MOOC IN THE PARADIGM OF SYSTEMIC MODELLING OF COMPLEXITY: SOME EMERGING PROPERTIES

Marc Trestini
marc.trestini@espe.unistra.fr

Isabelle Rossini
i.rossini@unistra.fr
Laboratoire Interuniversitaire des sciences de l'Education et de la Communication
LISEC (EA2310)
Université de Strasbourg
France

ABSTRACT - With the emergence of social networks, MOOC, informal learning through networks and connectivist approaches to learning, *Digital Learning Environment* (DLE) analysis is becoming more and more complex. The models which were previously used to account for the activity instrumented with cognitive purposes, are now showing their limits (Vygotsky, Leontiev, Kuutti, Engestrom, Rabardel...).The massive aspect of a MOOC is difficult to represent in such models. Its « open » character is no less difficult to model. The evolution of these environments is chaotic and their effects appear unpredictable. But chaotic does not mean hazardous. A complex system is naturally chaotic and it is not possible to predict the outcome of the process directly, by calculation. But it is possible, from systemic modelling to develop plausible scenarios based on the analysis of available data (training trace, trends, emerging properties, etc.). As Paul Valéry once said, "We are only reasoning on models », whether or not the models correspond to reality. The models are constructed from perceived realities, but enable one to assess emerging properties in a projective fashion; their counter-intuitive effects, for example. We hypothesize in this contribution, that the paradigm of systemic modelling of complexity (Edgar Morin, Le Moigne) appears more than ever as a framework which is suitable for the representation and analysis of a DLE of the last generation. In fact, by applying the theory of complex systems to the modelling of a MOOC taken as a case study and considered as a last generation DLE, we will report, in a projective manner, some of the emerging properties.

INTRODUCTION

« Education has always used teaching aids, the media, various instruments and processes to facilitate the transfer of knowledge to learners » (Baron, 2011, P. 109). The so-called educational technologies, which generally use that set of resources, never ceased to fuel the debate and controversy during the second half of the twentieth century and especially since the sixties, at which time they represented a Renewal of Education with the emergence of school radio and television educational programs. This integration in the education system continued with the introduction of computers in the classroom in the nineties and started expanding in the year 2000 with the use of computer networks connected to each other in schools and universities (MOOC, EAD, flipped classroom, etc.). The most recent ones like MOOC or DWE (Digital Work Environment) or the open and distance learning (ODL) devices will be considered here as the latest generation of Digital Learning Environment (DLE) that « as empirical objects, are most often of a composite nature, articulating digital and non-digital elements (Peraya, Bonfils, 2014, p. 5). As objects of research, they are generally considered instrumented activity systems that refer to the theories of activity (Vygotsky, Leontiev, Rabardel) and to the analytical models associated with them. The famous model of Engestrom is one of them. It is this model that is typically used by researchers in educational science to model these environments in order to study their behavior. It has the advantage of being simple and showing all the components of a DLE. And to evaluate a digital environment, we must compare it to a model. "We are reasoning only on models », Paul Valery said, as quoted by Le Moigne (1999). But we will see in this article that the choice of model is crucial. This is especially true when the DLE that is being studied becomes complex, which is what we hypothesize for the latest generation of DLE subjects and therefore a fortiori for the MOOC. It is also to avoid the abusive and sometimes risky simplification for analytical modeling that we opt for a more systemic modeling complexity (Moigne, 1999) to represent the latest generation of DLE. Indeed, « the simplification of something complicated applied to complex results worsens its complexity » (ibid.). Furthermore, the evolution of these environments is chaotic and the effects are unpredictable. It is not possible to predict the outcome of the processes, directly by calculation. But it is possible, from systemic modeling, to develop plausible scenarios based on the analysis of available data (traces of activity, trends, the emergences of phenomena, etc.). Models are constructed from perceived realities but enable the assessment and projection of emerging properties; the counter-intuitive effects for example. We hypothesize in this contribution, that the systemic modeling paradigm of complexity (Le Moigne, 1999) appears more than ever as a framework which is suitable for the representation and analysis of the latest generation DLE.

In fact, by applying the theory of complex systems modeling to a MOOC, taken as a case study and considered as a last generation DLE, we can realize in a projective way, some of the emerging properties.

THE MODELING OF A DLE CONSIDERED AS A COMPLEX SYSTEM

We explained in the introduction that it is because we perceive a last generation DLE as a complex phenomenon (e.g. MOOC) that it must, in our view, be represented as a complex system. Therefore, it is time to move on to the instrumentation of systemic modeling and the description of the different stages. We shall justify the choices we make, remembering each time to quote the theoretical fundamentals of the approach.

