Non-linearity and the observed lesson

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In this paper I will attempt to argue that the concentration on aims as a central tenet of classroom observation for teacher development is tied to the Newtonian discourses which—despite the rival claims of the 'new' science of Chaos and Complexity—still dominate the world of ELT. To do so I will outline the main ideas behind these theories, and relate them to SLA. I will go on to explain why I think the change in discourse is of such importance, and finish by using fractal images to illustrate the futility of the prominence of aims in lesson preparation and delivery.

Introduction

I arrived at Chaos and Complexity theory through Larsen-Freeman's (1997) article in *Applied Linguistics*. As I read her article, the ideas felt intuitively correct. As Bowers (1990) says, 'You don't see something until you have the right metaphor for it.'

Chaos and Complexity theory can act as a metaphor for the processes that occur within the ELT classroom; but more importantly, it can replace the discourses which dominate and inform much of our current practice. As James Gleick (1987: 5) puts it, the theory is 'a science of process rather than state, of becoming rather than being.'

The study of complex systems followed the study of chaos. The early proponents of chaos theory searched for the complexity that emerged from simplicity; the complementary question of how order emerges in large, complicated systems was only asked at a later date. The result was that at first we had complication arising from simplicity, which was followed by simplicity emerging from complication. Chaos is now understood in an interestingly paradoxical way as order without predictability. We cannot predict individual moments in the life of a system, but the end result of its seemingly random movement is discernible order.

So what are complex systems, and how can the understanding of their importance in other areas be extended to ELT? Complex systems are non-linear; to describe something as 'non-linear' is to describe it by what it is not. Something is linear if its output is proportional to its input. In a complex system this is not the case. Complex systems are non-linear in that the effect of actions upon them is disproportionate to the size or weight of the action.

Language learning is also non-linear: despite our linear syllabuses, and clearly defined lesson aims, progress and backsliding in equal and unpredictable measures are the norm, as we have all experienced:

> Learning linguistic items is not a linear process—learners do not master one item and then move on to another. In fact the learning curve for a single item is not linear either. (Larsen-Freeman 1997: 151)

The *-ed* regular past tense is a good example. First comes a period of correct, if limited, use, which may be learnt lexically. This is followed by a period of chaos as exposure to the language increases, and generalizations and random usage creep in. There's no way of knowing when this may happen with a particular learner, which example will be the straw that breaks the camel's back, or the pebble that sets off the landslide; nor can we predict when the process will end. As with any complex system, long-term behaviour is either difficult or impossible to predict: even very accurate measurements of the current state of a chaotic system may become useless indicators of where the system will be at some future time. One has to measure the system again to find out where it is. The parallel with the difficulties of accurate placement tests is clear.

The difficulty of prediction is thrown into even starker light if we consider another property of complex systems, known as 'sensitive dependence on initial conditions', which can have the effect of making a small change in initial conditions produce radically different results in the future behaviour of the system:

> Tiny differences in input could quickly become overwhelming differences in output. (Gleick 1987: 8)

Edward Lorenz, a meteorologist, first drew modern-day attention to this principle with his 'butterfly effect'. Does the flap of a butterfly wing in Tokyo, Lorenz asked, affect a tornado in Texas (or a thunderstorm in New York)? He concluded that it did, which among other things throws into real doubt meteorologists' attempts to predict the weather. As all our learners arrive in the classroom at different stages in their learning, the effect on their progress of this sensitive dependence on initial conditions cannot be underestimated.

Complex systems are interactive. The behaviour of the complex system is not built into any one component, but emerges from the interaction of its components. The functioning of the human brain, or even any one of its subsystems, like the visual cortex, is a property of the neurons and their circuits operating together. Thus, the functioning of complex systems often reflects co-operative behaviour and the emergence of structure.

For these reasons, complex systems tend to display local instability but global stability. In chaos theory, no one can ever tell where the system is headed until it has been observed over time. Long-term behaviour is difficult or impossible to predict: even very accurate measurements of the current state of a chaotic system become useless indicators of where the system will be. One has to measure the system again to find out where it is.

The SLA process is known to be complex. There are many interacting factors at play which determine the trajectory of the developing interlanguage. There is an interaction between the language forms in a learner's system: when a learner starts to learn a new form, formerly 'mastered' forms will become destabilized. Likewise, seeing a 'rule' in a new context temporarily destabilizes the learner's understanding of that rule.

We also need to take into account the huge numbers of interacting factors that have been put forward as influencing the success of SLA, as noted by Larsen-Freeman (1997: 151):

> Perhaps no one of these by itself is a determining factor, the interaction of them, however, has a very profound effect.

Language itself is an 'aggregation of static units or products' (ibid.) which are combined in speech in a dynamic process. Once again we see the relevance of the parallel with the study of chaos and complexity theory, described by Gleick as 'a science of process rather than state, of becoming rather than being' (1987: 5).

The dynamic patterns of complex systems display feedback loops. There's nothing driving the system, since the dynamics come from within the system itself, and the system uses feedback to move on, to evolve, and to develop. These complex systems are adaptive; they take in external influences, and change their internal structure to take advantage of the new circumstances.

