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Exploring the use of complexity theory and action research as frameworks for curriculum change

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Abstract

This paper considers the impact of a small-scale action research project which focused on the development of an emergent approach to curriculum making in a GCSE (General Certificate in Secondary Education) course in geography. In this context we argue that complexity thinking offers a useful theoretical foundation from which to understand the nature of dynamic pedagogic change resulting from the application of action research methods.

Results show that process-focused curriculum change can bring about shifts in both learning and assessment. This is seen as being the result of an emergence orientated approach to action research as a counter to more reductionist approaches which are often used and advocated in educational settings by teachers .. We conclude that a combination of complexity thinking and action research can offer a valuable medium through which the educational needs of learners and teachers can be addressed in different, localised contexts.

Introduction

The introduction of a National Curriculum in England in 1988 (DES 1987, 1989) led to a diminution of the role of teachers as curriculum developers, the result of a forced migration to a more centralised education system by the government of the day. This shift was in part due to the introduction of a content heavy curriculum framework which meant that teachers were increasingly compelled to serve as 'deliverers', rather than 'creators', of that content. . However, in September 2003 a small-scale pilot General Certificate in Secondary Education (GCSE, taken by 14-16 year olds in England, Wales and Northern Ireland) in geography was launched which offered a number of original features to encourage innovative approaches to teaching and learning geography. These features included new areas of subject content for geography at this level, including cultural geography, planning and a module on Geographic Information Systems (GIS). In addition, the new content was embedded within a flexible

curriculum which allowed teachers and students a wide choice of the content they wished to study; the philosophy underpinning the curriculum was one which advocated depth of study over breadth. Finally, the assessment regime included a variety of assessment approaches which assessed worked completed within the course rather than emphasising traditional terminal examinations.

The new departures offered by the project created an opportunity for teachers to develop innovative approaches to both curriculum making and assessment as little pre-existing material was available, giving the teachers involved a more central role in developing the course.. It was this potential for innovation in curriculum making, learning and assessment which motivated teachers, academics and researchers to become involved in the Pilot Geography GCSE. The philosophy of this course allowed, and indeed encouraged, the adoption of new approaches to both curriculum construction and pedagogical practice, when compared to pre-existing mainstream GCSE courses.

An important issue faced in the early development period of the Pilot Geography GCSE was that with so few schools teaching the course most curriculum resources needed to be newly developed, principally by those involved in the project. Little support was initially available from outside this group, particularly with respect to provision of published resources - this acted as a stimulus for teachers to design their own learning materials. The research project reported here focuses on the experiences of one geography department involved in the Pilot and the changes it made in the development of new approaches to classroom practice. These approaches were refined over time to meet the challenges of the curriculum project and the resultant development of classroom pedagogy is argued to be emergent in nature due to the complexity of the processes involved. . Complexity theory is used as a theoretical perspective as it helped foster a holistic deliberation on the process of change and emergence over the course of the project.

Complexity theory and classroom transformation

Complexity theory was initially developed within the physical sciences to describe and explain systems which are too complex to understand, or model, through linear computation, but which are not purely random (Mitchell 2009). Non-linear behaviour results in a lack of predictability - causes and effects are multiple and often independent, although underlying patterns may emerge within the system (Johnson 2007). Many such systems exist in the natural world (such as ant hills (Johnson 2001) and weather systems (Holland 1998)), where behaviour at a small or local scale may appear chaotic, whilst larger scale patterns are more clearly discernable. Such behaviour is the core of the concept of emergence, the process by which interactions in systems (or sub-systems) lead to change, not least in the development of new ideas and ways of working. Boschetti et al (2005) state that there is no standard definition of emergence, but central to the process is the idea that 'complex unities manifest properties that exceed the summed traits and capacities of individual agents..' (Davis and Sumara, 2006, 5). Whilst the origins of complexity theory reside within the natural sciences, it has been increasingly applied to describe and analyse social settings. Early examples of such work in the social sciences included research into cities (Johnson 2001), and into the processes and patterns of activity within business organisations (Stacey 2001, Fonseca 2002).

As a result of the expansion of complexity theory beyond the natural sciences a number of theoretical traditions have started to develop. Richardson and Cilliers (2001) have produced a simple typology of complexity theory, suggesting three distinct approaches: hard complexity, soft complexity and complexity thinking. Hard complexity theory is usually applied within the sciences, based on the application of computational modelling and quantitative analysis. At the opposite extreme, soft complexity theory is often used within the social sciences, where complexity is employed as a metaphor to explain social systems. Somewhere between these two lies complexity thinking defining complex systems as never being fully understood due to the presence of multiple factors interacting across different scales of activity. However, by creating environments and conditions which are conducive to emergence – a term which describes the way in which complex patterns, or systems, develop from numerous simple interactions - coherent change can be discerned. . Hardman (2011) is critical of this last form of complexity theory arguing that all too often researchers claim that the systems they work with

are complex, but offer no empirical evidence to prove this. However, whilst bearing this critique in mind, the current project considers emergent changes in curriculum, learning and assessment through the lens of complexity thinking.

The current paper focuses on the development of a new curriculum over the course of a year. Over this time, a teacher (one of the authors) and students worked together to develop new ways of working with learning, assessment and curriculum. This was achieved without a firm notion at the start of the process as to where the development would lead or end, and given the complex nature of the classroom, it is believed that the current paper demonstrates a practical case study of an emergent curriculum development project.

