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Personalized learning for the post-mechanical age

MILAN JAROS and RUTH DEAKIN-CRICK

This study describes an approach to learning and teaching that is structured as a project-based context-driven inquiry. The approach is positioned at the interface between knowledge-generation and use, and grounded in a generic notion of responsibility for the future of bodily life. The intention is to move the debate beyond the exhausted language of rigid oppositions between the academic and vocational, the universal and contextual. The purpose is to identify and nurture a personal portfolio of competencies responding to the contemporary material condition of humanity. It is expressed in terms of the student's learning power, a manifold of new assessment criteria and methodological steps constitutive of what a student could achieve having progressed through a given course. This is an approach in which competencies are outcomes supported rather than led by subject knowledge. The course structure combines traditional instruction with innovative project and assessment components and also provides an opportunity for the student to get acquainted with an employment niche. The practical applications of this approach at university and secondary-school levels have led to encouraging results for both staff and learners.

Keywords: Experimental curriculum; Knowledge society; Lifelong learning; Student-centred curriculum; Sustainable development.

Rationale

The crisis of the post-World War II consensus has had wide-ranging consequences for the agendas of government think-tanks since the 1980s. Educational institutions are no exception. For example, in 1985 a report published by the UK Royal Society of Arts (RSA) drew attention to the widening gap between the competencies and expectations of young people and those required by the 'post-industrial' society. Several measures have since been taken to reform all stages of education—always with a view to bringing it closer to the rapidly changing material condition of humanity. Alas! More than ever we hear public laments that the world of education—from schools to universities—is governed by the inert, fragmented world of

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the narrowly chosen printed word, of the memorizing of second-hand information, of performance for the sake of performance and examination for the sake of examination. In spite of introducing new 'vocational' subjects into the school curriculum and increased funding, applications for engineering and 'hard'-science degree courses (including computing science!) have been declining. Clearly, neither an increase in 'competition' nor in the larger doses of 'vocational' instruction will alone reduce the gap between the kind of a human being that emerges from educational processes today and that needed for sustaining a contented society and the standard of material life it has become accustomed to.

Many have already called for a move that would take educationalists beyond the exhausted either/or arguments inherited from the post-war years. Only by moving in that way can educationalists ensure that whatever reform is introduced will not be hijacked by sterile battles between the academic and non-academic, science and non-science, elitist and egalitarian positions. We propose to focus on the identification and nurture of relevant individual competencies expressed in terms of new assessment criteria and methodological steps constitutive of what a student could achieve having progressed through a given course of learning. This is a call for a new approach to curriculum structure and delivery, and for a new style of benchmarking in which the competencies are the learning outcomes *supported*, rather than led, by subject knowledge.

New technologies that emerged from science laboratories in the 1980s and 1990s have transformed again the division of labour and the relation between the human and natural environment. They have rendered obsolete the notion of a 'job for life' and with it the mid-20th century meanings of words like profession, skill, and learning. It follows that the human brain and hands must be empowered to adjust to and take advantage of this novel condition of humanity. Instead of expending their learning power on rote-storing of solutions to eternal problems and 'facts', students must acquire methods of retrieving and manipulating knowledge and information. They must be able to recognize and manage their own learning processes and pathways, defining them in terms of simple local parameters, and sharing them with others on a time-scale dictated by the event itself. They must be able to learn while working on the problem and to use self-assessment to control the direction, intensity, and standard of their work.

This scenario is the departure point for this paper. There are several recent documents produced by academic, government, and non-government organizations pointing to very similar objectives. The Tomlinson report (Department for Education and Skills 2004), proposing a reform of the secondary school education in Britain, the 'Opening Minds' project of the RSA (2003) as well as the Bologna accord (summarized by Loades 2005) signed by most major European universities are notable examples of such documents. They all encourage a shift from the institution to the student of the responsibility for learning process and outcomes. They also encourage an ownership of the material place in which the scientific, technological, or linguistic knowledge in question is being developed and applied.

Aims and structure

We begin by justifying our call for a radical change in methodology by grounding it in the fundamental, 'paradigmatic' shift in the material condition of humanity. We will contend that a bottom-up 'archaeological' method of inquiry—as opposed to the top-down 'positivistic' canon dominating much of the modernist discourse—not only helps to frame progression in learning but also places learning strategies and processes into a wider, generic scenario. We then consider separately the two major factors constituting this shift. These are the change in the character of knowledge and the new relationship between the born and the made, between humans and nature. The scenario hinted at in these sections amounts to a new lifecycle-embracing strategy of sustainable existence and purpose in life. It suggests a new 'categorical imperative' which we have found so motivating for most of our students.

The learning programme advocated in this paper consists in a dual process. It is led by a context-based (i.e. place, object, event) project. In the course of defining, researching, and implementing this project the student develops his or her learning power, which is manifest in a range of values, attitudes, and dispositions that interact with the 'living place' under examination. These values, attitudes, and dispositions emerge out of the practical-empirical as well and social-intellectual objectives of the project. They are supported and enhanced by a parallel, quasi-independent, more traditional subject-based and synchronous instruction. The learner, with the help of tutors, selects the specialist knowledge to match the ways in which *learning power* is actualized.

We present this proposal by first describing the concept of learning power. This is followed by a separate section concerned with project practices. The key task of this paper is to show how such a project is conceived, how it may be approached so as to live up, at least in part, to the lofty aims laid out in the above paragraphs. In particular, we will describe how the components of this process can be explicitly identified as those of personal learning power, i.e. as something both intuitively apparent but also co-existing as definite parameters for monitoring and assessment of both the learner and the teacher.

