

Evaluating the wider outcomes of schools: Complex Systems Modelling

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A continuing challenge for the education system is how to evaluate the wider outcomes of schools. Academic results are important but other, less easily quantifiable measures of success make for a complete education. For example, the development of students as life-long learners, employability skills, citizenship, self-confidence, teamwork and emotional wellbeing are widely recognised as essential qualities for individual success in adult life and for social cohesion. Unless methods are found to evaluate these broader outcomes, the education system will continue to focus on a single measure of school effectiveness: test/exam results. This paper describes the rationale and methodology underpinning a pilot research project that applies hierarchical process modelling to schools as complex living systems, using software developed by engineers at the University of Bristol, called Perimeta. The aim is to create a systems design which accounts for the full range of outcomes valued by each school, collect evidence of success – in the form of quantitative, qualitative and narrative data – and to model this using Perimeta software which returns visual analytic feedback against each outcome in the form of the Italian flag. Red represents what is not working, green represents what is successful and white represents what is not known, and is therefore an area for organisational learning and development. The project involves three Academies in the UK. The systems design which has been developed to underpin this pilot study, is one which recognises that the purpose of the school is to facilitate the learning and achievement of all students and the core processes which are essential for fulfilling this are: leadership learning, teacher learning and student learning.

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Evaluating Wider Outcomes of Schools

1. Introduction

The purpose of this paper is to describe the rationale and methodology underpinning a pilot research project that applies hierarchical process modelling to schools as complex living systems, using software developed by engineers at the University of Bristol, called Perimeta. The aims of the project are (i) to create a systems design which accounts for the full range of outcomes valued by each school (ii) to collect evidence of success – in the form of quantitative, qualitative and narrative data – and (iii) to model this using Perimeta software which returns visual analytic feedback against each outcome in the form of the Italian flag. Red represents what is not working, green represents what is successful and white represents what is not known, and is therefore an area for organisational learning and development. The project involves three Oasis Academies² in the UK. The systems design which has been developed to underpin this pilot study, is one which recognises that the purpose of the school is to facilitate the learning and achievement of all students and the core processes which are essential for fulfilling this are: leadership learning, teacher learning and student learning. In the first section we present the rationale for the project, then we explore why complex systems thinking is a useful approach for school improvement and discuss the three core processes which are the focus for data collection. Finally we describe hierarchical process modelling, the Perimeta software and briefly describe the data collection methods, before summarising next steps and discussing critical issues.

2. Background and rationale

Ten years ago Macbeath and McGlynn (2002) reviewed thirty years of school effectiveness research and described the shift that had occurred from evaluating schools as whole units to a more specific focus on what is happening in individual classrooms. They argued that this shift should be complemented by a wider focus on school culture:

'It is not a matter of either/or: school or classroom, management or teachers, teaching or learning. Measuring effectiveness means sharpening our thinking as to where we should give most attention and invest our energies at any given time and in the light of the priorities we pursue. And as we get better at it we recognise that in good schools the boundaries between different levels become so blurred that they defy even the most inventive of statistical techniques'. (2002:6)

They then go on to describe a model of evaluation that puts pupil learning at the centre but set in the context of a school culture that sustains staff learning, leadership that creates and maintains the culture and an outward-facing dimension involving home and community. They continue:

*'In deciding **what** to evaluate there is an irresistible temptation to measure what is easiest and most accessible to measurement. Measurement of pupil attainment is unambiguously concrete and appealing because over a century and more we have*

² The project team are grateful for the joint sponsorship from Oasis Community Learning, the University of Bristol Research Committee and PA Consulting.

honed the instruments for assessing attainment (and used them) for monitoring and comparing teacher effectiveness'. (2002:7)

The distinction between assessment and evaluation is that the latter demands taking a step back from a specific piece of work or programme of study and asking questions like: was the experience worthwhile? What did I learn from the process? What might I do next time to improve? How am I developing as an effective learner?

The early application of information technology as a tool to support data-gathering and analysis for the evaluation of school performance, combined with a target-driven culture of school improvement, has resulted in an ever more single-minded focus on quantifiable measures of success in schools. Fuelled by political imperatives, this has led to a reductionist focus on test performance at the expense of a wider, more balanced range of outcomes. Davies (2011) raises similar concerns about the current restricted view of 'success' from the perspective of strategic leadership. He suggests that, by focusing on too narrow a range of school performance measures, the upward trajectory of pupil attainment might plateau:

'Success can be seen in how children achieve academically, socially, spiritually, physically and emotionally; it is enabling children to be all they can be. The difficult question is how do you know that you have been successful? Standardized test scores, even when adjusted for value-added dimensions, tell only part of the story. Two challenges emerge. One is that measuring success by easily quantifiable measures is to ignore that some aspects of success are recognised by indicators which point to success, but do not by any means fully explain or measure that success. Secondly, approaches that make schools successful initially may not be the ones that are necessary to take them on to higher levels of performance, so that isolating what approaches lead to sustainable success is difficult. A good example of this is the difference between shallow and deep learning. Coaching children for standard assessment tasks (SATS) tests may increase short term results and the school would be considered successful. However, instead of putting in enormous efforts every year to boost results, a longer-term and more sustainable approach would be to involve 'deep learning' approaches that develop a learning culture in individuals and the school'. (2006:12)

However as technology has continued to develop there are new opportunities emerging for the re-presentation of complex data and the development of learning analytics which offer new ways of responding to complexity in learning communities (Buckingham Shum and Deakin Crick, 2012). Combined with insights into systems thinking, systems design and systems modelling developed in the corporate sector and in Engineering in particular, new technologies offer a potentially richer approach to evaluating the wider purposes of education and taking a broader view of pupil outcomes which is a better representation of the 'messy reality' of life in learning organisations.

