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Heuristic environments.

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Abstract. The purpose of this research is the identification of a paradigm which fixes the basic concepts and the type of logical relationships between them, whereby direct, govern and evaluate choises on new technologies. The contribution is based on the assumption that the complexity of knowledge is correlated with the complexity of the learning environment. From the existence of this correlation will descend a series of consequences that contribute to the definition of a theoretical construct in which the logical categories of learning become the guiding criteria on which to design learning environments and, consequently, also the indicators on by which to evaluate its effectiveness.

Keywords: complexity, logical learning levels, learning environment, cognitive mode, experiental qualities.

1 Introduction

The purpose of this research is to facilitate and support the achievement of complex knowledge connoting adequately the experiences that are made within the learning environments.
The contribution is based on the assumption that the complexity of knowledge is correlated with the complexity of the learning environment [1]. From the existence of this correlation a series of consequences emerge that contribute to the definition of a theoretical construct in which the logical categories of learning become the guiding criteria on which learning environments are designed and, consequently, also the indicators on which to evaluate its effectiveness.
To proceed, first identify the cognitive demands for each logical level of learning and, specifically, those relating to high-level learning, and second, define the qualities with which the experiences that are engaged in learning environments must be characterized so that they are adequate for this purpose.
To this end, Bateson's [2] logical categories of learning will be applied to the design learning environments; and hypertextual environments designed by Spiro will be adapted extending their implant from two dimensions, namely breadth and timing, and resulting, therefore, a new type of learning environments called 'heuristic environments'.
Finally, will be presented a software solution, called Mindnet, still under design, as a prototype of an heuristic environment.

2 Logical learning levels, cognitive modes and learing environments.

In order to understand what are the needs of the logical organization of knowledge of this historical time, Bateson's [2] logical categories of learning can be referred to.
Bateson essentially interprets learning as a change, a modification of behavior due to a reorganization of cognitive structures that occurs in a stochastic mode, that is based upon a procedure for 'trial and error', meaning errors like wrong choices able to provide to the organism informations which can contribute to its future ability. Consequently, the categorization of learning processes is based on the type of error that must be corrected in the process of learning: each logical learning level corresponds to a specific segmentation of the experience and takes a specific cognitive mode. Briefly, learning 0 refers to all those acts that constitute the knowledge-base and involves the simple receipt of information; learning 1 occurs when there is a change in the specificity of the response by correction of the choice within the same set of alternatives; learning 2 can be characterized as a change of the set in which the choice is made or a change in the segmentation of the sequence of experiences and takes place with the adoption of specific behaviors of a given context inside another, known as transfer of learning; while, learning 3 is a corrective change in the system of sets of alternatives from which is done the choice, that has, as result, the development of a final trans-contextual structure more abstract (obtained thanks to an intuitive tacit understanding), which includes, within it, a certain class of contexts in a relationship of mutual coessentiality. Briefly, learning 3 can be interpreted, according Bateson, not only as a way to make more flexible the cognitive habits of individuals, but also to make them more intelligent and to make of the same intelligence a general habit of the thought.
From having taken this categorization as a cornerstone of the construct, a series of deductions arising therefrom. The first is to observe that, between adjacent logical levels of learning there is a recursive movement, like an ideal ring, that breaks the principle of linear causality: *previous learning serves as the basis for what follows and it allows a different view of the first*. More, if this is always true for the first two levels, it is only true for the others operating an abstraction and taking into account the levels in absolute: in fact, from logical level of learning 1 more properly triggers a recursive spiral (as a result of the overlap of Bateson's theory with the theory of systems), in the sense that previous learning should be considered not alone, but as emerging from the the previous ones. Therefore it's possible to reformulate the principle in the following terms: *previous learning levels serve as the basis for all those who follow them and allow a different view of all the previous levels*.
Based on the assumption which states that the complexity of learning depends on the complexity of the environment within which it matures, we can assume the need for subsequent division of environments into levels depending on the type of learning that support and on the type of cognitive modes that activate and mature. Moreover, considering the fact that the division of environments has been made on the basis of Bateson's [2] logical categories, the principle of recursive spiral can be transferred to them: more specifically, *prior environments serve as the basis for those which follow and these allow a different view of the previous*.

Reasoning, then, by levels rather than by categories (learning, environments), it is noted as the principle of the recursive spiral is also applicable horizontally: the environment of a certain logical level supports the development of the corresponding logical level of learning, which allows a different view of the previousenvironment, and from the interaction between these, new cognitive needs and new learning environments emerge and, consequently, new logical levels of learning are reached. This produces a recursive meta-spiral, which proceeds horizontally by levels, from environment to learning and from this to the next environment, producing qualities or properties which will be unknown if the categories were conceived in isolation: in this way the environment and learning (already considered as emergent phenomena within the categories of which they belong) can be considered such as architects of a second degree emergence, which feeds back on the constituent molecules of this Organization.
Also, the logical categories, once regarded as indicators of excellence regarding the design of learning environments, must necessarily be taken as indicators of the evaluative processes of their functioning.

