The Application of Chaos/Complexity Theory in Classroom Teaching, Task Design and Lesson Planning

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ABSTRACT: Following the similarities of chaos/complexity theory in SLA introduced by some such as Larsen-Freeman (1997) and Finch (2004), an endeavor should be made to encapsulate the practical application of the characteristics of chaos/complexity theory in different aspects of language teaching. The purpose of this paper is thus twofold: first, it deals with characteristics of the chaos/complexity theory and the theoretical similarities in SLA; then, it introduces some practical application of the theory in classroom teaching, task designing and lesson planning. It is conclusively argued that the theoretical insights out of chaos/complexity theory have a dramatic impact on methodological choices, the design of tasks via finding ways to overcome the weaknesses in tasks and the design of lesson plans considering the unpredictability afterward.

Keywords: chaos/complexity theory; task designing; lesson planning.

INTRODUCTION

Going through the literature, one can find as Hall (1993, cited in Larsen-Freeman, 1977) states, science exists to explain the fundamental order underlying nature. The most precious explanations have taken the form of cause and effect linkages. As Finch (2004) puts, research into second language acquisition (SLA) has also shown a tendency to take its models from the physical sciences. For instance, approaches such as behaviorism, in the early part of the 20th century, were based on a cause-and-effect view of the universe that was particularly successful during the European industrial revolution. Although the new science of chaos/complexity theory has been considered as a major discovery in the physical sciences, some believe its effect on the more human disciplines will be as enormous (Waldrop, 1992). Larsen-Freeman (1997), for example, finds that the study of dynamic, complex nonlinear systems is meaningful in SLA as well.

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Chaos/complexity theory: Characteristics and similarities in SLA

In an attempt to find similarities between chaos/complexity theory and SLA, Larsen-Freeman (1997) points to 12 characteristics of the chaos/complexity theory as follows:

- Dynamic: changing over time, process rather than state.
- Complex: having many parts, constantly acting and interacting.
- Nonlinear: effect is disproportionate to the cause.
- Chaotic: a deep, coherent structure within apparent randomness.
- Unpredictable: cannot forecast future states.
- Sensitive to initial conditions: a tiny change can have a vast effect.
- Open: energy/information can flow in or out.
- Self-Organizing: a structure/pattern emerges as components interact.
- Feedback Sensitive: feedback is incorporated into behavior.

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- **Adaptive**: optimizes itself according to environment.
- **Strange Attractor**: global pattern but unpredictable details.
- **Fractal**: a pattern that repeats itself at different scales (e.g. a tree).
- Finch (2004) also explains some key concepts of complexity and systems theory and their relevance to language learning such as openness of system, connectivity, nonreducibility, emergent behavior and unpredictability and regularity. Some of the characteristics mentioned in light of SLA will be discussed as follows.

**Non linearity in SLA**

Although some studies such as information processing model state that acquisition of a language has a clear beginning and end state, and a somewhat linear path of development for each individual is predicted to go through highly similar stages in acquiring the L2, according to De Bot (2005a), there have also been a lot of studies that have not adhered to the linear view. They have shown that language acquisition, and language attrition are much more intricate, complex, and even unpredictable than a linear position would allow. Linguistic theories such as cognitive linguistics and functional linguistics, acquisition theories such as emergentism, and processing theories such as the competition model recognize that there are many interdependent variables, not only within the language system, but also within the social environment and the psychological make-up of an individual.

In Larsen-Freeman’s (1997) words, “Complex systems are also nonlinear A nonlinear system is one in which the effect is disproportionate to the cause. Conversely, in a linear system a cause of a particular strength results in an effect of equal strength”. This has been termed the “camel’s back” effect. A simple trigger, one which occurs all the time, might be enough on any given occasion to bring about a great convulsion in the system, or to throw the entire system into a chaotic state.

**Strange attractor in SLA**

According to De Bot (2008), the states of less variation are called attractor states. Attractor states can be recognized in first language development. For instance, the child's acquisition of one of the sub-systems of a language goes through various stages. According to De Bot (2005a), in dynamic systems, smaller systems are always part of greater systems, going from sub molecular particles to the universe, with the same dynamic principles operating at all levels. As they develop over time, dynamic sub-systems appear to settle in specific states, so-called attractor states, which are preferred but not necessarily predictable. Attractor states are by definition temporary and no fixed, but depending on the strength of the attraction. In line with language, De Bot et al. (2005b) state that for many L2 learners many sub-systems become stabilized before they have reached the target forms. Fossilization is a perfect example of an attractor state.