Osberg and Biesta (2008, 2010) have already considered the notion of emergent curricula, with a focus on the emergence of knowledge within the classroom. Their interest lies mainly in the what, rather than the how of meaning and its emergence. Curriculum is seen as the medium through which the subjectivity of children is shaped as they interact with knowledge, a process often driven by the preconceived goals of formal education systems, As a consequence of this socio-political constraint on the curriculum, driven by common goals and performative structures, Osberg and Biesta argue that '..it means limit must be placed on the kinds of meaning that can emerge in a classroom.' (2008, 315). The threshold they present for an emergentist curriculum is set at a high level, as they see the need for both meaning within learning and the development of human subjectivity itself to be emergent processes; this in turn leads to any notion of goals orientated curricula as falling short of emergent.

Within the current English education system, the threshold for emergence set by Obserg and Biesta (2008) cannot be crossed, as examination structures and a performative education system require a goals centred approach based on state sanctioned knowledge and enculturation. However, in the present study, emergence is defined in a different way, emphasising a participative approach to creating a curriculum which allows learning and assessment approaches to emerge, rather than focusing on the meaning of knowledge; this is a crucial difference as given the official restrictions with regards to sanctioned knowledge, the emergent process must instead focus on changes to pedagogy. Here, students can become

more equal partners in bringing about change. If a process led emergence is possible, Davis and Sumara (2006) provide a useful framework highlighting the need for a number of linked processes to be present. Such conditions exist within classrooms in the following forms:

internal diversity. Systems need to be able to react in a variety of ways by ensuring that diversity exists, so that innovative solutions to problems can occur.

internal redundancy. For diversity to be present there needs to be a level of redundancy, or duplication, within the system - such as shared responsibility and interests. This allows for easy interaction within the system and for elements to compensate for inadequacies within each other, thereby fostering support and success at the group level.

neighbour interactions. Here learning is seen as an interaction of the personal and the social. This leads to the idea that whilst collective interests emerge and are pursued, this does not preclude individual agency - leading to an environment where individual and collective interests are seen as mutually supportive rather than inherently competitive. It is these interactions which allow for the emergence of new ideas and perspectives.

distributed control. To allow the development of rich neighbour interactions, it is essential that the structure and outcomes of a group's activity (in the case of classrooms, this means learning) is not controlled from a single point. Any learning-based group must be given a level of decentralised capability, thereby allowing learning to arise in localised activity.

randomness. The system must allow for the exploration of possibilities, giving opportunity for personal agency and the internal diversity identified above.

coherence. Whilst randomness is important, complex systems are not chaotic and require a level of coherence to orientate the activity of the actors within the system. Therefore, coherence ensures that there is a loose framework within which individuals operate (Davis and Sumara 2006).

By holding these factors in tension, for example by balancing randomness and coherence, complexity thinking sees emergence of new ideas and processes

.

This is supported by Morrison (2003) who argues that with constantly changing educational environments and policies, any notion that curriculum, learning and assessment are developed through stable linear systems is untenable:

'Linear, mechanistic models of curricula no longer apply, and networks and dynamical, ever-changing curricula and turbulent environments are the order of the day….Gone are the simplistic views of linear causality, the ability to predict, control and manipulate, and the scientistic advancement of instrumental reason, and in come uncertainty, networks and connection, self-organization, emergence over time through feedback and the relationships of the internal and external environments, and survival and development through adaptation and change.'

(Morrison 2003: 286-7)

Morrison further argues that to realise curriculum change as part of a complex adaptive system, learning and assessment must also be explicit in the development of classroom environments. As curriculum, learning and assessment are inherently linked, a combined model of the classroom system developed by Shepard (2000) is a useful starting point (Figure 1). Shepard's work focused on the interplay of these factors and their roles in creating classroom cultures with particular reference to assessment. All the elements of the system are interlinked, whereby changes to any component will potentially have associated impacts on the character and success of the other two.
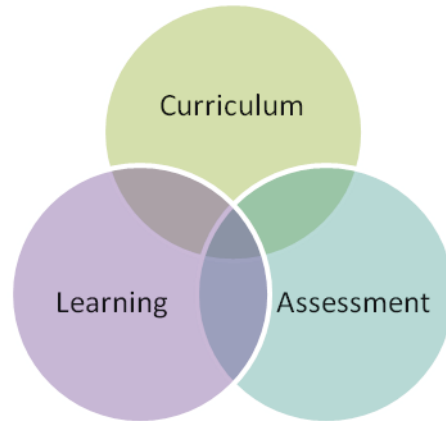
Figure 1 Diagram showing relationship between main elements of classroom pedagogy (based on Shepard 2000)

