# Applying complexity theory: A review to inform evaluation design

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ABSTRACT

Complexity theory has increasingly been discussed and applied within evaluation literature over the past decade. This article reviews the discussion and use of complexity theory within academic journal literature. The aim is to identify the issues to be considered when applying complexity theory to evaluation. Reviewing 46 articles, two groups of themes are identified. The first group considers implications of applying complexity theory concepts for defining evaluation purpose, scope and units of analysis. The second group of themes consider methodology and method. Results provide a starting point for a configuration of an evaluation approach consistent with complexity theory, whilst also identifying a number of design considerations to be resolved within evaluation planning.

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Over the last decade, an increasing literature has considered the implications of complexity theory or the theory of Complex Adaptive Systems (CAS) perspectives in development, health and social service policy, implementation and evaluation (Barnes, Matka, & Sullivan, 2003; Forss, Marra, & Schwartz, 2011; Haynes, 2008; Patton, 2011; Plsek & Greenhalgh, 2001; Sanderson, 2000, 2009; Stern et al., 2012; Vincent, 2012). Complexity theory is not a single coherent body of thought. Whilst complex interventions are often considered to be those with multiple objectives, strategies and components, implemented across multiple sites by multiple actors, the use of complexity in this paper refers to understanding the social systems within which interventions are implemented as complex (Shiell, Hawe, & Gold, 2008). This is what Byrne refers to as a 'complexity theory frame of reference' (2011, p. 12). A focus on the complexity of systems implies that apparently simple interventions, as well as complicated interventions, may be candidates for evaluation from a complexity perspective.

The basics of a complexity theory frame of reference are now well described in multiple publications (Byrne & Callaghan, 2014; Eppel, Matheson, & Walton, 2011; Patton, 2011; Rickles, Hawe, & Shiell, 2007; Room, 2011). Briefly, a complex system is comprised of multiple interacting actors, objects and processes defined as a system based on interest or function (Gare, 2000). Complex systems are nested, which means that some elements of a complex system may themselves be complex systems, or some elements

shared between multiple complex systems (Byrne & Callaghan, 2014). An example could be viewing a school as a complex system, interacting with other complex systems of households, communities and the wider education sector. The interaction of components in a complex system gives rise of 'emergent' properties, which cannot be understood by examining the individual system components (Goldstein, 1999). Instead to understand the emergent phenomenon, the system from which it emerged must be understood as a whole (Anderson, Crabtree, Steele, & McDaniel, 2005), including identifying both the elements within a system and their interaction over time. The interactions within a complex system are non-linear, with the implication that change in once component of the system may have a negligible or large effect on the system as a whole (Byrne & Callaghan, 2014). Non-linearity also means that small differences between systems may, over time, lead to quite different emergent whole system properties (Room, 2011). While schools may appear similar, the education results might be quite different. The implication of non-linear relationships is a difficulty in predicting the type and scale of system adaptations to interventions (Morçöl, 2012). The system is open to feedback from the wider environment it is operating within, meaning that systems may differ between time, social and geographic contexts (Room, 2011).

A complex system may show stability of emergent properties over time, with change suggesting a system has moved from one 'attractor state' to another. When the attractor state of a system changes, at the point of change, there are a number of possible attractor states the system could move to, within a 'phase space' (Capra, 2005; Room, 2011). While it is difficult to predict if and how a system will change in response to interventions,

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one target may be to understand the phase space of possible attractor states. For example, a change of government administration will often bring with it a change in ideology, which will in turn define the range of intervention options available for responding.

Again using schools as an example, evidence of unhealthy diets of children within schools impacting upon education achievement may be addressed by focussing on individual student behaviour or the school food environment. The degree to which the school environment is regulated, such as allowing or banning competitive and less healthy food options, will be partly determined by the perceived role of state versus market held by decision makers (Fleischhacker, 2007; Walton, Signal, & Thomson, 2013). However, previous decisions that may limit government action in regulating products, such as international trade agreements, will also play a role in defining possible interventions and hence the phase space of the school health system. The potentially unintended impacts of outcomes from one complex system (e.g. trade) on other complex systems (e.g. schools) results from the open boundaries of systems.

