Learning to Teach in 'Urban Complex Schools'

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Ofsted's (2003) report into access and achievement in urban education suggested that the gap in achievement at GCSE between deprived urban secondary schools and the national average continued to grow between 1993 and 2002. Recognition of the additional issues presented by urban education still dominates education today and urban education has become a political battleground. Those of us working within urban settings are familiar with the issues of cultural and linguistic diversity, parental disengagement with the education system, lack of role models, gang culture and a host of other issues which contribute to making teaching in these environments challenging. In some schools this becomes a vicious cycle of not being able to recruit and train teachers to deal with these issues within a school and subsequently the quality of education continuing to decline.

Perhaps one of the most successful initiatives to address this issue has been the work of Teach First, which was first established in 2002. Teach First is a unique route to gaining Qualified Teacher Status (QTS) through attracting highly qualified graduates who train whilst working as unqualified teachers in challenging schools. Both Teach First (2009) and Teach for America (Donaldson, 2008), on which Teach First is based, refer to their aim to address educational disadvantage in 'urban complex schools'. In this paper I wish to discuss what this notion of an urban complex school might mean and how it may be useful.

Experience of working with Teach First in London suggests that the use of the phrase 'urban complex schools' within their promotional literature does not relate closely to a specific definition of these schools that is used within the organisation. However, schools within the scheme are selected for their challenges and only those with more that 50% of pupils living in the lowest 30% of the Income Deprivation Affecting Children Index, those with low attainment in regards to GCSE grades A*-C (including English and Maths), or schools with 'Challenge' status are eligible. Furthermore many of the schools are located in areas of socio-economic disadvantage and this adds additional challenges in developing as an effective teacher within these schools. It is fair to say that very few of the trainee teachers grew up in the areas they teach in and thus must also understand the culture of the locality as well as the specific culture of the schools they work in.

Nevertheless, Ofsted (2008) deemed the programme to be 'Outstanding' within the London region and noted that the scheme was having a positive impact in challenging schools. This begs the question as to how trainee teachers learn to teach and become effective teachers in these challenging environments: how do they come to understand and effect positive change in 'urban complex schools'?

To break this problem down I intend to first of all draw on a growing theoretical field of complexity science to try and elucidate what *complexity* means in these settings. Secondly I wish to outline two studies to see whether this conceptualisation of schools as complex might be useful to student teachers and those who work with them.

Accurate definition of complexity theory within education is elusive and I have recently presented a paper on the difficulties of defining classrooms as complex (Hardman, 2010). As such I here wish to present only a brief introduction to complexity theory, whilst recognising that there is still work to be done in defining it within education.

Complexity science grew out of the physical sciences and is closely related to the field of chaos theory. This distinction between chaos and complexity is important and it is fruitful to explain it here before considering how these concepts might be applied to education.

A chaotic system is one in which a set of mathematical equations define the evolution of a system. An effective example is a double pendulum[1]. Whilst the motion of a single pendulum can be easily predicted, when we add a second pendulum attached to the end of the first, the motion of the pendulum becomes chaotic. To human perception this appears to be random but in fact it is not. A double pendulum can be accurately described by a set of equations. However, the system is highly sensitive to where it starts and as such it is impossible to get the pendulum to do exactly the same thing on two occasions. For a chaotic system then a small initial change can have a large effect over time, but the system is theoretically predictable – chaotic systems are 'determinate'.

Prigogine (1997) proposed that all complex systems are indeterminate, although there is still some debate about this (Osberg, 2005). As such a complex system might be characterised as the 'converse' of a chaotic system in that whereas a chaotic system is one in which there is seeming disorder but actually the system is mathematically defined, a complex system is one in which order spontaneously develops from a disordered state. The elements of a complex system interact with only reference to their local environment and yet on a larger scale the system has a defined structure. Examples of this phenomenon can be seen in Wilensky's (1998) model of bird flocks being formed through the simple interaction of birds with a random starting position and through Wilensky's (1997) model of ant behaviour in finding food. In these models, ordered states develop from the 'agents' of the system interacting according to simple algorithms and without appeal to mathematical equations which describe the whole system.

Prigogine (1989) was an early pioneer in understanding complexity in chemical systems and my conceptualisation of complexity stems initially from his work. Prigogine noted that in a chemical system a random change at the subatomic level was able to propagate through a system such that the entire system changed on the macroscopic scale. This change to the large scale properties of a system through the random interaction of components of on a smaller scale is known as a 'bifurcation'.

Complex systems however do not simply involve the progression of a system from a disordered to an ordered state but continue to adapt to changes in the environment. A complex system is in a quasi-stable state that changes according to both the internal randomness of the system and the external influences upon it. Returning to the above model for ant behaviour we can see that if a new supply of food is introduced into the system or the evaporation rate of the hormone the ants release changes then the system will adapt to these changes.