Complexity and Action Research

Shepard highlights the explicit links between curriculum, learning and assessment, but the model is incomplete as two elements are missing, the teacher (acting as a director and facilitator) and students (as learners and critical friends) (see Figure 2). Stenhouse (1975) argues that the role of the reflective practitioner is central to the development of classroom processes. The basis on which this research was developed was to see change as a complex process of innovation within curriculum, learning and assessment processes, facilitated by the teacher (one of the authors), who in turn created an environment in which students were able to play a part in developing the course they were themselves studying.
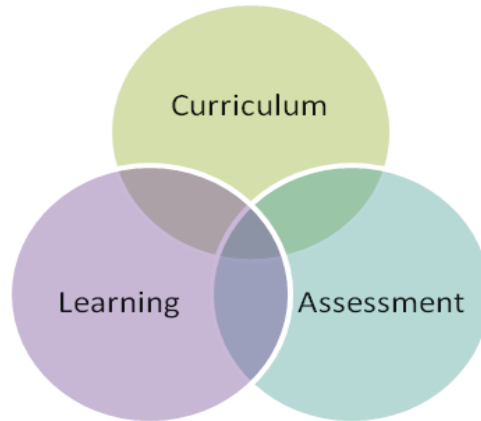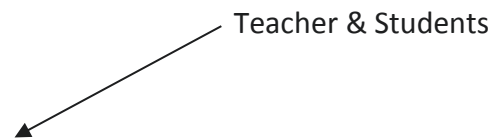
Figure 2 Developing a complex methodology

Teacher & Students

Osberg et al (2008) highlight one way of generating classroom practices when they state,

'..we are trying to articulate a different ethic or 'way of being' in education, that is less concerned with representing the real than it is with living it out in different ways.'

(Osberg et al, 2008, 214)

This suggests an approach to change which attempts to create new ways of working within a broad framework to allow differenet trajectories to emerge. This was attempted here through the application of an action research methodology with students working with their teacher to construct an emergent curriculum/learning/assessment system. The resultant approach to curriculum-making is similar in form to the process-led activity of Stenhouse (1975), as opposed to operating around simplistic behavioural objectives (Scott, 2008) inherent in the critique of Osberg and Bieta (2008) in relation to subjectification and knowledge building.

The idea of the reflective, critical professional as a contributor to curriculum planning and development has a long history (Stenhouse, 1975). In the case of geography education, the use of action research methodologies soon proved popular internationally (Gerber and Williams 2000, Butt 2002, 2010, Hillcoat 1996, Kwan and Lee 1994, Naish 1996) as teaching professionals

attempted to improve the quality of student learning within their classrooms – often within a context where theory had little obvious, immediate practical meaning. Many examples of action research are teacher-centred and teacher driven with little or no student involvement, which may act to close down the spectrum of potential trajectories of change. Here, the inclusion of learners in the process was intended to help create an environment where the emergent processes laid out by Davis and Sumara (2006) would have opportunity to flourish.

Any attempt to define action research is difficult, as it employs different techniques in different situations (McKernan 2008). Nonetheless, the basic foundation on which all action research was established is that of reflective practice linked to action within a particular social setting (Carr and Kemmis 1986, Elliot 1991, McNiff 1993). In the case of the project reported here the focus was on the development of a participative action research approach. This included seeking the opinions and reflections of students leading to emergent practices precipitating from the research, a process which lasted for a period of 18 months.

Radford (2007) is critical of certain approaches to action research, particularly those advocated by UK government policy (TTA 1998) such as the Qualification and Curriculum Authority's *Disciplined Curriculum Innovation* concept (QCA 2008). He argues that these are essentially reductionist in character and lead to a misplaced view that change can be brought about in simple and easily measureable ways, predominantly by seeking quantifiable outcomes; complexity theory fundamentally challenges such thinking. Radford suggests that outcomes should not be planned in detail at the beginning of the process and that a broader, more holistic view of research should be applied. This fits well with the view of practitioner development and action research as advocated by Stenhouse (1975), focusing on a generative process which brings change through reflection. However, Radford (2007) does highlight a danger in action research that it may lead to narrow, almost predefined, areas of focus which in turn hinder a wider, emergent view of change and development. If action research is to be a useful practical tool in bringing emergent change to classroom environments it must ensure that different voices and ideas are enabled.

Phelps and Hase (2002) have already argued for overlaps between complexity theory and the methodological grounding of action research. These include e common interests in open, non-linear systems, emergent change, the lack of predetermined endpoints, and the primacy of self-organised adaption. They also emphasise the interaction between agents in bringing about change, similar to the 'neighbour interactions' and 'distributed control' identified by Davis and Sumara (2006). Phelps and Hase (2002) also discuss the role of feedback and feedforward in unpredictable situations which help to bring system stability - once again characteristics inherent in carrying out action research, but also core features of complex systems. This presents a very different picture of action research when compared to Radford (2007), and suggests that careful, and consistent reflection on the process of action research is crucial if it is not to collapse into a reductionist pursuit for the 'correct answer'.

Finally, given the nature of action research being focused on bringing about change, there is an ethical issue to be considered within such research. Given that emergence, by definition, cannot be certain of the direction and outcomes of change, is there an ethical problem with using such an approach in curricula and pedagogic work? Woermann and Cilliers (2012) highlight this by arguing that any decision we make is based in part on subjective grounds as we cannot have full knowledge of any complex system of which we are a part and which we are attempting to change. They argue that there is no easy resolution to this issue other than to ensure that we ensure constant critique and self-critique in the decisions we make, in their words, 'the ethics of complexity cannot do more than generate awareness of the fact that we are always in trouble.' (p. 451). This makes the reflective and discursive elements of action research vital so that those concerned are aware of what they are doing and how change may impact on their lives.