Again, as Larsen-Freeman (ibid.: 152) points out, such feedback loops, which are accepted as agents of biological evolution, can also be applied to learning:

> In biology, of course, the agents are individual organisms, the feedback is provided by natural selection, and the steady improvement of the models is called evolution. But in cognition the process is essentially the same: the agents are individual minds, the feedback comes from teachers and direct experience, and the improvement is called learning.

Finally, complex systems are self-referencing; order is created within the seemingly chaotic system by 'strange attractors' forces or shapes of probability that seem to prevent the system from going beyond certain invisible boundaries. While these systems are extremely complex[1], order emerges from a simple set of rules, which govern the interactions of the system as a whole, and stability emerges from this interaction of individual components.[2]

A learner's interlanguage is also self-referencing in that it grows organically. While it can to a certain extent be described by rules, it is not produced by them. It is constantly changing and reacting to the feedback it receives; it is an open system, and moves to the strange attractor which gives it both impetus and order. Indeed, it may be that fossilization occurs as a result of the interlanguage becoming closed, and settling to a fixed-point attractor.

The acceptance of the relevance of Chaos and Complexity theory leads naturally to the examination of the current underlying discourses of ELT. On closer inspection it becomes clear that, as with most areas of our society, it is in fact Newtonian, mechanistic discourses that dominate and mould our view of the world:

> For three centuries the dominant scientific world view has been the image of a static, repetitive, predictable, linear, and clockwork universe. Sir Isaac Newton gave us classical physics, the laws of gravitation and mechanics, and the description of a deterministic world. This Newtonian worldview also profoundly influenced our psyche, our beliefs, our behaviour, and consequently, how we designed our institutions. We have been obsessed with linear systems and their effect has controlled almost every dimension of our culture. (Marshall 1996)

Marshall writes from a broad educational perspective. Bowers, however, commenting on the world of ELT, concludes that

> . . . the prevailing metaphors not only for language learning but for language learning research are essentially hierarchical and they are linear. They at once guide and constrain the way we think about teaching, learning, assessment, language, the teacher, the learner. (Bowers 1990: 128)

The effect of our deriving our insights into learners from the constraints of Newton's worldview are clear in our linear approach to learning. Our syllabuses, textbooks, and training courses are linearly organized. We talk of input and output. We also set our students off in pursuit of a target language, despite the fact that—as Larsen-Freeman has pointed out—'the very phrase "target language" is misleading because there is no endpoint to which the acquisition can be directed. The target is always moving' (Larsen-Freeman 1997: 151).

We also structure much of our teacher training and education around aims. The achievement of aims is implied through initial, and much in-service training, to be of paramount importance. Aims take pride of place on most lesson plan pro-formas, and achievement of aims is crucial to the success of any classroom observation. The fact that Newtonian, mechanistic discourses dominate our profession can be clearly seen, but why is the use of these terms considered of such importance? Through my reading of John Sutter's (1999) analysis of the work of Pennycook and Foucault, I have come to see that discourse is about more than words being used to describe practice. I will draw heavily on Sutter's paper to argue that discourses are self-perpetuating, and in themselves reproduce the reality which they purport to describe. In effect, the assumptions and judgements behind discourses are used to justify practice which in turn confirms the practice. Sutter (ibid.) uses Escher's 'Drawing Hands' to illustrate the point:

> Like an Escher drawing it becomes difficult, or impossible, to separate figure from ground; in fact, they construct each other.

Why are such terms, and their dominance in ELT, of such importance?

> Discourses are more than just *text*—they are, 'institutionalised ways of mapping out knowledge . . . and their use calls forth those discourses'. (Pennycook 1998: 7)

Where do they come from? What are the power relations and techniques that produce, maintain, and police these discourses in ELT?

Teacher-trainers can be seen as 'the gatekeepers and caretakers of ELT'. They create teachers who will further reproduce such discourses. It is here that the discourse, by shaping those who will become practitioners, itself becomes common sense, the accepted norm. As trainers produce teachers who operate within such discourses—and who see what they do as *common sense*—so teachers 'train' learners in the very same discourses. Learners also come to see what they, and their teachers, do as *common sense*—which in turn reinforces the power of such training. Indeed, it creates a demand for it.

Foucault writes that 'discourse is not simply that which translates struggles or systems of domination, but is the thing for which and by which there is struggle, discourse is the power which is to be seized' (1984: 110).

Power produces reality, and those with the power to influence future generations of ELT teachers adhere to, operate within, and perpetuate Newtonian, positivist discourses. That this discourse, perpetuated through training and development programmes, does not reflect the reality of the learning which takes place in the classroom, is a fundamental flaw in current ELT practice.

To give an example of the use of these discourses I will use fractals as a metaphor to examine the position of aims in classroom observation. Fractals are geometric figures produced through the repetition of certain equation, with the results plotted on a computer screen. They show how simple patterns can grow through the application of rules. Importantly, the rules include an element of feedback in that the result of one calculation is fed back into the next calculation.

