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COMPLEXITY THEORY: IMPLICATIONS FOR SECOND LANGUAGE LEARNING

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ABSTRACT

This article first begins with a short history of chaos or complexity theory and illustrates the function of complexity systems such as city system, economic and financial systems, transport and population systems, ecological systems, etc. Secondly, stable and unstable states in the movements of the system are explained. In the following sections of the article, seven key concepts of complexity and systems theory such as non-reducibility, open systems, emergent behavior, connectivity, unpredictability and regularity, the avalanche effect, and equifinality are explored and their relevance to language learning is also explained. The article ends with two more issues: explaining some characteristics of classroom systems and their relevance to teaching and learning, and discussing some objections to such learning environments.

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INTRODUCTION

Chaos or complexity theory was first proposed in physical sciences and mathematics to explain the behavior of complex dynamic systems. The systems usually involve a large number of elements or agents, which interact and give rise to a different order of complexity at a higher level. The systems are dynamic because they are always changing, sometimes gradually, sometimes abruptly. Complex systems are open rather than closed; that is energy and matter can come into the system. Change in complex systems is often nonlinear, which means that the effect is not proportionate to the cause. The nonlinearity is attributed to the fact that such systems are sensitive to initial conditions, a characteristic popularly referred to as butterfly effect, whereby even the flapping of a single butterfly's wing in one part of the world can have an effect on a weather system in another. It is this sensitivity to initial conditions that makes complex systems chaotic—they can change in unpredictable ways (Freeman, 2012). A city can be considered as an example of a complex system since it composes of elements and agents such as people, places, routes and activities that interact in multiple and changing ways. For example, people live, shop and work in certain places as a result of family history, transport systems, economic and many other factors.

As a result of evolving these factors over time, the patterns of living also change. In response to changes, the city (seen as a system) self-organizes and adapts. The city system has non-linear dynamics and may display relatively sudden shifts in patterns of living. For example, global changes in economic activity may lead to empty warehouses and factories which combined with rising house prices, may lead to regeneration of the city center as the empty warehouses are converted into apartments for young single people. This new city center population requires new entertainment and leisure facilities and asks for changed public transport. Economic and financial systems, transport systems, population systems, ecological systems such as forest or an atoll, and neutral systems can be considered as other examples of complex systems. Similar processes of self-organization, adaptation and emergence can be seen in each of the very different systems, leading to the suggestion that complex systems theory can work as a 'supra-theory' (Baake 2003) with the same principles of system behavior and similar types of system change applicable to all systems, including those of concern to applied linguists. A complex dynamic system moves through a sequence of states or modes of behavior; some of these systems are quite stable states where the system maintains the same kind of behavior over some time; others are highly unstable, with the system changing rapidly from one state to another. "Attractor" is the name given to a stable state because it seems as if the system is attracted into this state. According to Van Lier "it is useful to regard the classroom as a complex system" (cited in

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Finch,2001), therefore in the following sections we explore some key concepts of complexity and systems theory and their relevance to language learning classrooms. Readers interested in reading more about the concepts considered here are referred to the excellent expositions of Waldrop (1992), Larsen-Freeman (1997), Byrne (1998) and Laszlo (2002).

Non reducibility

We cannot understand a complex, dynamic system (such as a classroom or a language) by reducing it to its parts. This is a significant finding for 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 such as grammar, syntax ,morphology. Pronunciation, etc. and to teach them in isolation, on the assumption that the student will somehow put them all together to form language (Harris, 1997, p.13; Miller & Ng, 1996, p.134). But according to Larsen-freeman ,”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” (1997, p.157).

Open systems

Like the second law of thermodynamics, the language classroom and its participants are open systems since they receive continuous input (linguistic, affective, social), and they produce continuous output. Any tendency to atrophy is balanced by these processes, which stir up the learning environment and keep the classroom in a state of creative complexity. It is precisely the openness of all these interacting systems that makes it impractical to test linguistic proficiency, since negative input in any of the areas (e.g. a death in the family, a car crash, the breaking up of a relationship) can have a significant detrimental effect on attitudes and language performance.