In the project reported here, complexity thinking and action research are brought together to test the validity of these theoretical bases when seeking to understand the development of a curriculum project conducted at the classroom level. This led to two main research questions:

1.   Is it possible to develop an approach to curricula and pedagogic change which is truly emergentist?

2. Can action research offer a positive framework for developing and understanding emergentist approaches?

Institutional background

The action research project reported here was carried out over a period of approximately 18 months (from 2004 to 2006) at Every School, a large co-educational comprehensive school in the East of England. The school had approximately 1300 students on roll, including a sixth form of around 200 students. It is located 7 miles from a large city and serves a diverse catchment. Many of the students at the school are local children from nearby settlements, with a large minority from a small market town and its surrounding rural areas. The school had a lower proportion of students eligible for free school meals than the national average; the proportion of SEN students was in line with the national average. One of the authors was the classroom teacher who worked with the students to develop the curricula, learning and assessment approaches discussed below.

Methods of data collection

The methods of data collection employed during the course of the research were:

- Questionnaires. These were used to gain a broad view from students at each stage of the project so that all students involved had a voice for reflecting on their experiences and at the same time identifying how they would like their learning to change and develop over the next period.

- Focus groups. At the end of each stage of the project, a focus group of six students from each class was convened to discuss learning experiences and how the students believed their learning could be taken forward in the most positive ways over the next period.
- Reflective student diaries. Six students from each class were willing to keep a reflective diary of their learning and thoughts about the course. These were collected in at the end of each cycle of the action research which led to informal conversations about their perceptions.

At the end of each cycle, the reflective student diaries and questionnaire results acted as a basis for the focus group discussions so that a number of student views were used as a starting point for considering further development and change. We are fully aware of the fact that the teacher had the ultimate power to vito ideas where there was understanding that they may not be acceptable to the sider school system. Whilst not required on many occasions during discussion, these demonstrated the potential for asymmetrical power dynamics to arise and stifle potential avenues for emergence. Table 1 shows the timeframes and nature of the data collection over the course of the project.

Period	Focus	Data capture
Spring 2005	Baseline assessment of learning and assessment (general student population)	Questionnaires on learning and assessment, focus groupsfocus groups
Summer 2005	Action Research Cycle 1	Questionnaire
Autumn/Winter 2005	Action Research Cycle 2	Questionnaire, focus groupsfocus groups, student diaries
Spring/Summer 2006	Action Research Cycle 3	Questionnaire, focus groupsfocus groups, student diaries

Summer 2006	Final assessment of learning and assessment	Questionnaires on learning and assessment, focus groupsfocus groups. GCSE results

Table 1 Data collection framework

For formal analysis at the end of the project, transcripts of the focus groups and the diary entries were thematically coded to understand the main issues and ideas which students considered important as the curriculum, learning and assessment model emerged through the year.

Sample

The baseline element of the research data was collected through a questionnaire survey of the whole cohort of students in years 7 (aged 11-12), 9 (aged 13-14), and 11 (aged 15-16) (between 150-200 respondents in each year), and the use of focus groups and student diaries with sub-cohorts of 12 students from each year group. Given the nature of the action research, the main research cycles focused on the work of two groups following the Pilot Geography GCSE course. In 2004/05, the school altered its curriculum to allow students in the upper ability range (initially two from nine groups across the year) to begin their geography and history GCSEs in year 9. Within this year group these students all had a CAT (Cognitive Ability Test) score of 110, or greater. Consequently, the first action research group, for the main developmental period (academic year 2005/06), was a Year 10 (aged 14-15) group in the second year of their GCSE study.

The second group was a year younger (13-14 year olds). During the period of action research, they were members of a year 9 GCSE geography group following the first year of their course.

Unlike those in the year above, these students were part of an expanded upper ability band which had been doubled in size to include the top four groups in the year. This group included those at the bottom end of this upper ability band, with most students having CAT scores of between 90 and 100.

Results

Baseline

The baseline was used to give an initial impression of the perceptions of students concerning geography as a subject within the wider curriculum, and to act as a starting point for change. Surveys completed with Year 7, 9 and 11 students showed some very consistent patterns concerning their learning preferences and perceptions of assessment. With respect to learning, all students showed a preference for active learning approaches; most popular was the use of computers in learning, followed by the opportunity to do fieldwork linked to a project, or other aspect of course work.

Survey results focusing on assessment showed a number of consistent outcomes. Students preferred the opportunity to complete assessments through media such as ICT, group activities and presentations, or coursework. A typical response from a student when discussing their assessment preferences is given below,

'…coursework, especially fieldwork with follow-up projects. You can work by yourself in class……..any assessment that can be done over a number of lessons.'

(Girl A, questionnaire, Year 11)

Students from higher year groups showed greater levels of negativity in their views on assessment. Year 7 students were more likely to identify assessments as challenging them to think, whilst year 9 and 11 students saw the process of assessment as stressful and adding pressure to their learning. Another difference between Year 7 and the higher years was centred on styles of feedback. Year 7 students believed that both grades and comments were important as feedback, whilst students in Year 9 and 11 highlighted the receipt of grades as most important.

The surveys and focus groups led to an initial decision to develop student-centred learning approaches through the research period, and to link them to the opportunities afforded by a new curriculum for the introduction of innovative assessment practices. Over the three cycles of action research, particular patterns of change emerged through student participation in the research process.

