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Digital Paradoxes in Learning Theories

Marcello Bettoni

Abstract**—**As a learning theory tries to borrow from science a framework to found its method, it shows paradoxes and paralysing contraddictions. This results, on one hand, from adopting a learning/teaching model as it were a mere "transfer of data" (mechanical learning approach), and on the other hand from borrowing the complexity theory (an indeterministic and non-linear model), that risks to vanish every educational effort.

This work is aimed at describing existing criticism, unveiling the antinomic nature of such paradoxes, focussing on a view where neither the mechanical learning perspective nor the chaotic and non-linear model can threaten and jeopardize the educational work. Author intends to go back over the steps that led to these paradoxes and to unveil their antinomic nature. Actually this could serve the purpose to explain some current misunderstandings about the real usefulness of Ict within the youth's learning process and growth.

Keywords**—**Antinomy, complexity, Leibniz, paradox.

I. Introduction

WITHIN the history of modern rationalism and science, we can focus on two frameworks of thinking which have fostered new paradigms of the human knowledge. The first one, pursuing the best aims, claimed to solve the issue of learning by introducing a new definition of language and by founding its derivation rules on a mathematical model. As a result, the issue of learning – and more specifically, how do we learn – has been over-simplified as it were just a data package delivery, and it has opened the way to one paradox of Ict. This kind of reductionism relies on a long-standing tradition, strongly supported by the view of modern rationalism and classical physics.

The second one, which is more recent, borrows from the theory of complexity a concept of learning as a complex system made up of the dynamic interactions of various elements over time. This viewpoint is characterized by emergence and unpredictability. This model leads to a non-linear, erratic process of learning which can be only limitedly predicted and which is difficult to control and to understand. It really threatens learning at its roots: that the teaching would cause the learning to happen.

The purpose in this paper is to walk back over the steps that has led to those paradoxes and to unveil their – in the first case - antinomic nature. In fact, author thinks, this is the reason why so many misunderstandings have arisen about the real usefulness of technologies within the youth's learning and growth.

M. Bettoni is with Cisem (Center for Educational Innovation and Experimentation), 20123 Milan, Via Petrarca, 20, (+39 0277404763/4764; fax:+39 0277404166; e-mail: fsbet@hotmail.it).

Furthermore another criticism, arising from the application of the theory of complexity to the educational pattern, to unveil some unsolved and crucial nodes which would jeopardize all educational efforts will be examined.

II. The Transmission Data Model

The traditional learning pattern that has been handed down to us over time is based on the *lectio*, a latin word which means *reading.* Actually since the medieval times, any class started by reading a sacred or authoritative text, then the teacher discussed it by presenting different interpretations and points of view. In both cases however the attention was focussed on the transmission of knowledge by an "authority" (be it a sacred text, an author or, in the worst case, the teacher) to the students' mind.

The gnoseological path of science and philosophy since the XVII century has confirmed this "descending on brain view" by developing a knowledge pattern that seemed to be functional to a mechanical and operational learning design.

The first who tried to destroy and re-build the human knowledge on a new basis was undoubtedly René Descartes: he resorted to powerful operating tools (methodical doubt, *mathesis universalis*), then he gained a prime out of doubt truth (*cogito, ergo sum*).

Afterwards Leibniz focussed more deeply on this *mathesis universalis* : if we could build a language made up of shared and non ambiguous characters, by established and certain combinatory rules, thought and reasoning would simply become an arrangement of symbols, a writing game, a mechanical manipulation, that is, a calculation. This would imply that each problem would be solved in a finite number of steps through a sequence of finite instructions as finite, applied by means of a precise algorithm. Once this language and these rules are established, any problem can be solved: the misunderstandings between men and women will then be solved by sitting at a table and by just saying: "calculemus".

This ideal arose from lofty ethical goals: reducing the language to calculus through a sequence of procedures and controllable mechanized steps, meant laying the foundations for the elimination of differences between men and the construction of a world of peace and culture. In the XVIII century, troubled by wars of religion, this pacification program had undoubtedly a great value for mankind. In the early '900 behaviourism developed a theory which perfectly complements this concept: psychology should be limited to studying observable behaviour, ignoring completely what is happening inside the human mind, which by definition is unknowable, unfathomable.