Epistemological foundations

According to the systemic modeling theory, modeling a complex system is first the modeling of : a synchronic action system (that works), a diachronic system (which changes during working), a teleological system (which has a purpose, a goal) and a recursive system (it implies empowerment) in an active environment. Systemic modeling also requires compliance with a conjunctive logic that aims to join and not separate the concepts of « Active Environment » and « Project or Teleology » or those of synchronic operation « the Making » and diachronic transformation « the Becoming ». The cybernetic procedure characterizes the conjunction of the first two concepts; the structuralist procedure is the combination of the last two. The combination of these two concepts led to the concept of the General System.

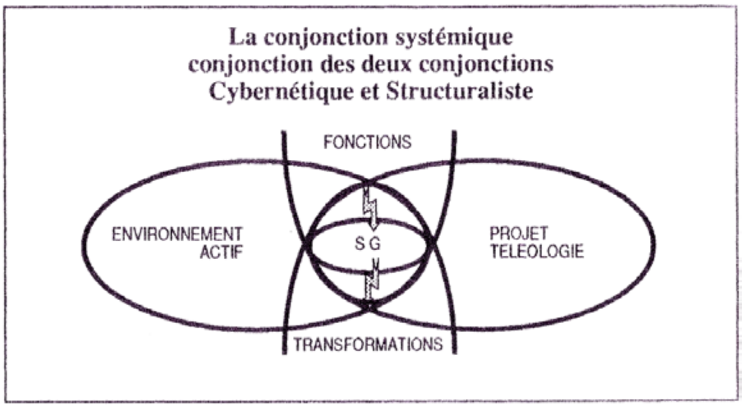

Figure 1 : The systemic conjunction of two conjunctions Cybernetic and Structuralist (Le Moigne, 1999, p.40)

Systemic conjunction proposes « to consider the operation and transformation of a phenomenon as inseparable from the active environments in which it is carried out and from the projects for which it is identifiable» (Ibid. p.40).

Identification and representation of processes

We therefore do not begin to represent things, objects, individuals, organs as was done in Analytical Modeling (AM) but the actions or complex actions that are systematically represented by the black box or a Symbolic Processor that accounts for this action or that series of actions.

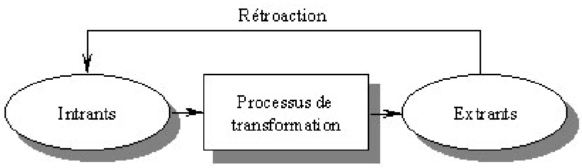

Figure 2: Process identification

This is the basic concept of systemic modeling (SM) to start from what the system does, otherwise known as its projects. It is then up to the modeler to search for functions and transformations (or operations) which are insured or which are to be insured. First, the modeler has a rough perception of the world to model. This stage features the *first level of the archetype model* for the articulation of a complex system of nine levels (Moigne, 1999, p.58). Its perception, first syncretism, only allows him to perceive the overall function of the phenomenon to model and make out its outline. Thenit can be fitted into its environment. Its perimeter can be drawn; the project becomes identifiable, distinguishable from its environment. Concretely, this can be represented by a closed contour, a little like a mathematical empty set: a « potato » in some way. This activity will result from the project description and recognition of the main functions and secondary functions as that are nested within each other and interrelated. They gradually will fill up the empty shell that represents the outline of the project. For example, if one recognizes in the remote tutoring, one of the essential functions of a DLE, it also considers that the main function consists in a number of nested functions: technological assistance, content expertise, methodological consulting, facilitation and evaluation (Develotte and Mangenot, 2010, p.3).
This set of multiple actions (or processes) that the modeler will have identified, may take place within a conceptual map created for this purpose by the modeler (see fig. 3). It will be necessary to clarify the traits of the perceived phenomenon to model. « For the families' project, we will associate the hypothesis of subsystems that we seek to articulate … referring to the global modeling system project" (Ibid. p. 54).
To facilitate the representation of these processors, we agree to denote « Pr » processor symbolizing « the black box » or the process and by « t(i) » the period during which values are assigned as the values of its inputs and its outputs. The processes characterizing the active phenomenon are now seen in their actions, that is to say, acting within the system. Their function is to « do »something.

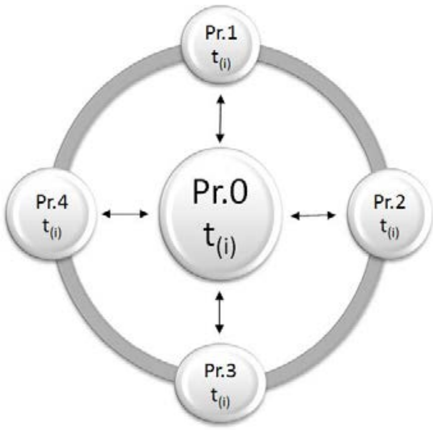

Figure 3: Blank example of concept map of a system.