Curriculum

The curriculum emerged around a central focus on effecting choice for students wherever possible, both in terms of the learning approaches adopted and the curriculum content the students followed. Less choice was available to the Year 9 group as they were completing a core element of the curriculum which had less inherent content choice. However, even here, opportunities existed to establish choice. One Year 9 unit of work focusing on 'Extreme Environments' was centred on developing a holistic understanding of a particular environment, in this case the Himalayas. A degree of choice was achieved through a simulation called the 'Essential Guides Series', where students were asked to complete the majority of their work through creating a guide to the Himalayas. This acted as a portfolio of work on the unit, giving some curriculum autonomy in relation to areas of content and format.

Year 10 students were afforded a greater level of choice by being offered alternative units of work, available in the second year of the course - either studying Coasts, or engaging in Fieldwork, followed by a module on Cultural Geography or Travel and Tourism. By allowing this simple choice, students were able to play a role in deciding the nature of the geography curriculum they followed.

The curriculum for both Year 9 and 10 was developed to allow students to play a more student-centred role in expanding their own learning and creating learning environments which were process, rather than product, oriented. This is highlighted in the results of an interview which asked Year 9 students to reflect on the elements of a 'My Place' unit (focused on local geography) which they had enjoyed most. The focus group highlighted a portfolio piece based

on diaries they had developed, which recorded their use of the local area. The reasons given for them favouring this piece of work were that the outline was focused enough to make the exercise clear, but also flexible enough to allow students to do 'your own thing' (Girl A, year 9). Furthermore, one student commented that the unit encouraged 'research about yourself' (Girl B, year 9), making the exercise more interesting and relevant. The fact that students were able to write up their portfolio piece on Powerpoint, as opposed to producing a standard written report, led to some commenting that they preferred this work, as it 'doesn't feel like writing' (Boy A, Year 9).

The generally positive reception of a more autonomy-driven curriculum led to the emergence of a structure which used clear frameworking and resource support, whilst retaining a varied choice in formats and content. This ensured that the curriculum remained process, rather than product, driven, a system which was achieved by developing a curriculum approach for each unit of study in which introductory, teacher-led work, was completed before engagement with a student-led follow-up activity, in which student autonomy was retained. The work was therefore structured, but still allowed for independent effort and decision-making.

Learning

Student views, prior to the start of the research project, demonstrated a strong preference for engaging with learning through the use of ICT and project work. To support more autonomous student working styles, particularly in Year 10, a 'projects–based' approach to the units was developed - with each section having a 'key lesson' to introduce an area of work, leading to a three or four lesson mini project. However, an attempt to create an independent learning unit for the Year 9 group - focusing on issues of tourism, to be completed via a website during a school holiday - showed that whilst ICT was a popular medium, the context of learning was still important. In this case, whilst all students had liked the nature of the tasks and the digital interface, some did not like completing it in their own time. Others found the lack of direct teacher support a block to their progress. This showed that there were limits to the introduction of independent learning beyond which the students were unwilling to go.

Through reflections on the learning completed during the research period, students emphasised a general confidence towards the processes of curriculum and pedagogical change across both year groups. They asserted that they understood the work well, with both groups reporting that they had enjoyed the extensive use of ICT. As the research progressed, this led to the development of an emergent model of ICT integration into the learning process which focused on the facilitation of independent and student-centred approaches through the use of computer mediated learning. These were supported by other face-to-face, and group, activities. However, it was noted through informal observation that some students in year 9, mainly boys, became progressively less efficient when using ICT in taught sessions as they started to employ the computers for internet gaming if not closely supervised.

All students highlighted that the work they had been asked to undertake had been both student-centred and independent. Most found this positive, with many comments in both survey and focus-group data emphasising that the work had been challenging:

'very challenging – the most challenging work I have done at school' (Boy C, questionnaire, Year 9)

Whilst the majority of students were very positive about the transformations being developed, a minority of students found the level of independence offered difficult to embrace, for example,

'I would have preferred more structure, with more lessons where you told us stuff. I'm not always that motivated and the way we've been working made it difficult for me.' (Boy B, interview, Year 10)

This minority view led to the need to consider how a greater level of structure could be reintroduced in a way that would still allow for the independence which many preferred whilst also supporting those who required more help. This led to the attempt to develop a form of 'structured independence' as outlined below. It also demonstrates in practical terms Woermann and Cilliers' (2012) notion of constant reflection and awareness that we are 'always

in trouble', needing to act ethically to ensure that all students are engaged and learning to their potential.

The wide spectrum of learning approaches afforded was very popular - for example, there was widespread support for the diary exercise (outlined above) and fieldwork in year 9, and fieldwork and internet orientated research in year 10. To sustain these more autonomous approaches, unit booklets were written for year 10, which were seen by the students as a good starting point for further research work as they helped to develop their understanding. As an extension of the project-oriented work, Year 9 students were given the opportunity to develop a strand of experiential learning, which included an evening at a local climbing centre as part of their work on the Himalayas. Most also took the opportunity to spend a weekend in the Lake District studying glacial landscapes and visiting the National Mountain Exhibition.