**Dynamicity in SLA**

Gleick (1987 cited in Larsen-Freeman, 1997) puts that one of the major principles of complexity theory is that complexity theory is the science of process rather than state, of becoming rather than being. Smith and Samuelson (2003) also believe that changing over time is an integrated property of a system. The dance metaphor is used to make clear that cognitive, social and environmental factors continuously interact, resulting in co-regulated interactions and the emergence of creative communicative behaviors. There seems to be much in common between language and complex nonlinear systems. This can have two usual interpretations. The first common meaning is that language can be described as a collection of static units, but their use in actual speech involves an active process (Larsen-Freeman, 1997). The other common meaning of ‘dynamic’ is equated with growth and change. Rutherford (1987, cited in Larsen-Freeman, 1997) suggests that an organism is a better metaphor for language than a machine, because machines are constructed, but organisms grow. Language, seen synchronically or diachronically, is undeniably dynamic (Larsen-Freeman, 1997). Moreover, as Larsen-Freeman (1997) puts it, languages undergo nonlinear changes diachronically. As Ellis (2007) states, an individual’s language system with its numerous sub-systems is in constant change and the system as a whole and the sub-systems will show a great deal of variation, that small differences between individuals at a given point of time may have a great effect and that there is no such thing as an end state.

**Complexity**

Van Lier (2004) argues that complexity science includes chaos theory, which looks at physical, biological, mental and social phenomena in a completely new way. Larsen-Freeman (1997) considers complexity as one of the characteristics of language. Language is complex and composed of many different subsystems which are all interdependent. Language system is a complex system in which sub-systems interact continuously with each other and with their environment. Therefore, language development can be seen as a non-linear process in which complexity is an emergent rather than a fixed property.
Connectivity

One of the basic characteristic of complex systems is that everything influences and is influenced by everything else. These mutually influential relationships are called “connectivities”. De Bot et al (2005a) state that all the components of a complex system are directly or indirectly connected. This new systems view of research focused on organization rather than isolation. Instead of dissecting the subject into parts and further examining these in isolation, it observed the organization of the interactions that held the parts together (Finch, 2002). Finch (2002) argues that human bodies as supra-organisms could be seen from this perspective as open systems which have ordered complexity, and continually receive input, and therefore do not conform to the second law of thermodynamics, which states that closed systems tend toward entropy. Larsen-Freeman (1997) also asserts that “Complete Interconnectedness” is one of the characteristics of dynamic systems. She goes on to explain that all variables are interrelated, and therefore changes in one variable will have an impact on all other variables that are part of the system. Consequently, complex systems cannot exist in isolation, but affect each other in a multitude of ways. In terms of the language classroom, everything occurring in the classroom can have impacts on everything else. The teacher’s use of competition as a motivator is an example of this concept. The teacher’s paying attention to just few students can have effects on other things such as other students’ motivation, learning and interaction.

Nonreducibility

According to Harris (1997, cited in Finch, 2004), a dynamic system cannot be understood by reducing it to its parts. This is a significant finding for applied linguists and language teachers, since it means that target language cannot be fully acquired by studying it in parts, whereas the practice for so long has been to divide the target language into components (grammar, syntax, morphology, pronunciation, etc.) and to teach these in isolation, on the assumption that the student will somehow put them all together to form language. Larsen-Freeman (1997) contends that even if we could identify and measure all of the factors in second language acquisition, complexity theory tells us that we would still be unable to predict the outcome of their combination.

Emergent behavior

According to Dornyei and Murphee (2003), groups have been found to have a life of their own – that is, individuals in groups behave differently from the way they do outside the group. Finch (2004) argues that complex systems often show surprising and unexpected behaviors that appear to be a property of the system as a whole, rather than of its components.