It must focus on observable behaviour, because only what is empirically verifiable can be described in scientific terms. In so doing, psychology is "called out" from introspective task about what happens inside the "black box", (the human mind).

In the same way, behaviourism cleared the field for the reduction of thought to language, to mere calculation, as David Hilbert, a German mathematician who lived at the end of '800, clearly stated: "Our whole culture, as far as it is based on penetration and on the intellectual ' enslavement of nature, finds its foundation in mathematics", and "A mathematical theory is not to be considered complete until you have made it so clear that you can explain it to the first man you meet in the street".[1]

It thus clarifies the concept of the vertical and hierarchical structure of the tree of knowledge: the roots and the trunk are made up of mathematics through which the activity of our intellect can be described, by drawing up a protocol of the rules under which our thoughts really proceed. Thinking, speaking and writing are the same as calculating, or forming true propositions according to an algorithm of precise and shared rules.

Starting in the '20s of the twentieth century, within the logic of studies designed to give a stable theoretical foundation to the concept of algorithm, which until then had been mainly intuitive and operational, the computability theory was born. According to this theory, the study of algorithms is due to the study of effectively computable functions, and the theoretical foundations of computing are laid. In particular, the idea of Church-Turing laid the foundations for an analogy between the machine and the human brain, based both on the same finished and combinatorial system of rules [2].

The framework is outlined with clarity; informatics would prove that Leibniz was absolutely right: you can play all the expressions of thought (which in the scientific equivalent language) in multimedia form, using the definition of a simple alphabet (the binary code with two "letters", 0 and 1) and a system of instructional algorithms. That is the language of data corresponds to the universal language that Leibniz longed for. The setting of a transmission data pattern of knowledge was entirely given by the mind-machine analogy.

A. Learning Objects and Transmission Model

This perspective considers the problems of learning as a mere transmission of data. If it were possible to reduce the intellectual operations to mere computing procedures, the issue of learning would be reduced to that of knowledge, and this in turn would be describable as a pure transmission of data. The definitions and rules of this language would be so clear that even an idiot would gain access to knowledge through a simple transmission of information.

This paradigm of learning is still quite widespread in the schools, where learning is accomplished through a linear sequence of the teaching process :

teacher→student→learning→knowledge

It is based on the assumption that the learner has a passive role whereas the teacher, as authoritative transmitter of knowledge, has a central role.

The automation of this concept of learning is the basis for the great illusion of indefinite growth and dissemination of human knowledge, according to Laplace's view. The Learning Objects represent perhaps the most technologically advanced application of the idea that self-contained, available, reusable, interoperable modular units may be a decisive impetus to the dissemination of knowledge.

Unfortunately, the transmission model is totally inadequate to explain the true nature of learning, which is active, constructive and social, as the educational debate over this last century has emphasized. Continuing the trend of the twentieth century, pedagogical research has overcome the "mind-machine gnoseology" as a system of input-calculation-output, showing the constructivist, cooperative and situated nature of learning.

Today this is viewed by general consent as an active process of the learner, a reordering of one's own models in the personal cognitive background of knowledge; the dialogical process by its nature develops and consolidates through relations and mediation with the others, because it implies real situations, such as the execution of an operational task, a project work etc. The term competence is the key to this new vision of learning.

B. The Paradox

In a constructivist, collaborative and situated learning model, ICT can play a key role. Indeed it is clear that they act as process accelerators within the transmission model of knowledge communication. It is on the strategies of social and collaborative approach instead, that it releases its enormous potential, not just as an accelerator. We refer to active teaching and planning, the role of ICT in cooperation and communication (a key to dialogical, interactive and situated learning), to metacognition on their own - and the others' - learning processes (from peer review to social network), the ability to play in a simulated or enhanced reality (virtual and enhanced reality), using the playful valence, emotional intelligence and multiple means provided by multimedia. This guidance seems to be now accepted in the international debate on the role of technology in teaching.

As a consequence, ICT are seen as able to free knowledge transmission from the enslavement to the dull scientist's paradigm of «delivery data package» learning and they are conceived as basic to the recovery of true, communicative, emotional, entertaining and constructive knowledge. In other words, the information and communication technologies bring closer to Leibniz's dream of a mechanical learning, yet they are used for a class activity that goes well beyond the age-old design of knowledge as data transfer. How can we explain this contradiction? Above all, how can we come out of it?