The ultimate aim of this project is to develop useful ways of assessing complex processes in learning communities which encourage powerful learning and feedback at all levels of the learning system. What we are seeking for is a richer approach to evidence based self-evaluation which will enable a holistic approach to learning and performance, a participatory

culture of high aspirations and deep learning and a context of continual improvement where standards of pupil attainment continue to improve.

All this is a particular challenge for schools and groups of schools which have a broader view of education and a desire to extend the measures of school performance beyond the easily quantifiable. These include schools underpinned by alternative philosophies such as Co-operative schools or Humanscale schools as well as many faith based schools. Writing from the perspective of Church schools, for example, (Grace, 2002) refers to this challenge when he writes:

'Such religious and transcendent purposes, a sense of mission rather than simply of provision, gives...depth to a schooling process that is otherwise dominated by a rhetoric of test scores, performance standards and professional accountability'.

Bryk et al (1993) also point to the need for more studies of the inspirational ideology which animates many Catholic schools. They admit the scepticism which this idea produces, especially in a research culture strongly influenced by secular and positivistic assumptions, but make a powerful case for such research:

'Some may question our claim of a causal role for this inspirational ideology unlike the effects of academic organization or school structure, which can be largely captured in regression analysis and effect sizes, estimating the influence of ideology is a more complex and less certain endeavour. Ironically, these effects are harder to study and yet also more pervasive ... To ignore the importance of ideology because it cannot be easily captured in statistical analysis or summarised with numbers would be a serious mistake. Statistical analysis can help us to see some things but they can also blind us to the influence of factors that are beyond their current horizons'. (1993, 303-4)

This pilot research project takes on the challenge of evaluating the wider intentions and outcomes of schools more systematically, drawing on both quantitative, qualitative and narrative data. Good schools have always sought the views of students and parents in taking a broader view about how well the school is doing and planning for change. In the UK, Ofsted inspections continue to monitor broader aspects of education like spiritual, moral, social and cultural development but this evidence typically becomes secondary, rather than integral, when overall and final judgements are made about performance. *The fundamental questions behind this project are these: if we acknowledge the importance of student attainment but also have the ambition to educate our students for a set of broader outcomes, how can we know how well we are doing and what we might need to do to improve? How can we do this in systematic, sustainable and convincing ways?*

3. Reframing Schools as Complex Living Systems

A fundamental issue for education and schooling is its sheer complexity. Schools have multiple stakeholders and multiple outcomes. A school's core processes of student learning and achievement are themselves complex and dynamic and cannot be reduced to, or described by, a single variable. As Wheatly and McCombs argue, a school is a living system and in order to understand improvement and change in schooling we need to take this into account (Wheatley, 1999, Wheatley and Kellner-Rogers, 1998, McCombs and Whisler,

1997). A complex living system is one which is self-organising, purposeful, layered, interdependent and operating 'far from equilibrium' (Davis and Sumara, 2006, Checkland and Scholes, 1999). This means that there is no single blue print for school improvement because each school operates in a unique context – what works in one may literally not work in another. Leaders therefore need to be able to respond appropriately to their context as 'designers of learning' rather than 'deliverers of pre-determined curricula'.

There are properties of complex systems that form a set of principles which underpin learning design. Blockley (2010) identifies 'layers, feedback loops and processes' as key properties and emergence as the unpredictable outcomes of the relationships and interactions of key processes within a system. Emergence is at the heart of complex systems thinking - thus the challenge of dealing with uncertainty and risk is a challenge at the heart of leadership. Fundamentally this requires us to recognise that there are limits to what we can know and therefore predict. Knowing what we don't know and acting accordingly is 'humility', a core virtue for both leaders and learners, for without humility there can be little new learning or change. The ability to purposefully adapt and change throughout a lifecycle is what makes an organisation or an individual resilient and sustainable. At the heart of this resilience and sustainability is learning - self-aware, purposeful, conceptual reorganisation - at all levels of the system.

In terms of developing evaluation models for schools, systems thinking also demonstrates that a reductionist focus on the measurement and improvement of a single variable (for example a test result) distorts both the process and the outcome of the system (James and Gipps, 1998, James et al., 2007, Assessment Reform Group, 1999, Reay, 1999). As Mason (2008) argues

'trying to isolate and quantify the salience of any particular factor is not only impossible, but also wrongheaded'. Isolate, even hypothetically, any one factor and not only is the whole complex web of connections among the constituent factors altered - so is the influence of (probably) every other factor too'. (2008:41)

We know for example, that a over focus on high stakes summative testing and assessment not only distorts how teachers teach, but it also distorts student learning and creates an 'own goal' since it depresses student motivation for learning (Harlen and Deakin Crick, 2003b, 2003b). It does more than simply relegating wider outcomes to second class goals – it actually scores an own goal.

