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COMMENTARY

Developing systemic theories requires formal methods

Fernand Gobet*

Centre for the Study of Expertise, Brunel University, Uxbridge, UK

Ziegler and Phillipson (Z&P) advance an interesting and ambitious proposal, whereby current analytical/mechanistic theories of gifted education are replaced by systemic theories. In this commentary, I focus on the pros and cons of using systemic theories. I argue that Z&P's proposal both goes too far and not far enough. The future of gifted education depends not on whether theories are mechanistic or systemic, but on whether these theories can explain the phenomena under study. In particular, there is a need for more precise theories expressed formally, either mathematically or computationally.

By proposing a radical rejection of the classic method in science, Z&P's proposal goes too far. There is no doubt that the standard analytic and mechanistic approach of science has led to tremendous advances in our understanding of natural and artificial phenomena. Examples abound from physics, biology and psychology, to mention just a few. Ever since von Bertalanffy's classical work on general systems theory in the 1920s (Von Bertalanffy, 1973), scientists have attempted to apply systemic ideas to natural and social systems. While interesting results have been obtained with the systemic approach, I think it is fair to state that, broadly speaking, its heuristic power has been inferior to that of the classical approach. A good example is offered by the systemic approach in psychotherapy (Böszörményi-Nagy & Framo, 1965; Watzlawick, Beavin, & Jackson, 1967), which started in the mid-1950s. In spite of great promises and some indisputable successes, several reviews have shown systemic psychotherapy to be less effective than cognitive behavioral therapies, which are essentially analytical and mechanistic in nature (e.g., Grawe, Donati, & Bernauer, 1994; INSERM, 2004).

At the same time, and paradoxically, Z&P's proposal does not go far enough. Complex systems *are* complex! Rigorously implementing systemic methods requires more than just theorizing about the relations of a few components of a system and their environment. It requires a careful analysis of *all* the components, systems, subsystems and relations involved. This is colossal work. Because of the postulated nonlinearities (e.g., phase transitions, chaotic behaviour, positive feedback loops), ignoring a single component or relation might have the consequence of totally mispredicting the behaviour of the system.

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*Email: fernand.gobet@brunel.ac.uk

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Consider the example of chess world champion Bobby Fischer discussed by Z&P. When describing the "Fischer system", they mention Fischer, his mother, sponsors and chess grandmasters. Granted, this example was not meant to be exhaustive. However, it is clearly an oversimplification. At the least, the system of young Bobby Fischer should include his elder sister, his coach Jack Collins, his fellow high school students and chess players of various ages. It should also include the relations between these individuals. Changes in some of these relations might have had crucial consequences for Fischer's development: a more directive mother might have interfered with Fischer's interest for chess and different friends in high school might have diverted Fischer's attention to other activities. Again, because of the nonlinearities postulated by systems theory, any of these could have had considerable impact on Fischer's chess career, and it is not possible to ignore them *a priori*. One could argue that at least some inanimate objects should be included in the system as well. In Fischer's case, he spent an inordinate amount of time studying chess books, and there is no doubt that some of them must have affected his development particularly strongly.

As should be evident by now, describing a system is extremely hard. In fact, assuming a "flat" system of N components – that is, ignoring a possible hierarchy of subsystems – and assuming that a link from component A to component B is different to a link from component B to component A already implies N × (N-1) relations. And this is a vast oversimplification, as diverse types of relations must be considered as well (affective, cognitive, motivational, etc.). In addition, these relations will change as a function of time and will be the source and object of feedback loops, either positive or negative. This raises at least two issues. First, how is it possible to collect all this information? And, second, how is it possible to process all this information in a meaningful way and without oversimplifying matters?

Considering the practical difficulties in collecting all the relevant information, it is understandable that Z&P never describe a system in its full complexity. In fact, it could be argued that their account is often analytic, focusing only on the aspects of a system that seem important, either intuitively or theoretically, and ignoring many aspects that could in principle matter. Given the known limits of human cognition, it is not surprising that systems are simplified and approximations made. For example, when Z&P talk about the "environment" rather than discussing every component and relation of this environment in detail, they take advantage of the hierarchical and decomposable structure of most natural and human-made environments, which is a powerful way to simplify the phenomena under study (Simon, 1969). Simplifications of this sort are acceptable because natural and human systems tend to be homeostatic and robust to perturbations – a fact that is all too well known in therapeutic settings where change is difficult to induce.

Mechanistic analyses of systems can often be useful approximations to the full complexity of these systems, which cannot realistically be tackled except for simplified textbook cases. Indeed, there are many current examples of scientific domains where the boundary between analytical and systemic approaches is very fuzzy indeed. A good example is offered by network theory (Newman, Barabasi, & Watts, 2006), which is the study of systems *par excellence*. Thus, rather than opposing analytic and systemic approaches, it is more fruitful to see them as complementary approaches.

Von Bertalanffy (1973, pp. 84–86) warns us from the dangers of using analogies, as opposed to explanations, to describe phenomena. He also argues that systemic theories can be expressed unambiguously and exactly only using mathematics. I agree, with the qualification that we now have other precise formalisms, most notably those offered by computer languages. A systemic theory of gifted education would be truly useful only when it is expressed formally and in enough detail to allow its predictions to be tested against empirical data. Given the complexity of the phenomena under study – number of variables and interactions involved, dynamic character of the data and presence of non-linear effects – computational modelling offers an ideal formalism for developing such theories (Gobet, Chassy, & Bilalić, 2011; Lane & Gobet, 2003).

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