C. Chat, Social Networks, Net Searching and Multitasking

The antinomic nature of this paradox, as it will be shown later on, would retain the character of intellectual idleness if it

were not punctual within many contradictions reflected in widespread public and practitioners debate over education, at all levels.

We refer to the use of chat, of social networks and to the so-called phenomenon of multitasking, for which ICT are largely responsible. We might wonder whether ICT cause the students to be estranged from reality and since the contacts developed through the Internet involve the emotional sphere, helping them to express and to enrich themselves, we should wonder whether they risk to marginalize and hinder their exploitation. Chats and social networks are a clear example: solipsistic risk of marginalization and alienation from the real world or useful tool for reflective, collaborative and cooperative learning? Another example is given by research done through the network: all students, from primary school to higher education, are used to carrying out research through the Internet on all sorts of subjects, without receiving any particular indication and operational training on how to make research. You take for granted the question of how to search, when it is, from an educational point of view, the most significant issue.

Finally, the phenomenon of multi-tasking concerns neomillennials, the digital natives who have, through familiarity with the technologies in which are immersed from birth, a trend to do *at the same time* more operational tasks: for example, doing their homework, chatting and listen to music. All this at the expense - it raises some questions - of concentration, reflection, depth of analysis and creativity. [3] Who is right?

III. The Theory of Complexity Model

The Theory of complexity, also known as Chaos theory [4] is set on the opposite side of the deterministic view that inspired the transmission data model. It arises from mathematics and physical sciences and has been imported into the social and cognitive sciences [5]. According to this theory, learning is a complex system of dynamic interactions among variables over time, such that we cannot hope to take control of it.

Instructional systems aren't closed systems and, above all, aren't under our control. They are not the sum of their parts, so that we can manage the whole by manipulating one variable. Knowledge is not a quantifiable object (as in learning objects perspective) to transmit, as it was a data package. Consequently, human behaviour and learning aren't predictable, due to a lack of the linear causality that characterizes the transmission data model. On the contrary, ----- human learning is erratic, recursive and dynamic, made up of multiple interactions, impossible to control and to ultimately predict: in a word, unfathomable. Such a view is set at the opposite side of the traditional, linear and computational paradigm that has been applied to learning over centuries, and that has been briefly described above in II. Furthermore, it may lead to a nihilistic and pointless vision of education, showing no confidence about the outcomes a learning design can lead to. This view threatens the educational work at its roots and jeopardises all educational efforts.

IV. Antinomy and Criticism

A. The Antinomic Nature of the Paradox

Let's try to face the first paradox. Will ICT lead to a new freedom or rather to an old captivity? Are they tools of emancipation or of a new imprisonment? The contradiction is only apparent. For example, when we acknowledge the potential of instant messaging, of a LCMS, of a blog as an effective educational activity, we are pointing out at something totally different from chat, LCMS, blogs in their purest digital sense. In the first case we refer to ICT as a language of teaching and training, in the second to ICT as metalanguage, as the protocol rules that are above the rules of language teaching, protocol that defines the formal and non-ambiguous syntax for developing and transferring data. Let's make some examples which could help to clarify the idea.

When it is said that instant messaging, blogs are tools for ------communication between learners, for metacognition, for ----- active teaching and planning, we don't refer to a messenger or a chat channel selectable from the web in their pure operational sense, but to a serious design of teaching a course that provides, under certain conditions, also the chat, or blogs as tools for achieving a given educational goal. Obviously, a chat or a blog, not subject to control from outside is a really "giant waste of time", as objected by many persons about social networks such as Facebook, Twitter or Netlog. The difference makes all the awareness of educational design, and we must find within its language the keys of its success, and not in the technology of the medium as such. It *per se* ensures the efficiency of the model, not its effectiveness. Another example, a serious and endemic one indeed, as mentioned above, are "researches" carried out through the network. Now, students from any type of school, course and grade regularly use the network as a means of study and analysis. It has become by now a widespread habit. The problem is: how a student, a teacher and parents – who are actually the ones who carry out the research - were trained in choosing sources, in the logic of a search engine, in checking the reliability of a site? If you consider the network as mere availability of information made possible by the TCP / IP protocol, the ability to print it on your desktop, we can say that it helps in teaching and learning. It helps in that it considers learning as "data transmission". Under this aspect, that is, as accelerators of the process, ICT are really unbeatable. So there is no point in asking the students to do the research. Actually the teacher could do the research himself/herself.