Unpredictability and regularity

Finch (2004) states systems exhibit unpredictability, along with patterns of regularity. Taking the analogy of the weather as a complex system, meteorologists are finding that whatever the level of sophistication of measurement, the outcomes of the complex interactions (connectivities) of the weather factors cannot be predicted with absolute certainty, so that it is not possible to predict that it will rain. In line with the unpredictability in language teaching, Cvetek (2005) discusses that every teacher knows that in spite of the best prepared lesson plan, it is impossible to predict what will happen at any given time in the lesson and thus prepare in advance what may be the best teaching decisions in that lesson. This is even much more evident for student teachers during their teaching practice in schools. Lacking the necessary knowledge and experience, many student teachers, when faced with the unpredictability and complexity of classroom teaching, report a feeling of increased anxiety and fear.

Butterfly effect in SLA

Butterfly effect is an offshoot of chaos/complexity theory. The analogy of a butterfly in the West Indies flapping its wings and causing a typhoon in Hong Kong is meant to demonstrate that minor connectivities in one location can contribute to exponentially increasing connectivities elsewhere, eventually causing major repercussions (Rea, 2003). Butterfly effect stresses that minor differences at the beginning may have dramatic consequences in the long run. Some minor changes may lead to huge effects, while major perturbations may be absorbed by the system without much change. De Bot et al (2007) talk about the butterfly effects in SLA. For instance, it has been repeatedly argued that a problem in one particular area of language learning affects other areas. Accordingly, the effect of phonemic coding difficulties may not be limited to reading and writing skills, but is likely to spread to the development of oral language, in both perception and production. Larsen-Freeman (1997) also deals with the butterfly effect. A small change in initial conditions can have huge implications for future behavior. In fact, the behavior of systems with different initial conditions, no matter how similar, diverges exponentially as time passes. A phenomenon known popularly as ‘the butterfly effect’ exemplifies this feature and underscores the interdependence of all the components in the system.
**Chaos/complexity theory and language classroom teaching**

Drawing a number of chaos/complexity parallels in the language class, Larsen-Freeman (1997) states that languages go through periods of chaos and order just like other living systems. Although Larsen-Freeman (1997) does not think that teaching and learning are physical sciences, she believes that a chaos/complexity theory lens helps us look at things from a new perspective. Regarding the similarities between complex nonlinear systems and SLA, Larsen-Freeman (1997) emphasizes that language learning is a dynamic, complex, open, self-organizing, feedback sensitive, and constrained by strange attractors. Larsen-Freeman (1997) believes that there are issues in SLA that can be illuminated by the chaos/complexity theory, for example, mechanisms of acquisition, definition of learning, the instability and stability of interlanguage, differential success, and the effect of instruction. She also suggests a number of potential contributions of chaos/complexity theory to various aspects of language and language acquisition. Van Lier (1996, cited in Finch, 2001) also considers the classroom as a complex system in which it is fruitless to search for casual relations. Van Lier (2004) also has added his interpretations from his ecological perspective to her suggestions. They argue that chaos/complexity theory:

1. Encourages a blurring of boundaries and dichotomies.
2. Warns against settling for simple solutions prematurely, as well as against rejecting contrasting viewpoints.
3. Provides some fresh light on SLA phenomenon.
4. Refocuses our attention in the light of emergent phenomena, foregrounding certain problems, and obviating others.
5. Discourages cause-effect-based theories.
6. Underscores the importance of details.
7. Reminds us to hold the whole and to find a unit of analysis that allows this.

To put in a nutshell, the dynamism of SLA is seen in the ever changing character of learners’ internal L2 grammars. It is complex because a multitude of interacting factors are involved in the SLA process. Larsen-Freeman (1997) concludes that the conceptualization of language as a fixed, static, atomistic entity is being challenged by one that is much more nonlinear, organic, and holistic. Moreover, the SLA process is open, that is, there is continuous input, and the interlanguage system is self-organizing. This means that there is restructuring in the interlanguage, the return to order. According to Larsen-Freeman (1997), despite the similarities among interlanguages of speakers with different L1s, they are constrained by the strange attractors of their L1s, which can affect more than the strange attractor of English. Another contribution of chaos/complexity theory in language teaching, Brigg (1992, cited in Reigel, 2005) states that feedback and iteration are dubbed the ‘heartbeat of chaos’. Feedback, whether positive or negative, changes the system. Positive feedback pushes systems to expand. It is the interplay of positive and negative feedback that gives the complete system its complexity. It is possible for language learners to receive positive feedback from their peers as well as from their instructors. To summarize the application of chaos/complexity theory in language teaching, we should outline what we can get from chaos /complexity theory put by Brown (2000) as a summary of the lessons put forward by Larsen-Freeman (1997). Here are what the researchers in SLA should take into account according to this outline:

a) Beware of false dichotomies, and look for complementary, inclusiveness, and interface.
b) Beware of linear, causal approaches to theorizing. SLA is so complex with so many interacting factors that we cannot assign a single cause for it,
c) Beware of overgeneralization, and pay attention to details; the smallest, apparently insignificant factor can turn out to be very important, but on the other hand, beware of reductionism in thinking.

**Chaos/complexity theory and language tasks**

Introducing FFCF, Kumai (1999) considers how chaos/complexity theory works for language tasks. FFCF stands for Framework, Freedom, Comparative Encounters, and Feedback Sensitivity. Framework stands for the rules of the activity. Freedom, on the other hand, represents how much latitude students are given, the chaotic side. Having both in an activity is a necessary but not sufficient condition to enter the edge of chaos. Comparative Encounters means having students interact with each other in order to find their relative fitness level; this can lead to higher overall fitness as the activity progresses. Finally, Feedback Sensitivity refers to having the activity designed in such a way that students must respond or react to feedback coming from others. FFCF proved to be useful in examining why some activities create sustained L2 use whereas others do not. In Kumai’s (1999) words, placing task-based language teaching under the tent of chaos/complexity theory is useful in that the results from other fields can be applied. For example, the concepts of fitness landscapes and the edge of chaos arose from studies of biology and artificial life (Kauffman, 1993). Chaos/complexity theory can...
provide new insight into the design of tasks and be helpful to find ways to overcome the weaknesses in tasks. Although task-based language teaching can be seen as “innovative” or even a “threat” (Ellis, 2003), using this theory to give it another theoretical underpinning can increase awareness of its practicality and effectiveness in mainstream language teaching.

**Chaos theory and lesson planning**

According to Cvetek (2007), language learners and future language teachers should plan for the complexity and unpredictability of the classroom. When planning their lessons, the teachers should become less concerned with detailed objectives and explicit results, and more with devising possible and probable classroom (lesson, activity) scenarios to which they can react. Thus, their lesson plans should contain less detailed descriptions of classroom activities and teaching procedures, and more alternative “strategic plans” that should serve as broad guidelines, based on which teachers can generate their own situation-specific procedures and classroom techniques. It is worth quoting Iannone’s (1995) metaphor in this regard: “Good teachers or even good curriculum designers are like jazz musicians responding and improvising to the critical points in their music. As they play, implicitly or explicitly, they recognize there is order in the disorder of their worlds”.

**CONCLUSION**

Chaos/complexity theory has the potential to contribute to our awareness about various aspects of language and language. As Sheila (2001) states, the theoretical insights out of chaos/complexity theory have a dramatic effect on our methodological choices. Then, in light of the choices teachers make, researchers have access to ever-evolving dynamics that help them better understand the complexities of the SLA process. As a result, theories are revised and the ensuing pedagogical suggestions once again impact instruction. Larsen-Freeman (1997) states that language as a complex system is dynamic, complex, nonlinear, chaotic, unpredictable, sensitive to initial conditions, open, self-organizing, feedback sensitive, adaptive, strange attractor and fractal. Finch (2004) also considers features such as openness of system, connectivity, nonreducibility, emergent behavior and unpredictability and regularity as those similar in chaos/complex systems and language. Language teachers should help language learners to accept complexity and unpredictability of the classroom as a natural condition and become, as Lorenzen (2002) states, “chaotic elements in the classroom”. So doing, we should accept complexity and unpredictability of our own teaching/learning environments not only by responding to problematic situations in novel and unpredictable ways but also by “chaotising” our classrooms according to the principles of chaos theory.

Chaos/complexity theory can also give us new insight into the design of tasks and help us find ways to overcome the weaknesses in tasks. It is also useful in designing lesson plans and the unpredictability afterward. Their lesson plans should contain less detailed descriptions of classroom activities and teaching procedures, and more alternative “strategic plans” that should serve as broad guidelines, based on which teachers can generate their own situation-specific procedures and classroom techniques.

**REFERENCES**