The defining properties of a fractal are self-similarity, repetition of patterns at all scales, and infinite complexity and detail.

The study of fractals and fractal shapes in nature can be extremely instructive. As with flocking birds, fractal shapes are not random. Their form is built into the formula. Yet randomness or indeterminism plays a key role in leading to the creation of the pattern at all different levels of scale. By using a few simple guidelines, and allowing them to repeat themselves randomly, nature produces the complexity of form that we see everywhere. Thus high levels of freedom are combined with simple instruction to produce coherent wholes.

Traditionally we approach lesson observation or lesson plan 'construction' through Newtonian eyes. Only by clear models, elaborate guidelines, and myriad theoretical constraints, can the quality of the final product be assured. Aims and sub-aims play an important role in this, ordering and pre-ordaining the development of the lesson. Once again, fractals can be illuminating here. In a fractal there can be no definitive measurement, since there is always a smaller scale. Attempting to measure a fractal is ultimately frustrating, as the information we receive is incomplete and never-ending. Here the parallel with SLA is clear. How many linguistic, psychological, sociological, psycho-sociological, and cognitive variables do we need to measure to arrive at an accurate picture of a student's interlanguage? When we finally learn how to measure those variables, will we be able to plot a student's interlanguage, or will those variables reveal others on a finer scale, and so on?

Fractals force us to take a step back and assess them holistically. What is important is the movement and shape of the whole and how it compares to other systems. Fractals suggest that searching for ever more precise measures of discrete parts of a system is futile, and reveals little.

Furthermore, concentration on aims can be related to focus on forms which, as Thornbury (1999) puts it, 'entails the pre-selection and pre-teaching of discrete items of language (it is thus proactive)'.

In both cases the teacher has decided before the class what the learners should learn, and there is no room for reaction to the needs of the students as these are revealed in the course of the lesson. This focus on form (rather than forms), entails 'a prerequisite engagement in meaning before attention to linguistic features can expect to be effective' (Long 1991 quoted in Doughty and Williams 1998: 3). This would allow the learning of form to be led by student needs, not driven by the linear expectations of the teacher.

I would echo Richards' call for a move away from a technical view of teaching; our increased understanding of the non-linear nature of language and learning should lead this move. Teacher training can and should be in the vanguard of this movement. This of course challenges what Kerr (1999) memorably terms the 'flat-earth' model of initial teacher training: 'the argument that trainees at this level should only be exposed to a map of language teaching that is immediately navigable and applicable'.

The interactions in a classroom form an extremely complex system. If, in our attempt to help teachers to develop, we concentrate on training them to view the aims and sub-aims as the building blocks of a lesson, we run the risk of hindering their ability to view the whole of the lesson. Fractals teach us that, on closer inspection, the seemingly discrete objects and patterns of which it appears to be formed turn out to be all part of one seamless flow.

Lesson plan aims essentially follow the teacher's agenda, and allow for control of the lesson. Fractals, in their visual depiction of complex systems, show us that by encouraging teachers to control lessons with essentially teacher-centred linear aims we run the risk of producing teachers who are unaware of the complex patterns that are woven in the interaction between learners and the language to which they are exposed, and which they produce.

The replacement of unrealistic Newtonian discourses with a discourse based on an understanding of the complexity of language learning will, I believe, aid us in producing classrooms which are conducive to learning, and will allow us to explore unhindered what it is that a teacher can do to allow learning to take place. We can begin to change the dominant non-linear practice of ELT today by allowing teachers to enter the classroom with no other thought in mind than to react to and accommodate the different learning needs of their students, unencumbered by teacher-led discrete item aims.

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Notes

1 Complex both in the sense of the degrees of complication they exhibit, and also in the sense of how structured, intricate, hierarchical, and sophisticated they are; in the second sense 'complexity' is an indicator of how many layers of order or how many internal symmetries are embedded in a process. In both cases complexity is synonymous with disorder and a lack of structure.

2 The BOIDS experiment illustrates this perfectly. This computer simulation involves a collection of independent bird-like objects placed in an environment full of obstacles. The BOIDS are given three instructions;

1. Maintain a minimum distance from other objects in the environment, including other BOIDS.
2. Match its own velocity with the BOIDS in its neighbourhood.
3. Move towards the perceived centre of the mass of the BOIDS.

No matter how many times this programme is run, the end result is always the same: the birds form and sustain a flock while avoiding the obstacles in their environment. This emergent order, the flocking of birds, is captured without giving the BOIDS a rule 'form a flock'.

Marshall (1996) makes four observations about the relevance of the BOIDS experiment:

- Rules that create complex flocking behaviour do not relate to flocking behaviour. They relate to what an individual BOID should do in relation to other BOIDS.
- Flocks form from the bottom up and not from the top down.
- The close interaction of the BOIDS with each other allowed the flock to adapt to changing conditions naturally. The focus of each BOID was on ongoing behaviour and not the final result.
- Complex behaviour, like flocking, need not have complex rules. Simple rules will yield profoundly complex results.

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