

# Reengineering the management of Educational change in the light of chaos theory?

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## *Abstract*

*The insights of chaos theory have proven useful for conceptualizing social sciences and human social change. This paper examines the question of indeterminism and its implications for a new relationship between management, change and education. The popular management approaches to deal with change in educational organization are found to be paradigmatic and follow a linear sequence. In order to show the importance of reengineering the relationship between management, change and education in the light of chaos theory we addressed three questions: a) what is chaos theory?, b) how change is happen in management of education?, c) how to reengineering the management of educational change in the light of chaos theory? We utilized an analytical approach and study the previous research, arguments and literatures in this field. The results indicated that due to the universe is a chaotic place (uncertainty and unpredictability) therefore, education managers and principles living in an uncertain environment. Education is connected to the rest universe and as such is fully subject to the chaos that naturally exists in reality.*

**Key Concepts:** *Chaos theory, education, management, school principles*

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## **Introduction**

The explosion of scientific interest in chaos and nonlinear dynamics has brought with it a number of attempts to draw broad implications for areas usually considered far removed from the physical sciences. In other words, chaos theory arguments are general enough to apply to any type of entity, including individuals, groups, and organizations, and therefore they are relevant to a large domain of social science problems. Young (1991a, 1991b) asserts that chaos theory challenges many of modern science's cherished ideals: predictability, causality, formal deductive models, reductionism, and generalization. He argues that chaos theory affirms what many social scientists have argued for the better part of this century, namely that "the mission of social science changes from a quest for a stable codification of social laws to a more intersubjective and political endeavor in which human choice is used to shape and to elicit the knowledge process" (Young 1991a:328). As a result, this paper concludes with claims about the study of management of change in education for which chaos theory provides new theoretical arguments. We address three questions as follows:

- 1. What is the chaos theory?**
- 2. How change happens in management of education?**
- 3. How to reengineer the management of educational change in the light of chaos theory?**

Indeed, just as there are many applications of nonlinear dynamics in physics, engineering and biology, education management theory has been transforming rapidly with the nonlinear influence. It would be correct to reengineer the relationship between management, change and education and call chaos theory in education management as a new paradigm in education thought. Nonlinear theory introduces new concepts to management for understanding change, new questions that can be asked, and offers new explanations for phenomena. To find out more and answer the paper questions in the following firstly, we need to discuss the principles of chaos theory and nature of change and outcome it has for management of education.

## 1-What is the chaos theory?

It is assumed that the universe is a chaotic place, full of uncertainty and it can be difficult to predict exactly what is going to happen at any given time be it the present or the far future. Scientists and mathematicians have developed chaos theory to explain this phenomenon. Chaos literally means disorder, confusion, unruliness and anarchy. Synoptic view of contemporary society--the postmodern world--hardly does justice to its immense social transformation. Some authors describe it as a post-industrial society (Touraine, 1974), the "second great divide in human history" (Toffler, 1970). Postmodernists (e.g. Harvey, 1989; Smart, 1993) place importance on the fragmentary character of our society, while others (Toffler & Toffler, 2006, Mehralizadeh, 2005, Brown & Lauder 2001, Hirst, and Thompson, 1999) emphasize the trend of globalization, and regional unification in some spheres of human life. "Chaos theory" is the popular term used to describe a novel, quite revolutionary approach to a wide range of mathematical, pure science, and applied science fields. Other people prefer the terms "complexity theory" or "dynamic systems theory." It purports to be a "new paradigm," that is, a comprehensive framework to guide and evaluate research and analysis that transcends the limitations of conventional ("normal") science.

Chaos has been contemplated by mankind for several millennia. A modern view of chaos theory was written by Gollub and Solomon (1996). They wrote (282), "A chaotic system is defined as one that shows sensitivity to initial conditions. That is, any uncertainty in the initial state of the given system, no matter how small, will lead to rapidly growing errors in any effort to predict the future behavior...In other words, the system is chaotic. Its behavior can be predicted only if the initial conditions are known to an infinite degree of accuracy, which is impossible." It is easy to see from this description that all work, be it professional or not, is subject to the whims of chaos. Any one in public service, be it a doctor or a cashier at Quality Dairy, deals with uncertainty while dealing with the public. It is impossible to predict with certain accuracy what is going to happen next. Even less public driven jobs have this uncertainty. The long term is even worse. How can any given action be used to explain why something happens later?