Within education the characterisation of complexity has been applied to a variety of areas including school leadership (Morrison, 2008); curriculum (Osberg, 2005; Doll, 2008) and action research (Radford, 2006). With respect to teacher training and development, which is my main area of interest, Davis & Sumara (2006) discuss how teachers operate within 'nested complex systems'. They give an example of school mathematics in which the subjective understanding of an individual can be conceived of as a complex system, but this system is part of the 'classroom collectivity', which

[1] I shall be demonstrating both a simple and double pendulum.

in turn is part of the system of 'curriculum structures' and superseded further by the system of 'mathematical objects'. They note that these systems have arbitrary boundaries but nevertheless advocate this concept of nested complex systems as useful for understanding how successful teachers function. Successful teachers, they propose, are able to 'jump' between and deal with these different levels of complex systems simultaneously.

The notion of a nest of complex systems, each made up of a range of interacting factors seems to satisfy our descriptions of 'urban complex schools'. Experience in challenging schools suggests that there are a host of factors which can affect teachers and pupils and that these factors are dynamic. In urban settings the influences mentioned earlier: cultural and linguistic diversity; parental disengagement; gang culture sit alongside the factors which influence learning in all schools: individual motivation; clarity of explanation; engagement; classroom control and many others. Complexity theory seems to fit this picture and allow us to consider how these factors influence each other. Beyond this sense of applicability though, how is this characterisation of complex systems useful to the field of education and specifically to understanding 'urban complex schools'? Elsewhere I have proposed that complexity may have three possible uses (Hardman, 2010).

Firstly, a teacher with an understanding of complexity would be primed to recognise the sensitive and dynamic nature of classrooms and schools. Experienced teachers know that the teaching profession is one of the most varied and dynamic and that classrooms and staffrooms are unpredictable places, yet there is no theoretical basis for this and complexity, if further defined, may provide this. As well as teachers, policy makers and researchers would also benefit from an appreciation that these systems resist simple descriptions.

Secondly, this characterisation of schools as complex systems might provide a framework for investigating how successful teachers operate within challenging environments. Whether Davis & Sumara's (1998) notion of jumping between levels in nested systems will serve as a useful starting point or not remains to be seen. In my own experience of working with teachers however it is apparent that focusing on just one aspect of practice or a specific strategy for improvement is deficient in recognising the interaction of a huge range of factors that exist in schools and their localities.

Thirdly, it might be possible to provide specific insights into how learning takes place within classrooms. Smith & Thelen (2003) have done work in investigating the dynamics of young children learning to walk and van Geert (2000) has developed models of learning in classrooms. These models focus on specific aspects of complex systems and recognise the interplay of many other factors. I believe that this is as much as we may hope for in terms of modelling complex systems. The fact that a complex system is sensitive to change means that if we are to model or describe a system and omit any detail at all (for the sake of comprehensibility) then we risk completely misrepresenting the original system. We must recognise that the only truly accurate model of a complex system is the system itself.

As well as this issue there are a range of sensitivities to using complexity science within education that we must be mindful of. A review of literature has shown that there is a tendency to apply metaphor between complex systems in the physical sciences and the social sciences without fully considering the differences between these systems. Perhaps even more problematic is the lack of concrete examples of complex systems within education, whereby care has been taken to elucidate

what the mechanisms of change are and how factors within the system interact to cause dynamic organisation.

With these problems still to overcome and complexity science within education still in its infancy then, what can we currently say about the usefulness of complexity theory in considering how teachers learn to teach in urban complex environments? For the rest of this paper I wish to focus on two studies in which I attempt to find this out. Firstly, a small scale study in which I gained the opinions of trainee teachers with respect to the usefulness of complexity as a framework. Secondly a proposal for a deeper study looking at how Teach First teachers learn to teach.

I conducted a small research project with a PGCE science cohort in order to address the question: how useful would the framework of complexity science be to a student teacher within a PGCE science programme?

Given the importance of the specific context in which such research is conducted it is proper to here describe the context in which this study is being taken place.

The INSPIRE PGCE is a programme run in partnership with Imperial College London in which post-doctoral researchers in the physical sciences (physics, chemistry and engineering) train to teach through a nine month programme. The programme consists of four weeks intensive training followed by two school-based teaching practices and as such might be thought of as being organised with the Teach First model in mind but still maintaining many aspects of a traditional PGCE route. As well as teaching experience participants are expected to deliver 'INSPIRE activities' for 9 weeks of the programme in which they use their scientific knowledge to deliver extra-curricular activities designed to promote science. This additional pressure, combined with the fact that the schools are all within an urban setting, suggests that there are a range of interacting factors which participants must deal with beyond those of a 'standard PGCE programme'.