Emergent behavior

Complex systems show behaviors and characteristics that are different from the behaviors and characteristics of the parts or members. This property of the system is called emergence or emergent behavior. Showing surprising and unexpected behaviors appears to be one of the characteristics of the system as whole, rather than of its components. In isolation birds for instance move around as they wish, but when in a large group of birds, they somehow manage to act as if in one system, seemingly knowing when the whole flock is going to turn in any particular direction. This “emergent behavior” appears as a result of the connectivities (interactions) of the individual animals, and is a property of the whole system. In second language learning which is subject of this paper, it has been observed that the group dynamics of the language class differs from the characteristics of its participants. According to Dornyei & Murphey “ Groups have been found to have a life of their own- that is , individuals in group behave differently from the way they do outside the group”(2003,p.3). Concerning learning that occurs in the classroom, Complexity theory tells us that a climate of cooperative social interaction, full of linguistic affordances (Van Lier,2000:252) which are perceived and used as appropriate, “ produces new, elaborate, advanced psychological processes that are unavailable to the organism working in isolation” (Vygotsky,1986,p.61).

Connectivity

A main feature of complex systems is that everything influences and is influenced by everything else. That is, bilateral influential relationships called “connectivities” exists in complex systems. Complex systems affect each other in many ways, so they cannot exist in isolation. In case of language classroom, everything that occurs there impacts on everything else. Employing competition as a motivator is an example of this concept. Telling students that “the first group to finish is the winner” immediately implies that the other groups are losers, and that speed of acquisition or performance is an important criteria of language learning. Students place importance on winning, rather than on quality of work, and interactions between students and groups change correspondingly. At the end of the activity, everyone (including the winners) ceases work, since the goal of being first has been achieved by some of them (Kohn,1992.p.47). Shortly, we can consider emergent behavior as a source of creativity and innovation and which is unpredictable and amazing.

Unpredictability and regularity

Systems show unpredictability, along with patterns of regularity. Taking the analogy of the weather as a complex system, modern day sophisticated equipment allows forecasters to predict that it will rain in a given city on a given day. Meteorologists are finding, however, 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, even in the short term, to predict that it will rain in any given locality (e.g.a school playing ground). In other words, the weather forecast is always at best an approximation, based on probabilities. However, as Stein (1989) states, even these unpredictabilities show evidence of consistency:

“Even though the behavior of the system is unpredictable in detail, surprising regularities nevertheless exist; for many diverse systems, the transition from regular to chaotic behavior shows certain universal features, independent of the details of the system.....a given experiment may have many outcomes, a given problem may have many solutions, all nearly equivalent, near optimal, with none much better than the rest” (pp.xiii-xv).

This principle, in terms of the EFL classroom, can tell us that at the local level ,results cannot be predicted, and specifics of learning are unique to every individual. At the global level, however, regularities emerge from the sea of probabilities, and general outcomes can be determined. When teaching certain aspects of language, therefore, the teacher can offer the students various appropriate language-learning affordances and help them to work through these in groups, at their own speed, obtaining the learning input that is relevant to them, and moving on to other activities when they satisfied. The final outcome will be similar, but with different paths of arriving at that outcome.

The avalanche effect

This concept is similar to the butterfly effect because a butterfly flapping its wings in Iran may influence air currents that finally lead to windstorm in Chicago. The avalanche effect

describes the outcomes of a process of continuous emergence. When changing conditions are too drastic for local adjustments of the existing structure, natural systems evolve new structures and new functions. Thus, any tiny stone being thrown on a heap of pebbles on a mountain, cannot be expected to have a noticeable effect. However, as more and more pebbles are thrown onto the heap, there will be a time when they move in unison, and an avalanche occurs. The reality is that an inflexible structure which refuses to adapt to changing conditions will eventually, at some unpredictable moment, cease to function. The event which causes such malfunction might seem insignificant, but will in actuality be simply one of innumerable connectivities. In this manner, pressures and processes in the language class can continue to build up until they reach a critical threshold; at which time they trigger sudden change. In order to prevent such potentially chaotic change, educational administrators will wish to replace a poorly advised crisis management approach with well-informed self-transformation.

Equifinality

The local unpredictability and global regularity of section 5 point to another characteristic of complex systems: equifinality. While connectivities remain unique at the micro level, the outcome at the overall (global) level can be the same, or similar, in two different systems. This regularity of outcome can be applied in the language classroom, simply by observing that different students learn in different ways, though aiming at the same goal. Even at the level of a single language lesson, with a stated language goal, therefore, there are many ways of achieving that goal, all of them equally valid. This concept is particularly interesting in the context of project work. If we broaden our teaching /learning goals to development of critical thinking, problem-solving and learning strategies, the student-directed language projects provide a means of achieving these goals in individually appropriate ways. Students working on an English class newspaper, a class webpage, or group survey of local native speakers of English, are all working towards the goal of target language linguistic fluency, but they are also following their own learning preferences/styles and employing their various multiple intelligence in ways that are appropriate to them. Rather than complaining that students have not all learned the same lexis, teachers can in fact be assured that students have all self-accessed the language which was appropriate to the learning situation, and have acquired this in meaningful, problem-solving contexts. As Dickinson and Carver note:

“A language course can only deal with a small fraction of the foreign language; therefore one objective of language courses should be to teach learners how to carry on learning the language independently” (1980, p.1).