Students emphasised the development of their learning environment as allowing them to engage in more independent work, an approach which most students found to be a very positive aspect of the course. The associated variety of approaches taken was also seen as a strength, for example,

'I have enjoyed doing work in different ways.' (Girl C, questionnaire, Year 9)

'Good fun trying out new ways of presenting ideas.' (Boy D, questionnaire, year 9)

'We got a lot of guidance, how and what to do, at the start…..but then very independent for each piece of work.' (Boy B, interview, Year 10)

The development of structured independence was particularly emphasised by some of the year 10 students, who saw the teaching and learning approaches adapted in the final action research cycle as challenging them, whilst also ultimately allowing them to develop their own learning,

'It's been very laissez-faire. There are the tasks you need to complete and rather than walk us through them stage by stage….telling us every five minutes what comes next, you've let us get on with it. It has been much better.' (Boy A, interview, year 10)

'Yeah, we've had more independence. It has motivated me more to get it done.' (Girl A, interview, year 10)

The development of strands of student-centred and independent approaches, facilitated by the use of ICT, led to a learning environment where students could be challenged whilst allowing them a degree of autonomy. All of this occurred in clearly defined structures, highlighting the notion of freedom within coherence - as emphasised by the complexity thinking approaches of Davis and Sumara (2006).

Assessment

The main developments in assessment which emerged through the course of the research were the extended use of comment-led feedback, and the introduction of e-submission and e-feedback to increase flexibility. Draft work was submitted for feedback, with 'comment only' marking being used to support the development of students' work. One major change to previous practice was that students were told that they would be allowed to submit only one draft for each assessed piece of work. They therefore had to decide at which point they were ready for individual feedback, leading to a flexible, formative assessment system. Work could also be submitted by e-mail rather than on paper, to be marked online and returned with comments added.

Both year 9 and 10 students highlighted that they had received a lot of useful feedback, leading to the development of a dialogic cycle and extension of their thinking. For example,

'The comments I have found most useful must be the ones like 'explain why' 'cause this then helps me improve my work. This was helpful because I can extend my work and explain more.' (Girl B, interview, Year 9)

Whilst some students preferred to physically hand their work in, many took the option of submitting draft work by e-mail. A popularly stated reason for this was that work was often returned very quickly, leading to the opportunity to continue working prior to the next timetabled lesson.

Both year 9 and 10 students again highlighted the quality and amount of feedback they had received. Clear elements of feed forward were developed to ensure that the enhancement of learning was at the centre of the assessment process, with the adoption of wider ranging styles of assessment. One year 9 student stated, in an end of cycle interview:

'…the geography assessments test us out in lots of different ways.' (Boy B, interview, Year 9)

Once again, the submission of much of the draft portfolio work allowed for rapid feed back and feed forward,

'…and we get it back really quickly as well. That's really helpful as we can get on and not have to wait until the next lesson.' (Girl B, interview, Year 10)

Assessment became deeply integrated into classroom learning, a form of 'assessment as learning' (Dann, 2002). The development of a dialogic cycle in assessment meant that, as with learning, the focus migrated towards the process and away from simple outcomes.

The role of the teacher

As a consequence of the major change in pedagogical approach which emerged over the course of the action research cycles, the role of the teacher also changed. Students in both year groups felt that many of their teachers had previously 'led from the front' of the classroom, talked for much of the time, and then asked them to complete textbook work. Students stated that the pedagogy that had developed in the department through this project had shifted the teacher's role to that of a facilitator - supporting with more formal inputs at points where new areas of content needed to be introduced.

The greater level of independent learning also led to a shift in the role of the teacher, again, seen positively by the students,

'Means you've given more individual help when it is needed; feeding back when we need it.' (Girl A, Year 10).

The role of the teacher also developed beyond that of an individual responsible for curriculum delivery. The act of undertaking the action research project, particularly in attempting to work within an emergentist framework, led to a different form of relationship with the students and led to a widening consideration of the meaning of pedagogy and curriculum. However, this was constantly managed within the bounds of external pressures and policies which were increasingly apparent as the project developed.

Examination Outcomes

The students' perceptions of the ways in which they were taught and assessed were overwhelmingly positive by the end of the third action research cycle; these perceptions were further supported by externally examined results for both groups. The year 9 group was a mid-ability group, sitting the first half of the GCSE assessment a year early - but on the basis of only 67% of the time input normally given to groups for GCSE courses within the school. Table 5 shows the average course results by gender.

	Expected Grades*	Actual Grades	Difference
Boys			
Average Points**	4.9	5.1	0.2
Girls			
Average Points	4.9	5.4	0.5

Table 5 Year 9 Average GCSE Results for the Core Element of the Course by Gender

* - expected grades are those predicted by model D in Fisher Family Trust Grade Predictions. That is, predicted grades calculated using attainment data from the top 25% of schools in the country;

** - values based on numeric scores taken from GCSE grades, G grade = 1, F grade = 2, etc.

The boys' attainment is just above that expected through grade predictions (compared to that expected across the top 25% of schools in the country), whilst the girls were on average half a GCSE grade above expectation, showing that this group performed extremely well. The results show positive residuals which need to be considered in the light of the students completing the assessments a year earlier than normal, and with reduced curriculum time.