The pedagogically meaningful research issues are thus moved to the background: how can I ask the engine? How can I select the sources critically? How do I rate their reliability? How can I build up my knowledge? Only in this perspective assigning a work to a student becomes really useful: doing research on the subject in its true pedagogical terms, and not as mere availability of information.

Let's pass now to the issue of multitasking: does the tendency of contemporary neomillennials to many operational

tasks, fostered by the availability of massive media technology, represent a significant and positive change in the new generations' learning style, or rather a shift towards superficiality, a mark of inconclusive dispersion and of lack of reflection? If you consider ICT in their strictest meaning, as *metalanguage*, as a vehicle for transferring and processing data, you run out of options: from an educational point of view they are at best a lack of opportunities, at worst a pernicious deviation in the construction of a correct methodology of work and study, a "giant waste of time." If guided by a conscious educational design and oriented to the achievement of high skills, multitasking becomes a vital prerequisite to the development of competence: just think of the skills implied in a translation from the Latin or from ancient Greek or in a mathematical analysis problem solving, where you must know how to guess the same scenarios and different assumptions, managing both their compatibility with the rules and exceptions in grammar, syntax and mathematics to achieve a proper result / text. This is properly the *language* of teaching and didactics, the only one that can make sense in every learning project.

The paradox is just apparent: it can be explained basing on the meaning one gives to the tool he's using to perform a certain learning design : as a simple *metalanguage* in the first negative view, and as a *language* in the latter, optimistic view, the only one we are allowed to use in planning any educational strategy

B. Sense of Teaching and Complexity Theory

Let's have a look to the Complexity theory. The nihilistic perspective is undoubtedly the strongest criticism the chaos theory makes of education.

Why can't digital sciences help to control the uncertainty of the learning phenomenon, as occurs in physics, chemistry and so on? For example, in meteorology you can manage a large number of variables (the various constituents of the atmosphere) using complex algorithms (eg. non-linear equations of Navier - Stokes describing the behaviour of fluids at ----macroscopic level) and it is also possible to predict somehow different scenarios basing on input probability. And all this occurs thanks to the computing power of modern processors.

It is a really curious and paradoxical destiny: Ict help the empirical sciences to get out of the narrowness of the linear equations paradigm, but when exported into cognitive sciences, they show their weakness in managing a big number of variables.

What occurs here is totally different from what happens in the transmission data transfer model: there Ict seemed to become a real empowerment of learning; here exporting the Chaos theory as a pedagogical model seems to be of no help. Why?

The reason is that no component or condition of human behaviour is reducible to discreteness and translatable into a digital format. In pedagogy and in teaching this reduction would not be theoretically possible and would not make sense: the human variable remains, as the human brain, irreducible to a few or many control variables.

Ict can be of help in empirical and maths sciences of discrete systems, not in cognitive sciences, whose subject is perhaps the most continuous we get in the whole universe: the human being.

Therefore which role may the Chaos theory have?

Surely, if one takes it without modelling a learning framework, eg. for a language education [6], we can but foresee only nihilism.

Nevertheless, if it is viewed as an open system where attractor states and sensitivity to initial conditions may, for instance, serve as a guidance to a learning design, then it works; or, beyond nihilism, if we still believe in our teaching operations well aware that they cannot be monitored in their exact impact on the student, but that a general trend can however be expected over time, then it works.

V. Conclusion

To sum up, we think that both opposite models, - data transmission and chaos theory - when exported into the learning environment may really undergo a sort of reductionism that neglects the irreducible centrality of the human being as subject whose behaviour is hardly computable by its discrete variables.

To paraphrase Kant who, to explain the nature of antinomy cosmology in his transcendental dialectic, said that "thoughts without content are empty, intuitions without concepts are blind" [7], it can be said that teachers and teaching are blind if they aren't aware of ICT and that without them they are much poorer. If this kind of awareness is not set as the focus of any educational design, technology is doomed to fail the training, to build beautiful cathedrals in the desert, to fall into sterile technicalities that collapse on themselves. This results in making the digital division even deeper rather than bridging the gap.

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