Not only is it important to focus on a range of processes and variables in schools which are deemed to fulfil a particular purpose, but it is also important from a systems perspective to understand the whole, the parts and how they interact. These are described by Goldstone (2006) as 'contextualised' and 'decontextualised' aspects of a system. In developing contextualised accounts learners and their environments (students, teachers, leaders and organisations) are seen as parts of a single whole. How someone learns depends in part on the larger system in which they learn. Elements of the system (both individual learners and other system elements) cannot be understood independently. Rather, the interactions of the elements give rise to emergent behaviours that would not arise through their independence.

A key concern with a singular focus on contextualisation is its inability to lead to generalization (Goldstone, 2006). But complexity theorists have also identified some

principles of complexity that can be applied to different cases from seemingly unrelated domains - for example, Blockley's ideas of layers, feedback loops and processes, and the ideas of emergence and uncertainty. Thus, while learning, teaching and leadership are contextualised, we can also understand them as decontextualised and identify patterns which can be generalized across highly contextualised instances. So these two apparently contradictory ideas – contextualisation and decontextualisation – are two aspects of a common process of conceptual reorganisation (i.e, learning) (Goldstone, 2006, p.37). In other words, students, teachers and leaders must recursively consider general principles and specific contexts in order to learn:

3. Understanding schools as complex systems

We now turn to the model of a school as complex learning system which has informed this pilot study. A system is defined by its purpose (Blockley, 2010, Blockley and Godfrey, 2000) and the primary purpose of a school is the learning and achievement of its students. As we have argued, learning is a core property of a resilient system. Thus for schools, learning is both a core process and a product (desired outcome). This makes the application of systems thinking particularly salient for schools - in contrast for example, to a supermarket in which learning is a core process but providing food services and generating profits are the desired outcomes. In understanding the defining importance of purpose in a system, we also foreground the concept of direction, of journey of dynamic change and of lifecycle. For an individual learner, a team or an organisation, this implies an intelligent shared direction - and thus leadership. An individual student who is taking responsibility for their own learning and life story is exercising personal leadership towards a chosen purpose. A team or an organisation which is moving towards a shared purpose is exercising leadership through individual, team and organisational learning and change. For a school as a complex living system, leadership and learning are thus core processes as well as desired outcomes.

Drawing on Goldspink (2007a), Bryk et al. (2010) Deakin Crick et al. (2011, 2010) and Deakin Crick (2009) we have identified three key processes in schools as learning communities, which constitute sub-systems or layers of learning activities and provide 'viewpoints' from which to understand the system as a whole . These are (i) leadership - including both community and school (ii) teacher professional learning and (iii) student engagement in learning and achievement. In the next section we present the rationale for selecting these three viewpoints.

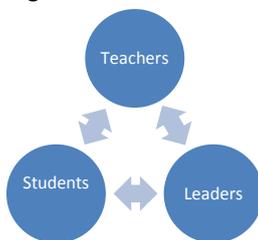


Figure 1. Three sub-systems or viewpoints for schools as complex systems

4. Three Viewpoints

4.1. Viewpoint One: Leaders leading learning and change in the community

In their conclusions to an extensive international survey of educational leadership and management, Davies and West-Burnham (2003) highlight several challenges for school leadership in the future, including equity and entitlement, social trends, policy and innovation, funding and the nature of 'schooling' itself, how and where it happens and what it comprises. They go on to argue for new models of leadership that are fundamentally concerned with strategy, values and learning. Beare (2001), looking to the future, suggests that schools will need a focus on learning as the prime mission and professional leadership where the leader and leadership teams give highest priority to the professional purpose of the school, personally and frequently monitor the learning programmes, put time and energy into school organisational learning and improvement, give support to the staff involved with learning programmes (and) put tangible emphasis on instructional leadership.

The relationship between school leadership and learning has been explored in several studies (National College for School Leadership, 2004, Day et al., 2010) which all concluded that the most successful systems, based on measures of student engagement and attainment, prioritised staff motivation and commitment, teaching and learning practices and developing teachers' capacities for leadership. In these systems, the headteacher was the 'leader of learning' and, by having a key role in developing the school's culture and climate, was the second most important influence on student outcomes after quality of teaching.

