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HIGHER EDUCATION FROM A COMPLEXITY THEORY PERSPECTIVE

Abstract

Complexity theory, as part of mathematics and physics, deals with complex systems (also called dynamical systems) in which many variables and many interactions between them, expressed as non-linear dependences, are involved. Such systems describe ever evolving processes happening in nature, where only change is a constant and unpredictability is omnipresent. The complexity theory also examines the dependencies of the processes. In what extent the outcome from one process will affect the other? As educational issues (educational system itself, class community, teaching methods, online learning, student community, student engagement, staff development, curriculum development, educational policy, local or global changes of the environment) in a great extent are behaving as complex systems, the complexity theory has inherently became well established discipline in educational research. In this paper we highlight the importance of a complexity theory as a viewpoint in educational research and we analyze three challenges present in higher educational sector from this point of view.
Key words: complexity theory, higher education, processes, changes.

1. Introduction

The scientific research in both natural and social sciences is usually more appreciated if it involves more mathematics (i.e. mathematical models, laws, data organization or data analysis). Especially when the research deals with *complex systems*, i.e. the systems composed of many interacting components. As these systems are usually nonlinear and evolve in time, they are often identified with nonlinear dynamical systems. The most analyzed feature of a nonlinear dynamical system is its predictability. The easier case is when the system after some time comes into equilibrium state, which means that the system is stable and predictable. Nevertheless, the systems are mainly dissipative and unpredictable, which means that in certain circumstances they show chaotic behavior. The "butterfly effect", that is the effect when small changes in the initial conditions yield to large changes in the system, is typical for the last systems.

The mathematical-physical branch that deals with complex systems is called *complexity theory*. Although not yet systematically formalized with axioms and theorems, it is applied in many natural and technical sciences (more can be read in (Bertuglia, 2005)). *Complex adaptive systems* are of special importance in complexity theory. They can be defined as (Bertuglia, 2005) "open systems made up of numerous elements that interact with one another in a nonlinear way and that constitute a single, organized and dynamic entity, able to evolve and adapt to the environment". Another attributes that can be added here that explicate adaptive complex systems, are self-organization, self-maintenance, feedback, diversity, connectivity, collectivity, co-evolution, holism.

Although originally formulated and examined in natural sciences (mainly mathematics and physics, but also biology and chemistry), complexity theory is also involved in social sciences. Each organization, community or society is a complex system of networked factors which interacts with the environment, adapts, self-organizes and continuously tries to develop and survive. Therefore, complexity theory extended its influence to sociology, economics and educational research.

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2. Complexity theory as an important perspective in educational research

Enabling a wider view of education as a global adaptive complex system (having all the key features: unpredictability, importance of networking and interacting between different elements of the system and with the environment, self-organization, continuous change and adaptation, aiming to survival and development), complexity theory inherently became very important instrument and viewpoint in educational research. As said in (Cohen2007, p. 33-34), “Individuals, families, students, classes, schools, communities and societies exist in symbiosis; complexity theory tells us that their relationships are necessary, not contingent, and analytic, not synthetic.” A good consideration of why complexity theory is inevitably involved in educational research is given in (Youngblood, 1997; Cilliers, 1998; Wheatley, 1999), “Complexity theory looks at the world in ways which break with simple cause-and-effect models, linear predictability, and a dissection approach to understanding phenomena, replacing them with organic, non-linear and holistic approaches in which relations within interconnected networks are the order of the day.” (Youngblood, 1997; Cilliers, 1998; Wheatley, 1999; Morison, 2006).

Having this multilevel approach, the complexity theory sometimes problematizes educational research. It is surely interesting approach, but not always easy to apply in practice. Even applied, the question is how useful it is as instead of control and predictability, mainly unpredictability and chaos take place. And not only that, some aspects of complexity theory have antinomial nature: cooperation goes together with competition, similarity with difference, individuality with collectivity, connectedness with separation, necessary deviance with necessary conformity, diversity with uniformity, partial predictability with partial unpredictability, solipsism with the need to understand collectivities (Morison 2006).

