

## COMPLEX APPROACHES FOR EDUCATION IN BRAZIL

**Patrícia A. Morita Sakowski**

Researcher and Chief of the Planning and Institutional Articulation Advisory Board (Aspla/Ipea).

**Marina H. Tóvolli**

Research Assistant at Ipea.

The idea that education systems can be seen as complex systems is based on the argument that learning, teaching, cognition, and education are phenomena resulting from interactions between the heterogeneous agents composing such systems: students, teachers, and parents, in the micro sphere; government institutions, network of schools, and universities, in the macro sphere. The interactions of these agents between themselves and with the system as a whole are characterized by feedback and adaptation, by which both agents and systems evolve.

Given the complex nature of education systems, new approaches seem relevant, and even necessary, if we consider that traditional methods are often not capable of capturing the dynamics of these systems, which are characterized by multiple causality and non-linearity.

In this context, the complex systems approach presents the potential to contribute particularly with *i)* overcoming a mechanistic view, towards a more holistic view of education; *ii)* a better comprehension of the system's dynamics, the simulation of different scenarios, and the "communication of theories", through computational modeling; and with *iii)* the identification of trends and leverage points, by means of association methods, such as machine learning, and of network analysis.

This paper aims to identify what has been done in Brazil regarding the complex system approach in education, and to bring to discussion the potential benefits of this perspective to education in the country. Firstly, the main concepts that have marked the theoretical thought of complexity in Brazil are presented. Then, applications of complex systems' methods and methodologies in education in the country are introduced, such as Agent-Based Modeling, Network Analysis, Intelligent Tutoring Systems, Educational Data Mining, and Learning Analytics, among others.

From the identified studies and research in the country, some insights of the complex system approach to education are brought up. First, teaching complexity concepts to students and educators, and familiarizing stakeholders with its terms and methodologies might be important as a way to counteract a deterministic and centralized thought tendency, and to improve educational research. Second, the emphasis on a trans-disciplinary curriculum, and on interdisciplinary analyses might promote effective learning, and might help tackle the complex nature of education systems, respectively.

A third insight is that recognizing and incorporating students' heterogeneity in educational practice and research is crucial. Fourth, computational modeling and simulation are powerful tools to teach complex concepts, to better understand underlying mechanisms of the observed phenomena, and to provide information that facilitate political decision-making. Fifth, network analysis can be employed for promoting system's resilience, identifying key nodes, and promoting information flow.

Finally, personalized learning is emphasized as an important way, not only to recognize, but also to incorporate students' heterogeneities in the educational practice; to improve educational performance; to promote cost efficiency, through educational productivity and organizational optimization; and to accelerate educational innovation. Personalized learning might be a good opportunity not only to help develop human capital, but mainly to diminish educational inequalities in Brazil.