I chose an exploratory research interview format (Fowler & Mangione, 1990), in which I gave an initial explanation of complexity theory, followed by a group discussion prompted by questions. In line with the recommendations of Oppenheimer (1992) I developed open questions which were as neutral as possible and expressed that I wanted participants to lead the discussion themselves so as to avoid my own opinions dominating discussion. I made the process as fully transparent as possible by explaining briefly the research I was undertaking. I expressed that I considered the participants as 'fully aware collaborators' and explained the process leading up to and following the interview in terms of my research.

There are a number of limitations to the study and I want to make these clear from the outset. Firstly, because of the nature of the programme there were at that time only seven participants. As such, statistical analysis of their viewpoints, through questionnaire for example, would obviously produce results which were statistically insignificant. However, such a small cohort allows a more in-depth analysis of viewpoints through interview and this is the main reason for selecting an exploratory interview format.

A second limitation is that the seven participants within the 2008/09 cohort were very able scientists and may have had a greater pre-disposition for understanding and using scientific models, such as those in complexity science, and as such it is difficult to extrapolate the results of this investigation

to other PGCE programmes. Part of the interview was devised to find out what previous experience the participants had of complexity and it was found that one had used complexity theory extensively within their PhD. The other six participants had heard of but could not explain complexity theory.

As well as these practical limitations, Radford (2006) has identified a number of issues with respect to educational research in light of complexity science and I wanted to be mindful of these issues in devising my methodology. For a researcher to assume that they are able to sit 'outside' a system and observe it fails to appreciate the dynamic interactions between researchers and the systems they focus on, nor does it recognise the sensitivity of those systems to the actions of the researcher. This was even more apparent as I am the programme director of the INSPIRE PGCE and as such the students could not be expected to respond to me as a 'neutral' researcher.

The only way to maintain the integrity of such a research project, whilst respecting the premises of complexity theory, is to accept the limitations of my own understanding of both the field of complexity science and the motivations and interactions of the student teachers I shall be performing this action research with. I am part of the system under investigation, and as such cannot claim to be outside of that system. I must also respect that the reflections which might come out of investigating the suitability of complexity theory are to some extent the product of my own personal history and that of the programme in which the research was conducted.

As this was intended to be a small scale study I decided it more appropriate to elicit these views towards the end of their PGCE programme once the student teachers had developed a broad understanding of the educational context of schools and developed a critical awareness of educational theory and policy. A further limitation of the study is that these student teachers had only taught for two terms and in two specific science departments each within London, thus limiting their awareness of educational settings. However, this is balanced by them having almost completed a PGCE programme and as such being well placed to comment upon the application of complexity theory within that specific context.

I at length considered how I might present my understanding of complexity science within a one hour session and without bias towards a certain viewpoint. I concluded that this is not possible and as such my study can only comment upon the participants' reflection on what I presented to them, which may contain bias I am unaware of. As mentioned previously, this study actually investigated the usefulness of the specific presentation of complexity I gave to this particular set of student teachers. Furthermore, because it is my personal conceptualisation of complexity within education that I presented to student teachers, the research question being posed by this paper is actually whether this particular conceptualisation is useful to those teachers. We must be cautious in extrapolating the results further.

I began the research by explaining the project aims and allowing the student teachers to read my research proposal. I then asked them to read a paper I had written and listen to a presentation on my interpretation of complexity theory. Once this phase was complete, we entered into a group discussion and I displayed the following prompt questions:

1) How much were you previously aware of complexity and in what context?

2) What do you think about ideas from the physical sciences being transferred into the social sciences?

3) What might be the advantages of introducing complexity to PGCE students?

4) What might be the disadvantages?

5) What do you think about 'hard complexity,' vs. 'soft complexity' vs. 'complexity thinking'?

6) If anything, what would you introduce to PGCE students?

In summary of the outcomes of the interview it is possible to say that there were three main positions taken by the participants. Firstly, one viewpoint was that it would be useful to be exposed to complexity theory and allowed to use this as a framework for viewing the classroom. In line with this viewpoint, a participant who had considered complexity theory explicitly within her PhD suggested that a social interpretation of it might be useful as a 'meta-narrative'. When questioned further she suggested that complexity might offer a framework into which other educational theory could fit and advocated introducing it early within the PGCE programme.

A second notion was that it would be simply too overwhelming to introduce the notion of complex systems within a teacher training programme and may induce a feeling of helplessness in the face of an unpredictable and dynamic environment. This is interesting and suggests that student teachers may prefer the support of simplistic concepts and specific actions early on in their careers. What is debatable is whether this allows them to gain a fuller appreciation of the complexities of teaching later in their career, and this cannot be ascertained from this study.