Sometimes good guesses can be made. Still, it is difficult in to prove causality in most cases. There are usually several alternate explanations for every occurrence.

Most people who have heard of Chaos theory associate it with the idea that tiny disturbances can cause enormous long-term differences. In the movie Jurassic Park, for example, the actor Jeff Goldblum waxed manic about the "butterfly effect," the idea that a butterfly flapping its wings could set in motion a sequence of self-reinforcing events that would ultimately result in a hurricane on the other side of the world. While within the realm of (distant) possibility, this misleading image has had an unfortunate effect, reducing Chaos theory as conceived by most people into a generic cliché for "the world's just a big, unpredictable mess." One often hears pundits invoking chaos theory to complain about frustrations with daily life, but that really does a disservice to the task of bringing the important insights of chaos theory to a wider audience.

Harrison (1998) in his book titled as "Chaos with Making a New Science" discussed the properties that all chaotic systems share. These include:

- Sensitive Dependence on Initial Conditions.
- The trajectory never repeats.
- They are nonlinear.
- The transition to chaos is preceded by infinite levels of bifurcation.
  - The infinite bifurcations preceding the transition to chaos are characterized by the Feigenbaum number.
  - Fractional dimensionality.
  - A Lyapunov plot of the distance between trajectories versus time will exhibit a straight line.
  - The initial points of the first return map always lie above a line making an angle of 45 degrees with the horizontal.

Thus, hidden in the apparent disorganisation is a great deal of structure.

The fundamental lesson of chaos theory is that the behavior of a wide range of "dynamic systems" (e.g., the atmosphere, the solar system, people behavior and organization management) is extremely sensitive to minute fluxes in initial conditions, thus making it virtually impossible to obtain accurate medium- and long-term predictions.

## **2- How change is happen in management of education?**

For more than one hundred years, paradoxically, education has been pointed to as the root of society's problems and hoped for as the panacea for social change and prosperity. As such, education is constantly undergoing change and reform to improve. Here we are face with three vital questions for educators as: what is nature of change? How it is happens? And what is the sound way of dealing with change in education organization or school?

With reviewing the literature on the nature of change in education and school, Fullan (1991) makes a number of key points. He states that the process of change is "detailed and snarled" with confounding variables. In other words the process is not linear, it feeds back on itself. The process is dependent on who initiates the change. The process is not easily demarcated in terms of time. This suggests that change should be viewed as a process not an event (Fullan and Park, 1981).

In response to how change is happens in management there are two methods of analysis as quantitative (planned change) and qualitative (ongoing change) approach to change in an organization. Typically the objective is to maximize the collective efforts of all people involved in the change and minimize the risk of failure of implementing the change. Many technical disciplines (for example Information technology) have developed similar approaches to formally control the process of making changes to environments. There are many schools of thoughts and tools that are related to change management. Most of them converge into three principles: The constructivist paradigm, the systems approach and the quantum principle. (From Wikipedia 2007).

The constructivist principle believes that the map is not the territory. Human beings create reality through language – this is what we call mental maps. Our mental maps are a product of the individual life experiences and are constantly reinforced by unconscious filters determining the information we process. No two mental maps are identical. Communication between people can be enhanced when people acknowledge this principle and try to explore other people's maps. The systemic principle focused on the life and mind as systemic processes. Have you ever thought about why a flock of birds can instantly change its direction although biologists have found out that the reaction time of the individual birds is much quicker than any signal that could potentially pass through the group? Have you wondered why the stock market skyrockets one day and plunges another day? Emerging evidence from complexity science indicates that large systems show a different behavior than their single parts. The quantum principles argue that we are living in a field which is a whole. Most of our day-to-day assumptions are still based on classical Newtonian mechanics, which usually are applied in the work with organizations. For example, most people would assume that if A is true, B is false. We base our work on quantum mechanics which teaches us that if A is true, B is equally true, and that A could not exist without B. Observers (or consultants, or leaders) are always part of a field, which they influence but by which they are influenced them instantly.