Several studies (Gunter, 2001; Bottery, 2004; Cochran-Smith, 2003; Darling-Hammond and Bransford, 2005), have established the importance of effective teaching for supporting enhanced student achievements, and there is now a great deal of evidence behind the claim that leadership that focuses on the quality of teaching is crucial for maintaining and supporting improvement in the quality of learning in schools (Schwartz and Bransford, 1998). At the heart of leadership for learning is the concern with making schools learning organisations supporting teachers' and students' learning and with greater outreach to the communities they serve (e.g. Mergendoller et al., 2006). As Silins & Mulford (2001) found in their comprehensive study of leadership effects on student and organisational learning, student outcomes are more likely to improve when leadership is distributed throughout the school community and when teachers are empowered in their spheres of interest and expertise. The McKinsey Report (2007), derived from an international survey of the most successful education systems, found that a focus on teacher recruitment and professional learning were more important as determinants of success than funding, social background of students, regularity of external inspection or class sizes. However, PricewaterhouseCoopers study into school leadership sounded a warning note when it found evidence that many school leaders, as a result of external demands, felt that they did not have sufficient time to focus on teaching and learning (de Vries et al., 1989).

In Bryk et al's (2010) research, the most effective school leaders were catalytic agents for systemic improvement, synchronously and tenaciously focusing on new relationships with parents and community; building teachers' professional capacity; creating a student-centred learning environment and providing guidance about pedagogy and supports for teaching and learning. Goldspink's research identified that the leadership qualities required for complexity are not among the typical selection criteria for principals. They include: a level of modesty and circumspection and a capacity to question one's own deepest assumptions while inviting others to participate in critical enquiry (Goldspink, 2007b). These personal qualities and the assumptions about leadership as a core systems process which underpin them have not

been widely applied in education and few school leaders are familiar with the relevant investigative, dispositional and analytical processes, for example (Zohar, 1997).

4.2 Viewpoint Two: Teachers as learners

Collaborative, classroom-based, research-informed professional learning and enquiry in schools represents an important facet of the 'deep structures' of learning in organizations and their communities. Professional learning is a vital pre-condition for school improvement through its positive influence on teachers' classroom practices and their students' learning (Birman et al., 2000, Siegel, 2010, Collins and Porras, 2004, Beer, 1984, Robinson, 2009, White, 2006). Schools' promotion of teachers' participation in school-to-school and other networking activity can support improvement-related activity in schools and classrooms through enabling teachers to access and engage with an expanded pool of practice ideas, resources, and sources of support, increased opportunities for mutual problem-solving, knowledge creation and transfer, and a heightened sense of valuing professional achievement and accomplishment (Little and Veugelers, 2005, Jackson and Temperley, 2007, Stoll and Louis, 2007, West, 2010, Katz and Earl, 2010). Thus, an excavation of a school's deep learning structures is likely to reveal that at the heart of those structures is the teacher as learner and scholar (Shulman, 2011).

Misunderstanding the nature of teacher learning by underplaying its complexity leads to focus on the micro-context (individual teachers or individual activities or programmes) to the exclusion of influences from meso (institutional) and macro (school system) contexts (Bore and Wright, 2009, Bottery and Wright, 1996). Adopting a complexity thinking perspective, we assume that teacher learning does not emerge as a series of isolated events but simultaneously in the activity of autonomous entities (teachers), collectives (school phase and subject groups) and subsystems within grander unities (schools within school systems within socio-political educational contexts). These nested systems and subsystems associated with teacher learning are interdependent and reciprocally influential. As a result, to explain teacher professional learning, one must consider what sort of local knowledge, problems, routines, and aspirations shape and are shaped by individual practices and beliefs. How are these then framed by the other systems involved? Thus we construe teacher learning as a complex system representing recursive interactions between systems and elements that coalesce in ways that are unpredictable but also highly patterned (Clarke and Collins, 2007). Therefore, identifying emergent patterns of interaction within and between levels of activity that would constitute an explanatory theory, here, of teacher learning as a complex system requires variable-inclusive (as opposed to control) strategies for research, development, planning and evaluation.

Complex systems need to be off balance in order to move forward. Wheatley (1999) in her analysis of large institutions as complex systems, notes that organizational equilibrium is "a sure path to institutional death". Helping schools and groups of teachers become aware of the full range of dissonance between their values and practices in relation to teachers' and school learning and leadership was an effective intervention for promoting change, growth and deep learning as part of the Learning how to Learn project (Pedder et al., 2005, Pedder, 2007, Pedder, 2006, Pedder and MacBeath, 2008). Further mapping of patterns of dissonance in schools nationwide was an important feature of the State of the Nation CPD study (Pedder et al., 2010, Opfer and Pedder, 2011). Dissonance between what teachers

consider important for enhancing the quality of their students' learning opportunities and perceptions of current practice may result in what Woolfolk et al (2009) refer to as 'change-provoking disequilibrium', further underlining the practical significance of attending to relationships between values and practices. Argyris and Schön's (1996) work on 'theories of action' illustrate that dissonance serves as a catalyst for schools to attempt to change their environment in ways that better support learning.