There are several challenges for evaluation implied by the understanding of complex systems described above. To summarise, the challenges posed by complex social systems for evaluation relate to uncertainty in the nature and timing of impacts arising from interventions, due to the non-linear interactions within complex systems and the 'emergent' nature of system outcomes (Dyson & Todd, 2010). There are also likely to be differing values and valuation of outcomes from actors across different parts of a complex system, making judgements of 'what worked' contested (Barnes et al., 2003). Due to the open boundaries of complex systems, there are always multiple interventions operating and interacting, creating difficulties identifying the effects of one intervention over another (Schwartz & Garcia, 2011).

Across the existing complexity informed literature, there is little consensus regarding what the key characteristics of a complexity informed policy or programme evaluation approach should be. Questions relating to: the purpose of evaluation; how evaluation questions are defined; which concepts from complexity theory are most relevant; and broad evaluation design principles need to be considered before looking at detailed method considerations. To advance consideration of these broad evaluation design considerations, this paper reviews both practical examples and theoretical discussion of evaluation approaches using a complexity theory frame of reference. The aim of the review is to identify themes to be considered in applying a complexity frame of reference to evaluation.

## 1. Methods

This study provides a narrative thematic review of identified academic journal literature (Dixon-Woods, Agarwal, Jones, Young, & Sutton, 2005; Mays, Pope, & Popay, 2005) related to complexity theory and evaluation. This review draws upon 46 articles in peer-reviewed journals identified from a search of bibliographic databases (including Scopus, Web of Knowledge, Social Service Abstracts, Sociological abstracts), limited to English language. Search terms were: complexity theory or complex adaptive system or CAS or soft system or eco* system; and policy eval* or prog* eval* or policy analysis or formative eval* or process eval* or outcome eval* or impact eval* or context eval*. This search identified 214 articles. Upon review of titles and keywords, 76 articles were selected for full review. Abstracts of papers citing these 76 articles were also reviewed for inclusion. In addition, reviewers of an earlier draft of this manuscript suggested a number of journal and articles for potential inclusion, which were hand searched. Forty-six articles were included in the full review. The most common

reasons for exclusion were: no discussion of evaluation methods; and not explicitly informed by complexity theory or a related systems theory.

As with complex systems themselves, the boundaries of the relevant literature are open and boundary judgements can always be contested. Search terms were selected to focus attention on articles explicitly identifying with complexity theory or CAS, rather than wider application of 'systems thinking'. The search terms also limited articles to those with an evaluation component, rather than more general policy, organisational or social science focus. Within the focus on complexity theory, an overlap between complexity and certain system theory fields is acknowledged (Midgley, 2008; Richardson, Gregory, & Midgley, 2007). For this reason, two 'systems' rather than complexity terms were included in the search strategy. Soft systems and ecological systems were considered terms referring to specific systems approaches, but also used in a broader way to distinguish from 'hard' systems theories (Maani & Cavana, 2000). Inclusion of these two terms doubled articles identified. Despite this approach, search results indicate that much of the literature informed by social-ecological models in health promotion and psychology, or systems informed operational research, has been excluded but may usefully contribute ideas to a complexity informed evaluation practice. Other terms relevant to complexity theory, such as 'context', were trialled but captured many articles well outside complexity and systems fields.

A feature of evaluation literature is the large volume of work published in books, conference proceedings or project reports. These are obviously not captured in this review, limited to peer-reviewed journal articles. With a focus restricted to peer-reviewed journals and explicit reference to both complexity and evaluation, there is no claim that the current review provides a definitive statement of the issues and methods associated with complexity theory in evaluation practice. However, the aim of the review is to identify common themes in the application of complexity theory, and not to provide a definitive 'state of play'.

Notes from each paper were made under the following headings: where has complexity theory been applied to policy/programme evaluation; what design and methods are associated with complexity theory; what are reported advantages/limitations of design and methods; if an opinion or theoretical paper, what are the suggested advantages or limitations of methods; what assumptions are being made about the nature of interventions; and what (if any) impacts on the policy process are discussed? The notes grouped under each question were compared to identify what the characteristics of a complexity informed evaluation approach are, when and where such an approach is appropriate, and implications for the policy process in which the approach is applied.

Twenty-three of the 46 papers were theoretical or opinion in nature, while 23 were focussed on describing or reflecting upon application of methods to a particular policy or programme. Table 1 shows the distribution of papers by year. It can be seen that the volume of peer-reviewed journal publications that consider a complexity theory frame of reference increased from

**Table 1**
Publication year of articles included in review.

| Year of publication | Number |
| --- | --- |
| 2012–2013 | 11 |
| 2010–2011 | 13 |
| 2008–2009 | 11 |
| 2006–2007 | 6 |
| ≤2005 | 5 |