Change management can be either 'reactive', in which case management is responding to changes in the macro environment (that is, the source of the change is external), or proactive, in which case management is initiating the change in order to achieve a desired goal (that is, the source of the change is internal). Change management can be conducted on a continuous basis, on a regular schedule (such as an annual review), or when deemed necessary on a program-by-program basis.

Change in education management may be approached from a number of angles and applied to numerous organizational processes. Its most common uses are in information technology management, strategic management, and process management. To be effective, change management should be multi-disciplinary, touching all aspects of the organization. However, at its core,

implementing new procedures, technologies, and overcoming resistance to change are fundamentally human resource management issues. Historically, education change is often addressed from an ideological perspective ( Apple and Weis, 1983, Dewey, 1916, Ernest, 1991, Kliebard, 1995). John Dewey began the change discussion from the public educator viewpoint suggesting that schools should provide access and enlightenment for all citizens. The reform movement changed focus during the World Wars and Cold War taking on a social meliorist viewpoint, this time asking educators to meet the scientific and employment needs of society and country.

However, after the clarifying the nature and knowing how it happens the important matter is that what is the sound way of dealing with change in education organization? Education organization is very complex and so far we have seen that there are a mix of models (information technology management, strategic management, and process management models) and approaches (constructivist paradigm, the systems approach or the quantum principle) are reactively or proactively followed by manager of education.

The constant in each of the above school change movements was dissatisfaction with the existing structure, its underlying ideology and the quality of student achievement it produced. The underlying belief of each movement was that the educational organization was not meeting some need. Besides the ideological viewpoint, school reform efforts can also be categorized according to their strategic perspectives. One can view change strategies in terms of scale – nation, state, district, school, department, teacher and student (Fullan, 1991). These strategies can be viewed from a market perspective – charters, vouchers, magnets and school choice (Chubb and Moe, 1990). One can view them from a systems perspective – organizational dynamics, total quality management, shared decision making and site-based management (Fiske, 1991). And, one can view these strategies from an educational perspective – curriculum reform, authentic assessment and professional development (Clifford and Guthrie, 1988; NCTM, 1989; Wiggins, 1989). No matter what perspective, ideology or strategy, the goal of all school reform efforts has been and is to change some aspect of the organization believing that the

change will lead to more efficient ways of producing quality education. This is the critical issue which needs to be considered as reengineering of the relationship between management, education and change in schools. (quoted from Wertheimer, and Zingo, 1998).

In fact, historical research on education in different parts of the world, suggests that educational change efforts have been tried again and again with little success and many disappointments. Most change efforts involve tinkering with innovations using the system approaches and linear system of analysis. But in spite of education managers efforts in planning of system its results are disappointing and sometime fundamentally different than what is expected. The critical question is what is going on with current approaches of education management analysis? Could complexity sciences provide insights into understanding the process of change in education? Answering this dilemma will require a different understanding of the process of change as suggested by Fullan (1991, 1995, and 1999). Since schools by their nature are complex, adaptive systems, therefore we need new conceptual frameworks to understand the dynamics of change from a complex adaptive systems perspective and suggest why schools remain the same and what is needed for change to occur. (Kosemetzky, 2000). This is a critical issue which we focus on it in the next question as reengineering of management of educational change.

### **3-How to reengineering the management of educational change in the light of chaos theory?**

As we have discussed above there are many applications of nonlinear dynamics in physics, engineering and biology, theories of education management have been transforming rapidly with the nonlinear influence. It would be correct to call chaos theory in education management as a new paradigm for reengineering the education management theory. Chaos theory introduces new concepts to management for understanding change, new questions that can be asked, and offers new explanations for change in education as phenomena.