3 Experiental qualities in hypertextual environments.

Focussing on high-level learning, and, therefore, on correspective cognitive modes, in order to develop flexible modes of cognitive processing, typical of level 2 learning, flexible learning environments developed by Spiro can be referred to: thanks to their multi-dimensional and non linear characteristics, it is possible infact to perform cognitive experiences on the same aspects of knowledge in a variety of ways and for a variety of different purposes. This helps to develop an habits of mind prone to changes within changes, which leads, albeit indirectly, to the acquisition of learning 3. Regarding level 3, it is, in fact, a learning that can not be reached directly, but 'along with other', as concomitant facts or phenomena: and, such as, it is often mistakenly regarded as secondary. The risk underlying this concept is, however, that not spelling out clearly the intentional purpose of the device even with respect to the achievement of *collateral* learning and (taking off from the state of latency overlooked sides in preparing the curriculum and environments suitable to the task) you end up with demeaning the invisible elements of the device, reducing them from intentional and, therefore, fundamental to unintentional and, therefore, perceived as inessential, accidental.
Once the objective is clear, it becomes evident that, although one can arrive to the logical level of learning 3 indirectly, there are, however, a number of conditions and formative experiences which can favour and support them. The research question then becomes: What learning experiences can foster this type of learning? What experiential qualities are necessary in order to reach the target?
One possible way to answer these questions is to extend the underlying conceptual framework outlined by Spiro's [3] hypertext environments along the direction taken.
The learning environments created by Spiro are designed to act as intellectual partners of the student with the aim of initiating and facilitating critical thinking and high-level learning. They prepare students to apply knowledge to new cases (the learning objective of the transfer) following the middle road between strict pre -specifications,

on the one hand, and immersion in a totally unstructured environment on the other, for the purpose of carrying out the integration between conceptual learning and general situational learning. It is, in practice, a browsing environment, organized around 'pieces of construction' finalized towards assembly of selective appropriate subsets, integrated to suit the needs of the particular situation: the pre-specification, then, is limited to the identification of points from which to start to think about the domain, while it is up to the pupil, supported by the tools offered, to build the knowledge and define its meaning, on the basis of irregular patterns of familial resemblance supplemented by interactions with the details of their specific contexts of use [3].
It is proposed here to enhance these environments, promoting a wider and earlier use of them, in order to make the experiences more meaningful in relation to the purposes identified: in addition to the experiential qualities present by definition in these environments, mainly the flexibility, increasing, therefore, the magnitude and timing of their use.

3.1 The breadth.

Because knowledge is used in a number of ways it needs to be organized, taught and mentally represented in many different ways, right from the very simplest level of learning. It is proposed here to transfer the control over the selection of prospects from the designer to the user. The first form of widening is concerned, therefore, with extension of their role, offering students the chance to practice in the management of complex issues already from the selection phase of crossing prospect's of the same subject, developing it, and forecasting possible connections. The type of environment to which it refers is not, therefore, the hypermedia product already packaged , which offers structured knowledge from others (in support of which there is already a rich literature): it suggests, rather, the use of these mindtools as real authoring systems, through which students can, by a wide margin of choice, not only start thinking in a flexible container that is already structured, where there are explicit perspectives and cases, but also appropriate the moment of the design.

3.2 The timeliness.

This reflection leads us to reconsider another aspect of hypertext learning environments created by Spiro, that relating when it appears to be more profitable to introduce their use in the educational processes, and that the psychologist places in the learning phase 2. This choice allows, in fact, the lower-level learning environments to use less flexible tools, which are too simple, allowing you to look at a concept, a phenomenon or an event from one perspective only, resulting in an inability to capture important aspects of conceptual understanding and account for the variability of the cases in which knowledge can be applied. Some studies by Spiro [4] have already shown, in fact, that the simplification of initial complex areas may prevent the acquisition of advanced levels of understanding and a constitutional inability to transfer knowledge to new situations that make people blind to the

complexity of reality, although they will acquire, flexible tools for learning in the future. In addition, the errors of over simplification may combine with each other to constitute a wider network of consequential and enduring misconceptions. Because knowledge is used in a large number of modes it is necessary that it is organized, taught and represented mentally in many different ways, right from the very simplest level of learning in order to prevent the dispersion of information and mental potential, which large population groups can suffer. It would seem more appropriate, therefore, to this end to prepare students early for this type of process. Proceeding, therefore, with the hypothesis that it is more profitable to start using them early timeliness, applied to an easier level of learning , not only in the case of simple and well structured knowledge domains, but also, in the case of complex domains which are ill-structured, precisely in order to present the reality as a unit, which proceeds from the simple to the complex and, so, favouring an early flexible structuring of knowledge.

4 Conclusion

The idea of learning environment evolves, so, in correspondence with the epistemological line outlined: it derives a concept of environment so strongly imbued with the *heuristic method* of work that goes on (that proceed discovering, infact *eurisko* is a greek term that means to discover), it finishes denoting like heuristic. *Heuristic Environments* are flexible environments that create the conditions for the formation of a flexible and multifaceted mind, capable to transfer learning and, thus, to get to the context of contexts. Using a metaphor, they are the 'space' of the thought in which students, like young epistemologists, are enabled to manage uncertainty and, proceeding by adjustments, to acquire knowledge of procedures for thinking, manage complexity, building a useful, shared and intentional knowledge, adapts to the individual style, which is embedded in concrete contexts of use and meets the cognitive needs identified.
After this first phase of reflection, research work has started designing Mindnet, an author program designed to support students in the difficult task of building and systematize the internal representations of both simple and complex concepts, taking into account the two experiential qualities highlighted, the width factor and the factor of precocity of use. The software, as well as the educational paradigm that underlies it, will be refined and tested as soon as the funds are found.

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