rangle \text{ AND } \langle P_i = ?\rangle \text{ AND } \ldots \text{ AND } \langle x_n \text{ is } A_{nj_n}\rangle \text{ THEN } \langle y \text{ is } B\rangle \ . \tag{5}$$

This action induces a doubt in students who mostly face a discomfort. Finding themselves in a not region of satisfaction they start questioning themselves about the available knowledge and new one. This self-questions are, actually, a reaction to the stimulus generated by the teacher, resulting in an answer in the form of propositions or new questions, $\tilde{P}_i$. As previously mentioned students should be taught how to use the fundamental questions, which are: *what, why, who, when, where* and *how* its derivations concerning research, debate, questioning and so on.

This student reactive behavior is an attemptive to get close to the real proposition, P_i, that fits the inference mechanism, i.e., $\tilde{P}_i \cong P_i$. In doing so, the loop of active teaching, active learning is complete in a *active-reactive* education process. The detailed active and passive information learning and teaching process is depicted in Fig. 3.

When using this sort of question-doubt-research-question-answer-knowledge educational process, universities would reach its origin by dealing with the learning process of how to think upholds by methodology for achieve a substantial technical knowledge.

This papers states that questions proffered by teachers and intentional vacancy in knowledge to be supervised and guided in classes leads to doubts in students that, in turn, drive to a sense of discomfort, generating a self-questioning process. This kind of self-questioning is understood as a way to reach a research behavior by using fundamental questions in the form *what, why, who, when, where*, and *how*. This mechanism reaches to new knowledge that may fit the answer concerning the initial questions or may fulfill those vacancies consciously let by teachers. This active-reactive educational process presents as spin-off the learning in acquiring mechanisms of reasoning, judgment abilities, critical sense, critical argumentation, and so on, and not only the knowledge that can be obtained in literature. Thus, experienced professors should guide their students in how to use this kind of reasoning concerning to research, to debate, or to generate appropriately questions according to the context they are inserted in.

The importance of questioning assumes, then, an elementary role to produce a dynamic interaction between students and professors. Indeed, questioning becomes a powerful mechanisms in any educational process but mostly fundamental in the universities and undergraduation programs that aims in teaching students to learn how to think.

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