If we are going to talk about reengineering of management, change and education we need to take into account the principles of chaos theory. These principles might be used to create such a guide to managers of education organizations, focusing on four conclusions drawn from applying complexity theory to education management framework to approaching change in organization:

1) All human complex changing systems are networks of personal relationships, in which the interactions between individual people sustain the dynamics of the system.

2) The effectiveness of any human complex changing system depends, not only on goals, objectives and education management systems, but even more on the quality of those relationships.

3) The key strange attractor driving human behavior is the mindset, the series of mental models, of any individual. While mindsets are purely individual, organizations and economies gain coherence as their members, through continuing interaction, share more and more elements of their mindsets.

4) To be most effective, education managers must demonstrate and encourage caring, meaningful relationships with all those in their personal networks, both inside and outside their organizations.

Based on theoretical and mathematical principles of chaos theory, we argue that the customary management theories of change based on the "prediction" and "control" of systems behavior are sometimes, if not usually, unobtainable. Specifically, chaos theory shows how it is possible for nearly identical entities embedded in identical environments to exhibit radically different behaviors, even when the underlying systems are extremely simple and completely deterministic. Wertheimer, and Zingo (1998) in their study focused at school reform in an urban school district in Denmark's applied Chaos Theory, as developed in mathematics and science, to educational organizations; and present a conceptual model for school reform consistent with this theory as described in table 1.

**Table 1:** Assumptions map of application chaos theory in education (Wertheimer, and Zingo, 1998)

<b>Key words</b>	<b>Assumptions</b>	<b>Educational /schools conditions</b>
Patterns	When a catalyst is applied to a system, noise – local disorder, turbulence, and fluctuations – becomes apparent. This noise, although seemingly random, contains patterns that, when analyzed, provide insight into the system’s complexity. In human social systems, noise is seen as both a distraction and barrier to change.	Teachers, principles, staff parents and pupils
Initial conditions	The noise generated when applying a catalyst to complex systems is dependent on initial conditions.	In schools, these initial conditions pertain to the organization’s inherent culture and the staffs’ personal needs.
New patterns	The patterns found in the noise are similar at all levels of magnification. This self-similarity can be visualized by a fractal. Fractals are self-generating landscapes which are identical at all levels of magnification.	In educational organizations, the levels of magnification correspond to individuals, schools and districts.
Predictable and unpredictable behaviors.	The system is deterministic – predictable given exact information about initial conditions. Unless one has perfect knowledge about the system being acted on, minor differences in initial conditions can cause unpredictable behaviors.	Complexity of education system

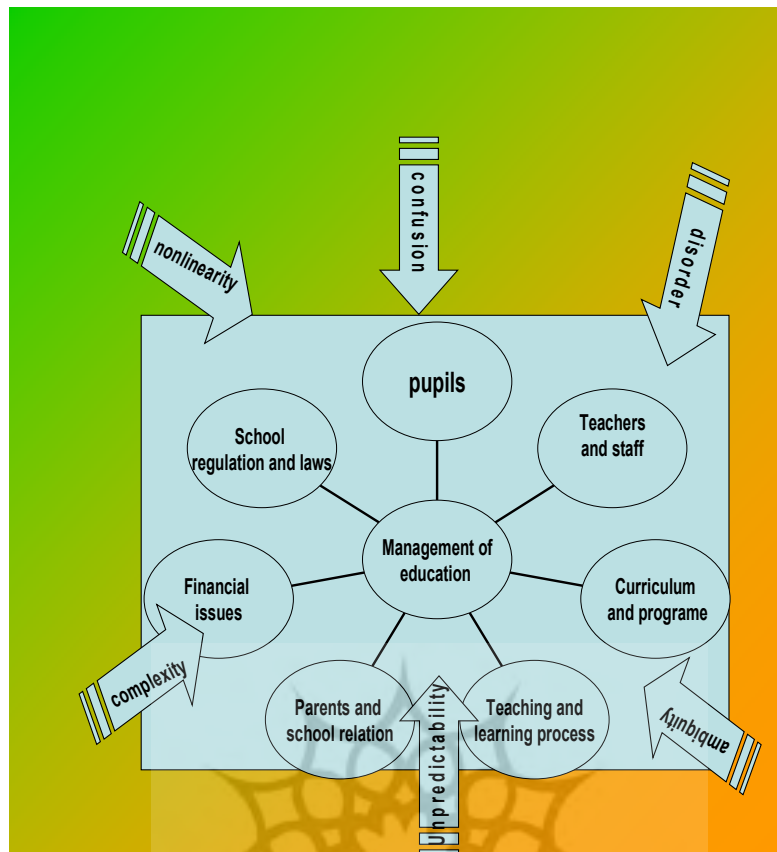
Wertheimer, and Zingo (1998) concluded that these assumptions map onto educational organizations and the assumptions that underlie chaos theory led us to believe that its application to educational reform is more than metaphor. Although they said that it is difficult to state that Chaos Theory is the essential model for conceptualizing organizational behavior. But they have identified a function that describes system behavior during school reform initiatives. they concluded that in at the