Peraya (2003) and Peraya Meunier (2004) and Charlier et al. (2006) were interested in the « approach by constituent functions of any mediatized training environment » without the modeling of complex systems theory having been explicitly mentioned (to our knowledge). The framework for these constitutive functions of any mediatized training environment provides a reference framework today. It highlights and connects eight functions. These functions are a) awareness, remote social presence, and interaction ; b) social interaction that includes : cooperation, communication and sharing current files and resources ; c) information management ; d) production (individual or collective) ; e) management and planning ; f) Support and guidance; g) emergence and systematization of metareflexive activity ; h) evaluation » (Peraya, D., Charlier B., et Deschryver, N., 2008 , p.20)

In addition, each of these functions has relationships with others and among all these, the information management function appears central. A study based on this framework is given here as an example. It covers a PLE analysis work (Personal Learning Environment) led by Peraya and Bonfils (2014). In this work subjects instantiate five of the eight constituent functions of any given mediatized training environment. These functions are the following: a) sharing current files and resources, b) information management, c) awareness, remote social presence, d) the production of print and multimedia documents and finally e) the function of communication and interaction. Each of these functions is associated with one or more specific device (ibid. p. 13). These functions, which are recognized and made explicit by the modeler (or project team), illustrate the first step of modeling presented here. They take place in a concept map built by modelers for this purpose (see Figure 3of Article of Peraya and Bonfils, 2014, p. 26).

In some cases, the modeler can see that the number of processors is rapidly increasing. This should lead him to make processor groupings in « super-class processor » and « processor » classes which are respectively represented by « parent processors » and « children processors », which are connected to each other.The recognition of actions or complex actions (processors).allows one to reach the construction of more or less specific classes used to group these processors in subsets, in view of their properties or attributes. « We can then differentiate the system in as many subsystems or LEVELS. Each level can be modeled by its network and interpreted relatively independently once the inter-level coupling inter-relationships have been carefully identified ”(ibid, p.54). The graph theory provides a variety of useful representations for systemic modeling. Here (cf. figure 4) are two others as examples that complete the representation proposed above.

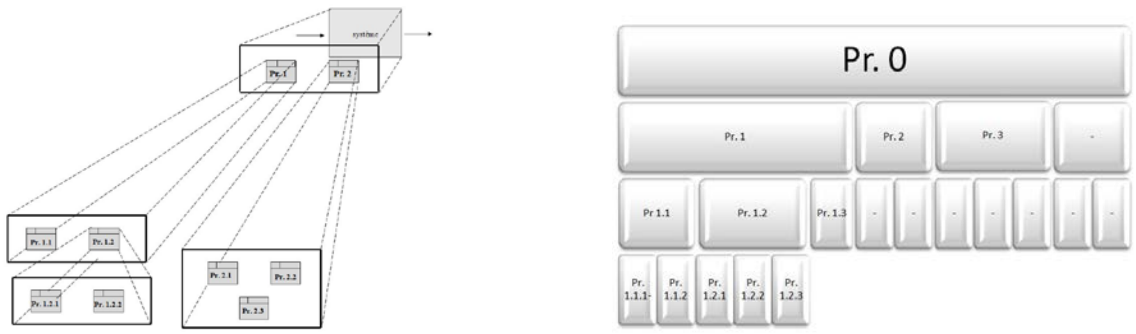

Figure 4: Examples of hierarchical representation

Active processors in an active environment (the system does)

The processors entered in the heart of the conceptual map will now be operated alternately taking into account the actions they produce, that is to say, in explaining how the input values (inputs) of each processor are transformed to become the output values (outputs). Modeling a working environment is modeling the activity which it carries out by the accomplishment of actions, of transactions and interactions. This step corresponds to the *second level of complexity of the archetype model* (which owns nine levels). Let’s add one more level of complexification that the modeler can perceive and represent simultaneously: the autoregulation of processes is also recognized. It constitutes the third level of complexification of the archetype model. To account for the complexity of this regulation, it seems appropriate to propose to the modeler to sketch a data flow diagram resulting from the object oriented modeling approach, such a diagram graphically represents the data flow through the processes of a system. Note that this diagram « is interested in data processing but doesn’t take into account the order, the decisions or the structure of the objects » (Rumbaugh et al., 1995, p. 178). It is in its interest to show how the output values are obtained from the input values, how these values are treated and how the system will behave. As we have said, it is during this relation between processors that new behaviors can emerge within the system.