A third viewpoint which developed was that it is entirely unnecessary to consider complexity science in this way, as teachers learn to deal with such systems through experience and a theoretical framework could be limiting. This seems to echo the all too common viewpoint that educational theory itself is not as useful as practical experience and advice in developing as a teacher. As a teacher educator it always saddens me when teachers have not yet appreciated the interplay of research and good practice but I do understand the pressures that lead to this thinking. Within the context of this study however, I do not feel that this rejection of theory *per se* warrants the rejection of complexity theory specifically, as a tool for student teachers.

Overall it was felt that complexity theory might be a starting point for models and analogies developed within the social sciences. This may take the form of a 'meta-narrative', allowing other concepts to be given a unifying framework, although more research must be done into the validity of this. Alternatively complexity might be offered as a way of viewing the classroom that complements other viewpoints in providing a framework to be considered or rejected by students as they train to teach. Although the role of complexity theory in the INSPIRE PGCE is not yet clear, this small project suggests that introducing complexity theory as a theoretical framework, to science trainees at least, may provide stimulus for better understanding the field of education. I believe such a discussion of complexity may sit beside traditional discussions about constructivist and behaviourist learning theories for student teachers to consider and form their own critical responses to. Further research is required to fully investigate the reported usefulness of a complexity theory framework to student teachers.

Whilst this small investigation has begun to scratch the surface of how teachers may respond to being introduced to complexity theory, it has not looked at whether complexity is useful in understanding how successful teachers deal with complexity in their classrooms and schools. To this end I am working with colleagues to develop a broader research project aimed at investigating how teachers learn to teach in challenging urban environments.

Subject to gaining the collaboration of Teach First themselves it is my intention to collect data on how Teach First science and maths student teachers learn to teach. This is still very much in the ideas stage and as such I would welcome feedback from the audience on the proposed methodology. The aim of the study will be to investigate the relative merits of a range of influences on the learning of student teachers. We hope to be able to replicate in some respect the DCSF (2009) "Becoming a Teacher" longitudinal study in order to provide a ready basis for comparison of Teach First with other training routes. This primarily involves survey and interview of student teachers at various points within their first few years of becoming a teacher. As well as this we hope that we will be able to gather quantitative data on the relative merits of a range of learning strategies employed by the participants. By asking them to rate their use of different strategies on a weekly basis we hope to build a longitudinal picture of how participants learn to deal with the complexity of their environment and become successful teachers. This will require some preliminary research to determine the range of strategies employed in learning to teach and careful thought in how these are categorised.

I feel it would be misguided to impose a complexity theory outlook on the participants before conducting the study and as such the lens of complexity theory will be employed in the analysis of results. It is hoped that quantitative data from participants recording their learning strategies will enable us to see if any dynamic patterns emerge which will allow us to better understand the interplay of different factors in learning to teach. For example, do trainee teachers 'jump' around in considering the nested levels of complexity that Davis and Sumara (2006) propose? Do more successful teachers move between these levels more often? Are there any patterns in strategies employed that indicate a 'typical' route to becoming a successful teacher or is every learning journey unique? How might the interplay of personal history and unique environment lead to the 'emergence' of successful teaching?

In this way it should be possible to both gain an understanding of how teachers learn to deal with the complexities of challenging urban schools and also allow us to see whether applying complexity theory to the data provides us with any new insights that would not be otherwise apparent.

In this paper I have proposed that learning to teach in urban environments and learning to teach through intensive training routes both introduce a host of factors which teachers must deal with in order to become successful in shaping learning. Complexity theory, I have argued, provides a theoretical framework through which to recognise these additional challenges and begin to understand how their interplay is part of a highly sensitive and dynamic system. Complexity theory within education has still not come of age, despite more than a decade of thought with respect to how it may be applied to better understanding schools. This is partly due to the difficulties in defining and understanding complex systems within education but also due to the lack of attention that complexity theory has received within education.

I have discussed here two ways in which complexity might be useful. From the small scale study of a PGCE cohort it appears that complexity theory could be introduced to trainee teachers alongside other theoretical frames, as long as there is a healthy level of criticality within the cohort. Doing so may allow the recognition that classrooms are dynamic and sensitive to small changes, as well as highlighting the interplay of internal and external factors in creating unique challenges.

Whether applying complexity theory to understanding how successful teachers operate is fruitful or not is yet to be seen. What is clear though is that there needs to be much more research into this field in order to either strengthen or reject it. Whilst we hope to begin on this road with the proposed research, it is apparent that one study alone will not be enough to ascertain the usefulness of complexity in educational research and I hope the proposal will illustrate how such studies might proceed.

Educationalists and policy makers alike agree that there is a need to tackle disadvantage in urban schools and there have been a number of initiatives to do so. What has not yet been presented is a theoretical framework which allows both teachers and researchers to understand why urban schools are so challenging and dynamic. I have proposed here that complexity theory may provide just that framework. However, only further research will reveal how useful this framework truly is.

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