4.3 Viewpoint Three: Students as learners - deep learning as a complex psycho-social system

Deep learning occurs when students choose to invest in processes of learning that are authentic, personally owned and enable agency in processes of knowledge construction. Learning Futures research (2010, 2011) identified 'authenticity, agency and identity' as key elements of pedagogy which lead to engagement and depth in learning, rather than superficial recall or performance orientation. Where these occurred, students described their learning as transformative for them as individuals - they were authors of their own learning journey, in a process of 'becoming' (Seely Brown and Thomas, 2009). Engagement in learning is necessary for depth of outcome, but it is a complex construct. Fredricks et al's review (2004) identified the components of engagement most commonly identified by researchers as behaviour and participation, (Fullarton, 2002, Willms, 2003), emotion - a sense of belonging and value (Willms, 2003) and cognitive beliefs about learning and achievement (Munns and McFadden, 2000). A range of studies provided evidence about how these variables contribute to engagement including: involvement and wellbeing (Zyngier, 2004, Shernoff et al., 2003, Goldspink and Winter, 2008), interest (Hidi and Renninger, 2006, Eccles et al., 1997) student epistemic assumptions, including assumptions about fixed/variable intelligence (self-theories) (Dweck, 2000, Baxter Magolda, 2004, Cano, 2005, Hofer, 2001, Schommer, 1990); meta-cognitive skill which has been found to have a greater impact on outcomes than intelligence (Veenman et al., 2006); and students' learning power (Deakin Crick and Ren, 2013, Deakin Crick et al., 2011, Deakin Crick et al., 2010). In addition to factors internal to the student, several studies identify the influence of pedagogy and school climate on learner engagement: school culture and climate (Anderson, 1982), and quality pedagogy (Newmann and Wehlage, 1995, Ladwig and Gore, 2004, Ladwig et al., 2007, Hattie, 2003, Hattie, 1999). Some aspects of pedagogy are particularly important to the engagement of low SES and Indigenous learners in Australia (Gale et al., 2008, Amosa et al., 2007, Zevenbergen et al., 2004) as are aspects of learning power and self reflection (Deakin Crick and Grushka, 2010, Goodson and Deakin Crick, 2009). Fredricks et al. summarised their review by suggesting that the individual types of engagement (behavioural, cognitive, emotional) have 'not been studied in combination, either as results of antecedents nor as influences on outcomes' and that research has tended to use variable-centred rather than pattern-centred techniques, cross-sectional rather than longitudinal (2004, p.87). The result is that we have little information about the interactions between different aspects of learner engagement and little information about the development and malleability of engagement over time.

Central to engagement is the idea that the learners themselves need to want to learn, and to become aware of themselves as learners. Black and colleagues (2006) argued that a focus on learning to learn and assessment for learning in schools is important particularly when it leads to the promotion of 'autonomous learning' or 'intentional learning' (Bereiter and Scardamalia, 1989). Intentional learning implies agency and choice on the part of the learner

and goes beyond the acquisition of study skills and strategies, requiring practices which invoke the learner to take responsibility for their own learning in a relational context. Hautamaki et al also emphasise the importance of learner agency and self-regulation (Hautamaki et al., 2002).

Learning power is a central concept in engagement. It is a term used to describe that complex mix of personal qualities that characterise effective learners and is defined as 'a form of consciousness characterised by particular dispositions, values and attitudes, with a lateral and a temporal connectivity' (Deakin Crick, 2007). Learning power operates through relationships, where trust, affirmation and challenge play a constitutive role and it is 'storied' in the trajectory a person brings to their learning and in their hopes and aspirations. Successive empirical studies identified seven dimensions of learning power: changing and learning, critical curiosity, meaning making, creativity, learning relationships, strategic awareness and resilience and a self-assessment tool based on these scales, which provides a framework for a mentored conversation which moves between the learner, their story and a negotiated learning outcome (Deakin Crick, 2004, Deakin Crick et al., 2004).

What has also emerged from these empirical studies is that the self-assessment of learning power is a necessary but not sufficient aspect of a learning ecology. Other key factors include (i) the quality of learning/assessment relationships; (ii) the creation of a locally owned language for learning, including dialogue; (iii) the extensive use of metaphor and modelling; (iv) the use of learning power dimensions as scaffolding for enquiry, (v) the re-sequencing of the content of the curriculum, and (vii) the relationship between the personal/autopoietic and the public in relation to learning. Learning power is thus a part of a 'learning journey' set in a complex living system. Seely Brown and Thomas (2009) suggest that this journey is about 'learning to become' set in a participatory framework, which embraces embodied and tacit knowledge as well as explicit knowledge (Polanyi, 1967, Heron and Reason, 1997).

These are some of the complex conditions necessary for deep learning, embedded in a critical socio-cultural context (Habermas, 1984, Freire, 1972) in which students identify value and purpose and are authors of their learning, embodied in a particular context in place and over time (Goodson and Beista, 2010, Goodson and Deakin Crick, 2009, Goodson, 2009). Deep learning is described by Bateson (1972) as third level learning, which involves personal transformation – rather than only repetition (primary learning) or learning to learn (secondary learning). Deep learning is best understood as a complex psycho-social system, with subsystems which include identity, experience and story. The learner arrives at a learning opportunity already possessing a way of knowing and being in the world which is the sum of their experience to date. Vygotsky (1978) described this as 'perezhivaniya', the term used for accumulated lived emotional experience, including values, attitudes, beliefs, schemas and affect. For Vygotsky, perezhivaniya is the process through which interactions in the 'zone of proximal development' are perceived by the learner, described by Mahn and John-Steiner (2002) as a complex whole, a system of systems which includes the inter-related and interdependent elements of participants, environments, artefacts (such as computers, or tools) and context. Sfard and Prusak, (2005) suggest that the notion of identity - 'collections of stories about persons that are "reifying, endorsable by others and significant" is the missing link between learning and its socio-cultural context. The challenge in this project is to develop forms of pedagogy which attend to the complexity of student engagement in learning and the concomitant depth of process and outcome, including (i)