Practically speaking, the data flow chart is generally built in successive layers which refine non trivial treatments. Any non trivial treatment must be described in a sub diagram. “The highest-level layer can be a single treatment or perhaps a single treatment to collect the entries, another one to process the data and another to produce final outputs » (Ibid., p.180). Figure 5 shows as an example, the diagram at its highest level of MOOC interface as an example and considered here as a DLE of the latest generation. The *third level f the archetype model* takes into account that we have self-regulating processes.

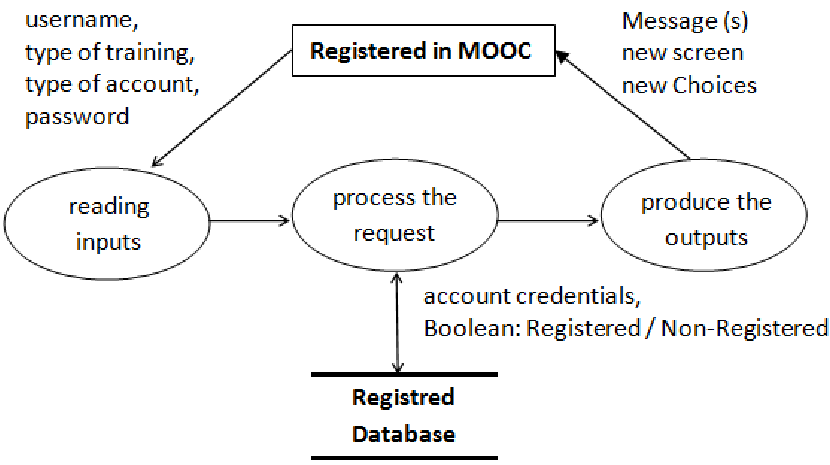

Figure 5: Data flow diagram of the highest level of the interface MOOC

Dynamic Perception processes (a system that evolves)

We have represented an active process in an active environment, i.e. a system "that works". This allowed us to locate the *fourth level of complexity of the archetype model*, highlighting the inter-relationships between processes at a specific moment in time. But the canonical model of the process (ibid., p. 47) shows that it is also suitable to represent the system which changes while "working" and to do this through time. Rumbaugh et al. (1995, p.87) notes that "these aspects of the system, time-dependent and change-dependent, are grouped in the dynamic model…" of the object-oriented modeling. We therefore propose the modeler to adopt this model to explain this action jointly, the transformation over time. One is thus encouraged to describe the typical sequences, highlighting the events which provoked the actions. The traces left by these events will be useful for elaborating the diagrams of states which currently reflect the changes in the system's state which are expected at this level of complexity (Ibid. p.60).

A system to decide

A *fifth level* is added on to the stages of complexity of systemic modeling. The system becomes capable of deciding its own activity, of processing the information it produces and of making decisions about its own behavior. This level marks a milestone in the gradual process of complexity of the archetypal nine-level model. The first four levels characterize an active process which works in an active medium. It exists, it does, it informs itself and it transforms itself. The levels which follow show first a capacity to generate, treat and memorize information (*level 5 and 6*). Next they are capable of coordinating (*level 7*) and of developing new projects as well as showing imagination (*level 8*). Finally, the active process of developing a capacity of autofinalisation which allows it to decide its future, to make choices about its own orientation (*level 9*).

CONCLUSION

Since it is considered as a complex phenomenon and as an object of study, a latest generation digital learning environment such as a MOOC can advantageously be represented and studied in the paradigm of systemic modeling of complexity, this is the hypothesis we put forth in this contribution. We apply the constructivist approach to better understand this emerging phenomenon.
Considered also as an intelligible and finalized tangle of interrelated actions, the system usually produces a result which is greater than the sum of what would have been produced if each of its parts had been taken independently of each other. Hence, the concept of emergence which « rejects the possibility that the overall knowledge of a phenomenon can only result from the mere knowledge of its fundamental components » (Wikipedia) is introduced. We therefore propose to extend the modeling approach by identifying emerging phenomenon which is unique to digital learning environments by strengthening the link between the two. Le Moigne (1999, p.41) recalls : « The incompleteness of a model will not be a regrettable imperfection, but a

necessary condition for anticipation, simulation and the possible emergence of new behaviors in this complex system ».
This comprehensive and systemic approach is currently being implemented by the Lisec research team (Strasbourg, France) and their findings will be published shortly. This contribution focuses on the relevance of the application of «complex systems modeling » for the modeling and study of a latest generation of digital learning environment as a MOOC for example.

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