present time it is the unenviable position of suggesting that our application of Chaos Theory to school reform is more than metaphor and less than mathematical model. The same idea is mentioned by Lorenzen (2005) that chaos theory is highly relevant to the field of school teaching.

Lampert (1985) describes several good examples of the chaos in education. Lampert accurately describes the first form of educational uncertainty. She further makes it clear that not only do students add to uncertainty in the classroom, so does the teacher. The teacher is an agent of chaos in the classroom. Every decision a teacher makes leads to an infinite number of possible new class scenarios. Of all the people in the room, the teacher is the most chaotic element because the teacher makes the decisions that drive many of the reactions of the other agents in the room. And, the failure to make a decision, in and of itself, is a decision and this also contributes to chaos (quoted from Lorenzen, 2005).

The connection between teaching and learning is also tenuous at best, which creates further uncertainty. Wrote Buchmann and Floden (2013), "Students' behavioral, emotional, and cognitive responses are affected by the contexts in which they live, of which school is only one (albeit, for some, an important one). The child whose creative writing suddenly improves may have been inspired by a parent's comment, not the teacher's language arts unit. The student who has never completed her homework can turn in a carefully composed essay. The lesson that has always excited students can miscarry with this year's class. Although experienced teachers have some sense of how students will react to a lesson or assignment, some uncertainty remains." (Quote from Lorenzen, 2005).

Education manager in general and school principal in particular in their planning and relation with pupils, teachers, teaching, learning, and society are forced to bear in mind the chaos condition of each action.(see figure 1).