the selfhood, identity and story of the student in community and tradition (ii) the personal qualities necessary to engage with new learning opportunities (iii) the co- construction of knowledge, skills and understanding and (iv) the competence to engage with authentic learning in the real world (Deakin Crick, 2012, Deakin Crick, 2009).

4. Introducing hierarchical process modelling

Systems thinking offers a way of both getting to grips with complexity and a forum for engagement and participation with the leaders, students and teachers. Systems thinking aims to overcome traditional barriers to such development by seeking to make complex ideas and data accessible in such a way that innovation and progress are possible. It does this by attending to systems design – of an organisation or a process – and modelling that complexity through a visual analytic. This then provides the salient parameters for a measurement model which informs intelligent leadership. Of the many systems thinking approaches available (Jackson, 2000, Rosenhead and Mingers, 2001, White, 2006), we have found the most appropriate for supporting collaborative development is hierarchical process modelling supported by Perimeta (eg Davis et al, 2010) which has three important characteristics:

1. Visual/ effective reporting of complex ideas and information is enhanced using hierarchical mapping of processes and an 'Italian Flag' model of evidence;
2. Assimilating all forms of evidence – data, prediction and opinion; and
3. Facilitating access to key information required for informed discussion, innovation and agreement.

The Perimeta software is:

- A learning analytic designed to model diverse and complex processes
- Driven by stakeholder purpose
- Capable of dealing with hard, soft and narrative data in evidence of success, failure and 'what we don't know'
- A visual environment for sense-making in complexity
- A framework for self-evaluation and dialogue

In using the Perimeta software for hierarchical process modelling the sequence of events that we applied in our pilot project are described here in logical order. First, the system boundaries are defined according to its purpose. Next a rich picture is elicited about the system including stakeholders and the core processes for achieving the system's purpose are identified together with measurement parameters. From here key outcomes of the system form criteria against which evidence gathering process is defined, for entry into the Perimeta software for modelling. The software then takes a range of types of data and provides evidence about what is working well – what is working against desired outcomes and what is not known. This is returned to the stakeholders as a rich, visual analytic to be used for decision-making, celebration and improvement.

5. The ECHO Project: a pilot example

The Oasis Education Charter is the shared statement about the values, vision and purposes of Oasis Community Learning (OCL), the charitable trust responsible for the Oasis group of Academies in England. The Charter describes what OCL's Academies will be like and the expectations of students' experience and achievement. From the opening of its first academies in 2007, the OCL Board of Trustees was committed to evaluate the wider outcomes of education, taking into account more easily measurable and important aspects like attendance and exam results, but with the addition of qualitative evidence about students' achievement and their personal experiences of learning at an Academy. The Board also has commitments to care for OCL staff, helping them to develop and flourish, and to engage effectively with the wider community, particularly parents and carers.

'ECHO' stands for 'Evaluating CHarter Outcomes' and the ECHO Project, running as a pilot in 2011/12, was designed to find ways of evaluating these wider outcomes of education, initially, the section of the Charter, *Transforming Learning*. OCL believes that one of the most important ways in which we can prepare our students for life after the Academy is by making them confident, resilient and caring life-long learners. To do this, teachers and leaders need to be appropriate role models. In addition, parents and carers must be fully involved with the education of their children and feel welcome at an Oasis Academy. Other Oasis projects are focusing on approaches to the evaluation of spiritual, moral, social and cultural development and the ethos and wider impact of Oasis Academies. These will provide evidence about OCL's effectiveness in delivering the other two sections of the Charter, *Transforming Lives and Transforming Communities*.

Defining the hierarchical processes (levels)

Accordingly, the Charter provided the first three levels of overall outcome (vision), outputs (critical success factors) and inputs (behaviours) for the systems design (see figure 4). From the *Transforming Learning* section of the Charter, thirteen statements were articulated to describe the intended behaviours (inputs) and experiences of students, teachers, leaders and parents/carers, creating a set of critical success indicators for Oasis Academies.

Nine strands of evidence of performance relating to learning of students, teachers, leaders and parents/carers was then gathered for input to Perimeta using questionnaires, semi-structured interviews combined research-validated questions with additional questions about the specific outcomes of the Charter and standard KPIs. The evidence provided by responses to each question or by themes from qualitative or narrative interview data was specifically designed to provide evidence about one or more of the thirteen input statements in the Perimeta software.