3. The higher education as seen from the complexity theorists’ point of view

More than in other levels of education, the word complexity has to be an unavoidable part of the definition of the higher education. In a sequel, we will analyze few specific issues in higher education from a complexity theory perspective.

3.1. Teaching and Learning

Complexity theory proposes new innovative strategies that move teaching to learning. It encourages educators to think of learning contexts (classroom, online learning tools …) as entities that can evolve and improve (Dron and Anderson, 2014; Finch 2004). The teachers create learning activities based on many inter wined factors: curriculum requirements, resources they have, pedagogical content knowledge, and the students’ learning experiences and needs, in which the learning will occur, and which at the same time have a positive influence on learning process. This requires from the teacher to be creative and to establish and maintain an effective learning environment where students feel safe and free to ask, discuss, collaborate and give their opinion (Jackson 2006, Craft, Hall and Costello, 2014; Cropley, 2001; Peters and Besley, 2013).

There are many aspects of learning that are still not well understood. For example, research about learning process can not explain "the fleeting", "distributed", "the multiple" and "the complex" paradigms (Law & Urry, 2003). There are many different types of time depending dynamic interaction and process in relation to "learning" situations in higher education. The conceptualisation of learning is still based mainly on the idea of individual support (Haggis, 2009).

3.2. Engagement of students in Higher education

Student engagement has critical role in student achievement within the learning process (Trowler and Trowler, 2010). With governments increasingly interested in measuring student outcomes (Zepke and Leach, 2010), and suggestions that student engagement can act as a proxy for quality (Kuh, 2009), a clear understanding of what student engagement really is, becomes essential. Student engagement is complex process that brings together diverse threads of research contributing to explanations of student success (Fredricks, Blumenfeld & Paris, 2004). Student engagement in Higher education is a typical example of a process that can benefit from complexity theory by considering different approaches in the research (Kahu, 2013). For example, the holistic approach tends to bring together diverse approaches of theory and research on student engagement (Bryson, Hardy & Hand 2009). In this approach, engagement is a dynamic continuum with different locations (task, classroom, course, institution), and thus not measurable by surveys but best understood through in-depth qualitative work.

3.3. Game-based Learning

As learning can also be seen as a complex system, game based learning combined with mLearning lends itself well to the various systemic dynamics that feed the complex learning process. Several popular definitions of games agree that they are entertaining, interactive, rule-governed, goal-focused, competitive, and they stimulate the imagination of players (Driskell & Dwyer, 1984; Gredler, 1996; Tobias & Fletcher, 2007; Vogel et al., 2006). The distinguishing feature of simulations is that they are reality based, but they can also incorporate common game features such as rules and competition (Bell et al., 2008; Hays, 2005; Tobias & Fletcher, 2007).

Complexity theory suggests that simulation games are more effective than other instructional methods because they simultaneously engage trainees' affective (e.g., motivation and attitudes) and cognitive (e.g., memory, knowledge base, and executive control) processes (Tennyson & Jorczak, 2008). According to them "Interactive cognitive complexity is an integrative information processing model that proposes learning is the result of an interaction between variables internal and external to the cognitive systems of trainees. Trainees' affective and cognitive structures interact with each other and with sensory information from the simulation game in order to enhance trainees' knowledge base. The process is iterative as sensory information continuously interacts with trainees' cognitive system and new information is stored.

4. Conclusion

In this paper we emphasize the importance of the complexity theory viewpoints in educational research. Being dynamical, evolving, diverse, self-organized, networked, connected with the external environment, unpredictable, open, holistic, the educational elements (processes, practices, communities, micro and macro systems) possess many features of complex adaptive systems. We later explicate the relevance of complexity theory in analyzing three issues in higher education: teaching and learning, students' engagement and game based learning. Although very helpful in thorough understanding of the educational elements, we believe that it will be mostly useful only as a descriptive tool and also in undermining and putting in questions the simple linear predictable concepts existing in educational research. As this theory penetrated in educational research from mathematics and physics, it can certainly help in finding mathematical models of some educational complex systems.

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