 The Year 10 group, again, completed the GCSE course a year early – doing so within 67% of the normal curriculum time given to other GCSE students. The results (Table 6) show the girls did very well, on average exceeding expectations by just over half a GCSE grade. In contrast, the boys actually did slightly worse than expected, by almost half a grade. This suggests that the outcomes for this cohort of students was not as positive as it might be. The negative residual may demonstrate that the development of the curriculum and pedagogic approach had not been successful. However, of the students involved a large minority were expected to attain the highest grade possible. This skews the residual as these students could not exceed, only fall below their target. Having said this, for this group, the final outcome in grade terms is less certain than for the other cohorts across the two groups

	Expected Grades*	Actual Grades	Difference
Boys			
Average Points**	6.9	6.5	-0.4
Girls			
Average Points	6.5	7.1	0.6

Table 6 Year 10 Average GCSE Results for the Core Element of the Course by Gender

(for explanation see note under Table 5)

Discussion

Osberg and Biesta (2008, 2010) outline a form of emergentist curriculum which focuses on the nature and emergence of knowledge. They argue that inclusive curricula can only occur where subjectification of children is not predetermined and can develop in many different ways. The consequence of this is that the curriculum must not have any established end points or outcomes. Such an emergentist curriculum is not possible in the current English system as external factors to the classroom, such as examinations and an imposed curriculum document ensure at least a degree of enculturation and goal-orientated activity; however, their model assumes that emergence is a process focusing on knowledge. However, if we see the process through which the curriculum, learning and assessment develop as emergent in its own right, i.e. that the process of learning and teaching is emergent as opposed to the knowledge with which it interacts, then this opens an alternative way of understanding the possible emergent nature of curriculum and pedagogy.

Davis and Sumara (2006) highlight a number of aspects of the classroom which encourage emergent patterns in learning and teaching. By stimulating a diversity of learning approaches in this study a number of innovations were considered, and then assessed. This led to 'positive redundancy' over the period of the project, allowing both teachers and students to further understand the forms of learning which are motivational, and helping them to appreciate the form and content of pedagogical practice which best enables student progress.

The independent nature of learning allowed for neighbour interactions and distributed control within the classroom, encouraging more open dialogue between the students and their teacher with regard to course development. These interactions were facilitated by 'distributed control' - a process emphasised in comments from the students, which served to highlight that teachers had adopted such a role during the life of the project. 'Distributed control' largely occurred at the more 'formal' level of curriculum change, encouraged through periodic reflection by the teacher and students regarding the type of learning to be fostered. It also occurred as part of the learning process itself, as students began to better understand the nature of independent study and learning. These changes stimulated greater engagement in learning by many

students. This is evidenced through student comments concerning their motivation and positive perceptions about the new learning activities.

The emergent curriculum, and associated learning activities, were given coherence by the course specification and use of action research - leading to 'participation in a joint project' (Davis and Sumara 2006: 149). However, for emergence to occur, whilst a coherent framework for structuring the curriculum and responding to learning needs is necessary there must also be appropriate freedoms to encourage change. The independent nature of learning, the use of flexible assessment methods, and the choice afforded by the curriculum making process all led to greater degrees of freedom within the pedagogic process. The increase in personal agency, for both teachers and students, encouraged debate and presented regular foci for change which facilitated emergent processes.

The development of the curriculum, and its associated learning and assessment methods, followed coherent trajectories. But these were emergent in that they could not be planned in any detail beforehand. The innovations which arose from the project were not part of a linear, predetermined process but were organic - they emerged out of experimentation, experience and discussion. As Morrison (2003) highlights, this was a process of adaptation, self-organisation and change, led by constant feedback and development. With an emergent innovative curriculum system being developed over the course of the project, the use of action research was of paramount importance as it facilitated discussions and encouraged change within a coherent framework. In these ways there is clear evidence from this project that even in a performative culture such as the English GCSE system, there is ample opportunity for emergentist approaches to curriculum and pedagogy, on the condition that the emergence is focused on these processes as opposed to one based on emergence of knowledge itself. Here the current system has little to offer.