In designing the strands for data collection, there was an awareness of the overall context of the school as a complex learning system. Boundaries of the 'system' were drawn to include students, teachers, parents/carers and community. Learning involves feedback at all levels and the use of Perimeta and the process of enhanced self-evaluation are seen as organisational learning and transformation. The initial application of the feedback from the Perimeta analysis in the pilot project will be its use by senior teams as a stimulus for strategic thinking and planning.

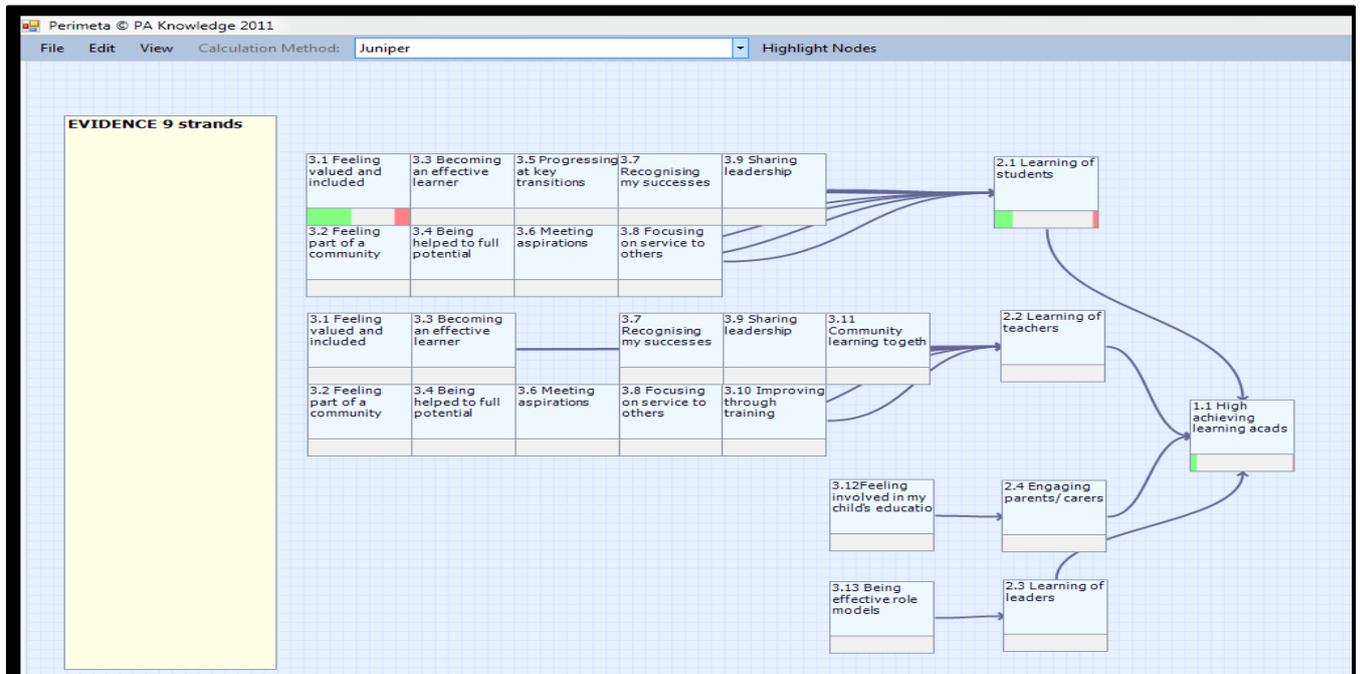
Table 4 presents this hierarchical breakdown of the three top levels in the hierarchical process model. Figure 4 illustrates the visual representation of a Perimeta hierarchical

performance model of 'transformational learning', in this case with indicative evidence to highlight some of the key insights that the model is designed to support. This is not complete – when all the data is added, the model will include more green, white and red.

Table 4 - Hierarchical Process Levels: Requirements for success of 'Transforming Learning'

1. Outcome	1.1 Establishing and sustaining a group of high achieving learning communities that enables everyone to realise their full potential and refuses to put limits on achievement			
2. Outputs	2.1 Developing the learning of students so that they realise their full potential	2.2 Developing the learning of teachers so that they realise their full potential	2.3 Developing the learning of leaders so that they lead the learning of teachers and students effectively	2.4 Engaging parents/carers effectively in the learning activities of the Academy and in supporting the learning of their children
3. Inputs	3.1 Feeling valued and included in our community 3.2 Feeling part of a community that focuses its activities on learning and achievement 3.3 Knowing that I am becoming an effective learner 3.4 Knowing that we are being helped to reach our full potential 3.5 Maintaining a good rate of progress at key transitions, for example, primary to secondary 3.6 Achieving results that meet my aspirations and expectations 3.7 Feeling that my successes are recognised	3.8 Contributing actively to a community which focuses on service to others 3.9 Contributing actively to a community where shared leadership is promoted 3.10 Providing evidence that training and development opportunities have helped me to	3.11 Contributing actively to a community that learns together, shares what works best and knows 3.12 Feeling included and involved with my children's education at the Academy and knowing that there	3.13 Being effective role models as leaders of learning
Sources of evidence	Students	Teachers	Leaders	Parents/carers

Figure 4 – Illustrative Perimeta model of 'transformational learning'



Within the Perimeta model complexity in ‘transformational learning’ system is clarified using an intuitive hierarchical structure. The evidence of success (green) and evidence of failure (red) are derived from responses and data provided by evidence strands. Where there is conflicting evidence this can be identified and challenged constructively as part of the improvement process. Lack of evidence (white) highlights the sources and impact of poor information and focuses on the value of deeper research – which may be specific enquiries developed by stakeholders. The model is iterative and ways of achieving better outputs and outcomes can be tested using the model, creating a forum for collaborative continuous improvement and a site for ongoing professional and organisational learning and leadership.