Systems

Before emerging the systems theory, the individual learner has been seen as a unique entity, with his/her own learning styles, learning preferences, multiple intelligences, perceptions, beliefs, and attitudes to learning. Systems approach confirms such a perspective but, it also enables us to look at the learner in greater depth, and to explain why (for example) affect is more important than cognition in the learning process (Stern, 1993, P.386). In the traditional, teacher-led view of language learning, the teacher is a provider of information, with the

learner as a passive recipient of that learning. The teacher knows what the learner needs and is determined to provide it for the student. The underlying assumption is that when the learner absorbs the knowledge provided, then the outcome will be successful, quantifiable learning. But research into affect (Arnold,1999) has shown that this is not the case, and that the inability of this model to provide results is not simply a matter of inadequate learners or teachers. Instead, Krashen's affective filters (1982) demonstrated that there are many factors impeding the supposed flow of learning from the teacher's jar to the learner's empty vessel. Low motivation, lack of confidence, poor self-esteem, anxiety stress, passivity, beliefs about learning are all considered as significant factors and language learning suddenly became recognized as a complex event. Teachers and researchers might well ask how the teacher is to promote language learning in this situation, when the student does not learn what the teacher teaches (Allwright,1984),and when the path to learning is blocked by negative affect. How can valid and affective teaching take place, when every individual in the class is unique?

One suggested way to approach this situation is to focus on student-centered learning and autonomy. This has shifted the responsibility for learning to the learner, and has reclassified the teacher as a facilitator of learning. In this situation, the teacher's new tools as Kelly(1996)writes, are macro-and micro skills of counseling. They require him/her to help students to become motivated to learn, to have self-esteem, to set realistic goals, and to assess their achievements effectively and accurately.

There are seven common characteristics concerning the classroom system

- The classroom is a collection of natural systems (T,SS), just as the forest is a collection of trees and animals;
- Each mini-system influences, and is influenced by the larger sum of systems(the classroom);
- This overall system is a whole, which cannot be reduced to its component properties;
- The classroom maintains itself, though its participants may change;
- The language –learning class is self-organizing and self-creating in response to other systems(e.g. university entrance exams, parental pressure);
- The classroom exhibits equifinality; the same final goal may be realized in a number of different ways;
- The classroom is a coordinating interface between other systems. The learner at one level interact with the teacher on the next level, who interacts with the school principal at a higher level (adapted from Laszlo, 2002, pp.25-58).

The aforementioned characteristics lead in turn to a number of conclusions which can be drawn regarding a systems approach to teaching and learning:

- A system view of learning sees language acquisition and the learning environment from a holistic view, rather than as the sum of a number of components.
- Equifinality can be applied in the language class by allowing students to work at their own speed, making learning achievements appropriate to their current

status, from the learning affordance offered by the teacher.

- Language learning can be approached from a humanistic perspective and can be seen as a linguistic, affective and social event which emerges with regularity from unpredictable interactions, but is greater than the sum of those events.
- The ELT/EFL class can be seen as an open system, with multiple subsystem (the participants). In this system, seemingly insignificant events can build up to critical thresholds, sparking sudden, irreversible shifts and new structures (the avalanche effect).

There are some objections to such learning environments. It might be objected that students are learning different things in this situation, and that some are going slower or faster than others. However, this approach simply acknowledges that students learn at different rates and in different ways. There has been a permanent problem in linear approach that students who do not comprehend today's lesson content quickly fall behind and lose their motivation, as lesson content becomes more difficult. In a lesson based on system/complexity syllabus, students can learn at their own rate, and can pay attention to the aspects of the language which they need to acquire. It might further be objected that assessment is a problem in this situation. However, the shift from what was learned to how it was learned indicates that it is no longer important to find out whether every student has memorized the same words. Instead, educators need to know to what extent students have improved their linguistic, affective and social skills, and what areas could best be worked on by them. In this situation, self-assessment and peer-assessment are valuable self-appraisal skills.

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