**Figure 1:** Dimension of change in management of education

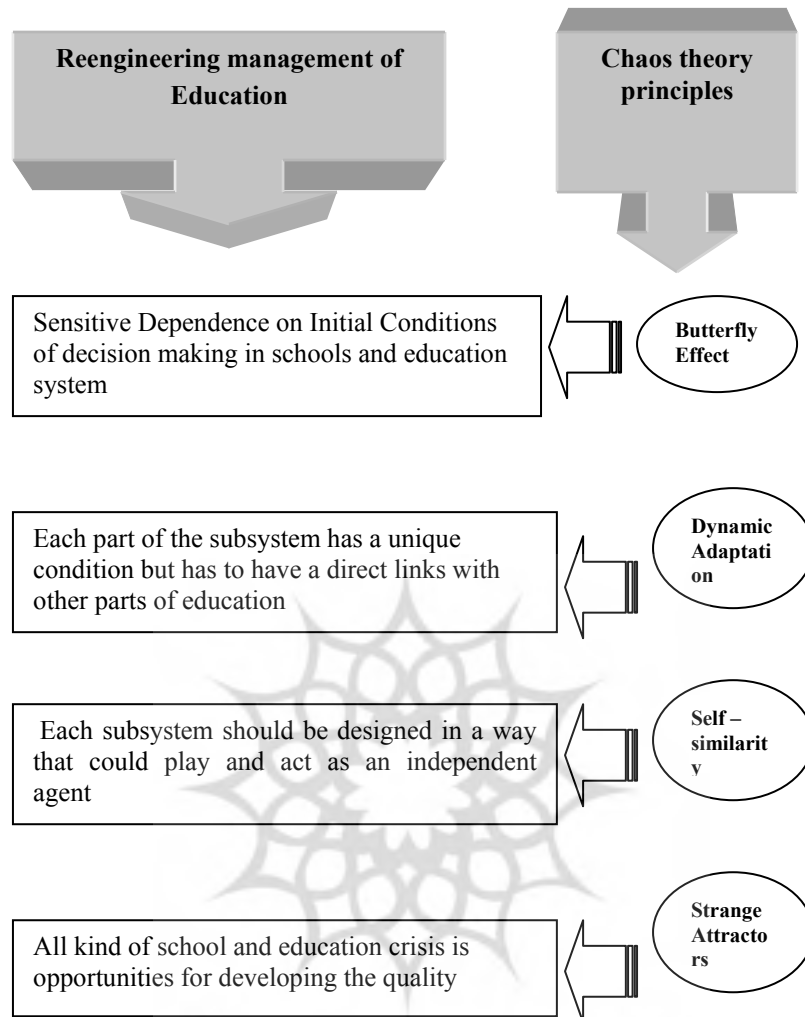
The initial, and all subsequent conditions, are not known to an infinite degree of accuracy with any given student or class. Hence, chaos must ensue. This chaos can be seen in two ways. First, every school day is uncertain until it occurs. Despite the best developed principle plans and school management techniques, the school will be subject to an infinite number of possible occurrences. Second, it is difficult to see the connection between management, change, teaching and learning. How can a school principle or teacher know what is taught is best for the student's learning in the short and long terms. Sometimes, good assumptions can be made by studying students. Therefore, all students are subject to a variety of chaos in their lives at school and in the world. Which effect

beyond teaching could have effected the result? Therefore school principles and educators will always deal with uncertainty in both how and what they should teach. (Lorenzen, 2005).

As figure 2 shows we could use the chaos theory to reengineering change in management of education. Here we have focused on four principles of chaos theory as batterfly effect, dynamic adaptation, self – similarity and strange attractors and their equivalent activity should be taken into action by school principals and education managers.



**Figure 2:** reengineering the management of educational change in the light of chaos theory



While chaos may cause uncertainty but it also creates the opportunities for school principles that create hope and change. School principles and teachers need to prepare for chaos and accept uncertainty as a natural condition. As Lorenzen, (2005)

stated, principles and teachers can not control the entire universe. But they can make impacts on the small slice of the universe they reside in des

pite all the chaos evident in it.

### **Conclusion**

In summary, chaos theory has had as dramatic impact in the social sciences and education management. It looking at school society as a complex adaptive system in which individuals come together to form entities at many scales work units or families, teachers, pupils, organizations, markets or governments, economies, social ecosystems. As a result, it seems logical to assume that the principles of chaos theory should be able to help education managers and principles, in organizations from the most mechanical bureaucracies to the most organic, new organizations, understand how to be more effective in dealing with change in school. Chaos-based ideas have been very influential, however, both for empirical and for theoretical wings of research. They have forced us to push our data sets harder in searching for time-series structure. They have reminded us of the possibility that some ostensibly well-understood theoretical models may contain a hidden wealth of rich, dynamic structure. In the light of chaos theory the education manager is considered as a number of trajectories within differing dimensionalities that depend on the level of detail or description that we are looking at.

Finally, in reengineering the relationship between management, change and education in the light of chaos theory, it remind us how modest we should be in our exploits to predict and make policy decisions for small (school) and large (education system) scale social systems. As mentioned by researchers, if we map the assumptions of chaos theory onto educational organizations, they provide a foundation for articulating the nature of change and its determinants. Using the assumptions that underlie chaos theory led us to believe that its application to educational change is more than metaphor.

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