Data Collection

During the pilot project, three Oasis Academies were involved in providing data:

- From students in different Year Groups: questionnaires and individual interviews
- From teachers: questionnaire and individual interviews
- From senior leaders: questionnaire and recorded group discussion
- From parents/carers: questionnaire
- Other aggregated data that is publically available like attendance figures and exam results

The following table summarises the data strands and sources of evidence.

Data strand	Stakeholder group	Source(s) of evidence	Notes
1	Students in Year 7	Research-validated questionnaire completed at the beginning and end of Year 7; N=300	Focus on the development of students as learners
2	Students in Years 8 and 10	Questionnaire with some research-validated questions plus questions relating to the Charter N=600	Questionnaire available online using the Oasis VLE; this allows for analysis according to gender, age, etc
3	Students in Year 9	Recorded interview based on a few questions designed to get under the surface of learning N= 30	A resource-intensive attempt to explore deeper learning
4	Students in Year 11	Questionnaire designed to provide evidence about the impact of education at an Oasis Academy on the transition to FE, training and/or work and on into later life N=300 (potentially)	Questionnaire available online and with incentives to complete it annually over several years; ambitious attempt to track the progress of students longitudinally and after leaving the Academy
5	Parents/carers	Questionnaire about engagement with and support from the Academy for children’s learning N=100	This strand will include a group of parents/carers whose first language is not English
6	Teachers	Questionnaire and recorded interview about the impact of CPD on classroom practice and experience of the Oasis ethos (rhetoric or reality?) N=30	An attempt to get under the surface of teacher learning and evaluate the extent of its impact on classroom practice and student outcomes
7	Leaders	Questionnaire for senior leaders initially, followed by discussion at a senior leadership team meeting about their role as ‘leaders of learning’, their impact on the culture and climate of the Academy and the learning of teachers and students	Student and teacher questionnaires also ask about the impact of the senior leaders on the culture and climate of the school with regard to learning; intention to extend this process to

		N=25	middle level leaders
8	-	Data from Key Performance Indicators, e.g. attendance, exclusions, student progress	Data for input to Perimeta will be relevant to each strand above
9	Students in Year 11	GCSE results N=300	Data to complement strands 4 and 8 above

The hope is that this pilot project will create processes that are valuable, manageable and sustainable in enabling Oasis Academies to broaden the range of evidence for evaluation that is available for internal planning, for further improvements in student achievement and attainment and to provide a richer source of data that is readily available for Ofsted inspections. It should also help to inform the OCL Board about the progress of Oasis Academies in meeting the expectations of the Education Charter. The next steps in the project are to enter the data into the Perimeta software and explore what the data offers to the schools in terms of feedback about progress towards their purpose. However, the data can also be analysed in traditional ways through exploration of relationships between variables. Our intention is to explore both and triangulate the findings leading to a more rigorous design. The schools themselves may choose to respond to the data in appropriate ways.

7. Key challenges

This project is a proof of concept: potentially the beginning of a much longer journey. The main challenge has been the paradigmatic worldview shift that is required in moving from a traditional social science approach to one informed by complexity thinking. Philosophically this shift requires a participatory paradigm which includes a critical realist epistemology, a theory of learning as becoming – rather than either acquisition or participation, and an approach to society which facilitates profound diversity, respecting community and tradition within a common framework. Methodologically the challenges of mixed methods are well known and the demands of inter-disciplinarity (engineers working with educators and engaged research theorists and practitioners) require time and careful listening.

Complex data collection, representation and interpretation challenge traditional approaches in which a 'post positive scientific method' encourages a reductionist focus on a part, not the whole. Leadership requires the harnessing of collective intelligence – and the speed and complexity with which data can now be manipulated and represented presents unique learning challenges for leaders. Understanding the weight of evidence which such data offers is a further challenge.

8. Conclusions

In this paper we have described the rationale and methodology underpinning a pilot research project that applies hierarchical process modelling to schools as complex living systems, using software developed by engineers at the University of Bristol, called Perimeta. We have outlined and developed a systems design for schools as learning communities which accounts for the full range of outcomes valued by each school and their communities. We have identified and implemented a data collection strategy to collect evidence of success,

failure and lack of knowledge in the form of quantitative, qualitative and narrative data. This is now ready to be entered into the Perimeta software which returns visual analytic feedback against each outcome in the form of the Italian flag. Red represents what is not working, green represents what is successful and white represents what is not known, and is therefore an area for organisational learning and development.

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