Towards the end of the project an emerging conceptual model of curriculum, learning and assessment was revisited, developed from the initial framework of Shepard (2001). Figure 3 shows the emergent contextualised framework for innovative pedagogy.
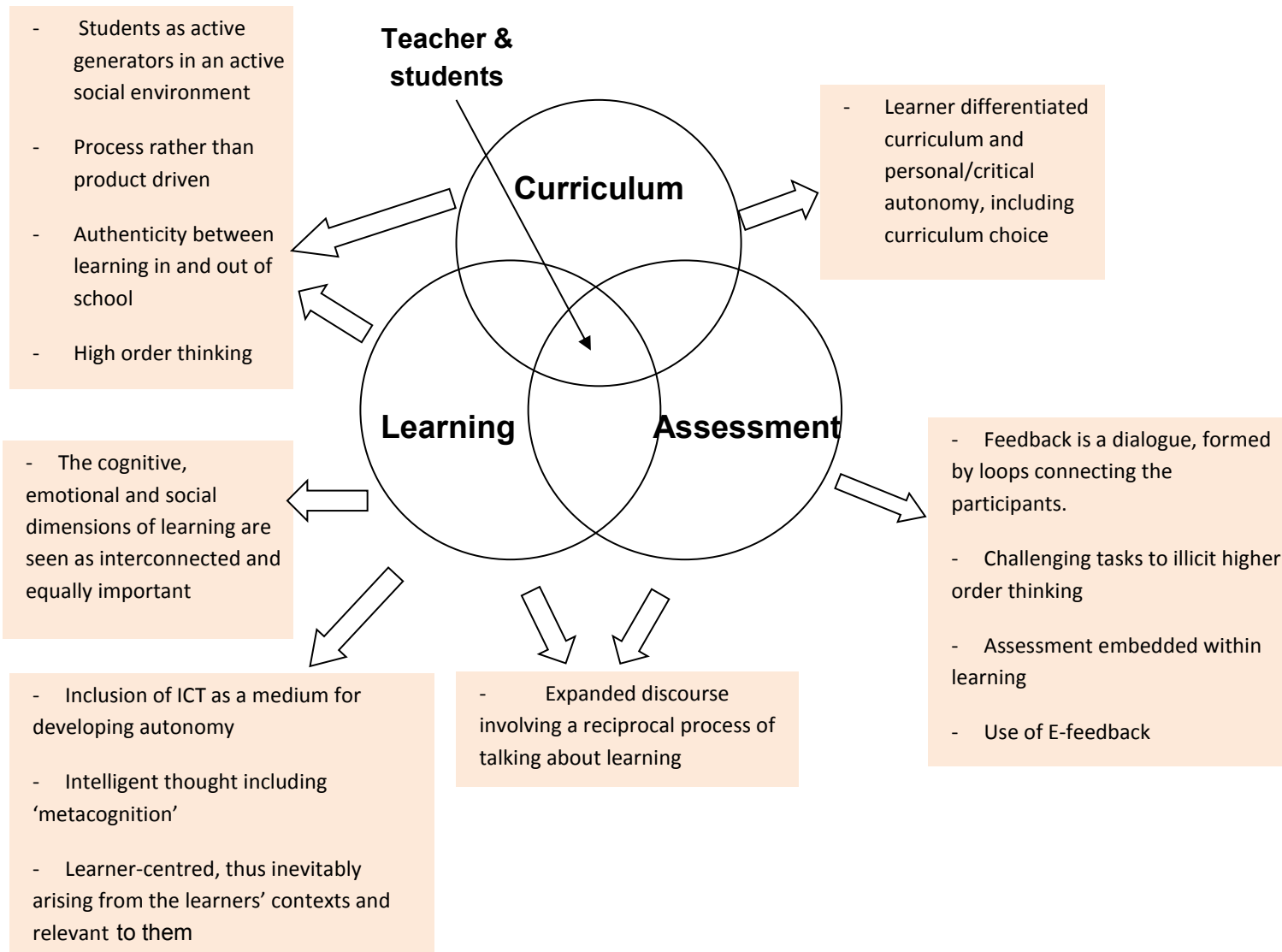

Figure 3. Summary emergent framework for innovative pedagogy for

the Pilot Geography GCSE course

The curriculum model emerged to offer a learner-differentiated curriculum which facilitated student choice and autonomy. Within this framework students became more active partners in their own learning within the context of a wider social environment - in part facilitated by them being given freedom to work individually or in groups, and to arrange the learning environment how they wished. The focus of the curriculum and learning was process driven, emphasising the development of understanding rather than the memorisation of facts. This led to higher order thinking and the development of metacognition through meaningful discourses about both understanding and learning, a process which was encouraged by the use of looped feedback and feed forward, particularly via e-mail.

Conclusion

Radford (2007) highlights the dangers of taking a reductive approach to action research. Such reduction tends to lead to the acceptance of simplistic views of cause and effect, and of linear progress created through controlled (often narrow) interventions. Curriculum development and the process of learning can become characterised as being linear - achieved through simplistic and narrow interventions, often with a predetermined endpoint in mind.

In contrast, Phelps and Hase (2002), argue that action research can serve as an ally of emergence within complex systems. The utility of a developmental framework based on process and complexity, achieved through the application of participative action research approaches is its offer of a critical and adaptive lens for curriculum and pedagogical innovation. Complexity thinking characterises classrooms and pedagogy as a more holistic system, with large numbers of variables linking together in a non-linear, often unpredictable, fashion. As Davis and Sumara (2006) show a number of processes, often themselves in tension, need to be encouraged if successful, emergent learning environments are to take shape. Innovative development cannot possibly be predicted or fostered in reductionist, pre-determined ways.

Rather, the development of pedagogy requires looser, emergent, but structured change. Complexity thinking and action research can offer positive frameworks for planning and executing such innovative change. They do not, and indeed cannot, offer clear and detailed steps for innovation - for such generalised models as these will always be too vague to be applied easily in particular circumstances. Consequently, it is not possible to offer generalised, theoretical models of 'best practice' as these will only ever be approximations and generic in character. Instead complexity thinking and action research offer ways of working and 'seeing' which is contextualised and takes due account of the needs of particular learners and teachers in different, localised contexts.

The results from this research project suggest that not only can emergentist curricula, learning and assessment approaches be developed, but that action research can offer a positive medium through which to achieve this. However, for this to be successful, the reductive tendencies of some action research approaches need to be explicitly and consistently challenged, and the ethical stance of being in constant 'positions of trouble' (Woermann and Cilliers, 2012) need to be remembered to ensure that all voices are heard and engaged with as new patterns of being emerge. In this sense, action research can be a positive medium for complexity, but it is in no way assured.

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