What is the methodological challenge?

Are we justified in calling for a fundamental re-assessment of educational methodology? This call amounts to a considered response to the paradigmatic shift in people's relation to the bodily life on this planet caused by an unprecedented growth of the human power to manipulate flows of energy. In particular, knowledge and its manifestations are no longer 'out there', to be mastered from a centre, acquired, and then used. New technologies challenge the boundaries separating the traditionally 'autonomous' domains of science and morality, nature, and culture, but also of memory and consciousness, of duty and right. Indeed, some of these changes have been described by many as body-invasive, as 'incorporations'. Some go so far as

to abandon the Cartesian causal, linear (mechanical) systems of thought in favour of models of society based on the theory of non-linear complex systems.

To bring the educational curriculum into closer contact with the material condition of humanity at the threshold of the post-mechanical age means simply to take this new condition on board—and to do so in such a way that it might open fresh opportunities for creating a consensus about the notion of stability and sustainability of bodily life on this planet without destroying the technological base on which prosperity depends. Clearly the top-down theorizing in the style of Kant or Newton can only be confined to front-line research in a few specialities.

The socio-cultural research model of knowledge the sciences developed in response to this challenge puts forward a conceptualization grounded in a local, context-based, and bottom-up genealogical approach. It may, for example, be found in Benjamin's (1999) *Arcades Project*, in Foucault's (1972) *Archaeology of Scientific Reason*, and more recently in Stone's (1995) *The War of Desire and Technology at the Close of the Mechanical Age*. It is this archaeological approach that will inform our notion of project-based learning described below. It is well in keeping with the idea of learning as a way of establishing one's identity in the material world, a way of 'naming of the world' (Freire 1972: 61), an 'integrative, whole body process that consists of rational, intuitive, affective, sensory and volitional ways of knowing' (Clark 1997: 28). This is a capacity almost synonymous with that of communication and consciousness. Learning and living are inherently integrated.

Humans, things, and the educational gap

The war of desire and technology is not new. For example, environmental and information technologies (EIT) and their uptake by institutions and individuals already constitute a well-established educational research and communication programme. However, it is a common educational practice that the process of experiencing material life (technology) today is removed into the abstract plane of a lecture room or a demonstration outfit. For the purposes of promotion of awareness and uptake of EIT such as, for example, new sources of energy, nanotechnologies, or human health management, EIT are defined, characterized, and demonstrated (communicated) by projecting them out of the system of generation and distribution. They are reduced to a 'model' site where stakeholders are shown and lectured to about a wind-turbine or a life-saving device. This creates 'an educational gap' between EIT as an 'image' created via the macro-indicators familiar from studies of 'networked society' (e.g. Castells 2000) as opposed to EIT as experienced (lived) reality by individuals. It is the latter that must also be addressed if educationalists are to alter the attitudes that might lead to new practices with a high uptake of EIT.

Accordingly, one of the key objectives of a useful project is to consider ways of defining and communicating and learning about this 'gap', with a view to minimizing its impact. This informs the way of approaching the empirical work. One must ask what do the relevant criteria for 'sustainability'

depend on? Who uses them? How do they frame decision-making processes? Is, for example, 'dematerialization', 'virtualization', 'de-personalization', and so forth taking place? Is there any real evidence for the substitution of information for material or energy? This then leads to another sequence of research questions such as: What is this bridge (theatre, school) made of? Why? Was it really necessary? What were the risks, costs? Who built it? Who designed it? Who uses it? Who benefits from it? What was there before? What sources of material, finance, and human input are involved? How did it change the status of the place? In this approach 'energy' is not just the act of, say, 'power generation' (burning oil or carrying a burden, i.e. KWatts). It is also the energy consumed in the course of learning and recognition, distribution and networking, and their impact on constituting a 'place' (i.e. the structural or positive and negative 'entropy' component of the energy-human interface viewed as part of a 'complex' socio-economic system)! In brief, we develop in the mind of the student a model of the material condition of life that enables him or her to separate it, via his or her own experience, from economic and technological progress without forgetting their importance. It is then possible to bring the individual parameters of the model (e.g. the generation and distribution of this particular site-energy) into wider context, i.e. how it is taken, by whom, for whose benefit, with what alternatives? The stakeholder now enters the problem via a personal research project, by being encouraged to investigate this as part of a life strategy and personal and local (bottom-up) 'archaeological' examination rather than via theories of 'growth' or macro-economic and educational (top-down) efficiency indicators familiar from the established 'analytic' educational practices and from the media.

What is knowledge and knowing in the networked society?

It is often argued that today knowledge, or more generally information itself, has become 'the raw material on which the new technologies act'. These technologies are built upon a 'network logic' that provides an immensely flexible structure through which to fuel innovation and growth. New materials, machines, and networks have promoted knowledge to the status of a most valued commodity. The rapid cycle of innovation–use–development serves to accelerate change and its dissemination, and ruthlessly destroys the boundaries separating traditionally 'autonomous' domains of science and art, nature and culture, globality and locality (Castells 2000: 100). In particular:

> [T]he shift from industrialism to informationalism is not the historical equivalent of the transition from agricultural to industrial economies, and cannot be equated to the emergence of the service economy. There are informational agriculture, informational manufacturing, and informational service activities that produce and distribute on the basis of information and knowledge embodied in the work process. …

Indeed, as we have suggested, such interventions in human fortunes have been described as body-invasive, as 'incorporations' (Canguilhem 1992: 45). As Crary and Kwinter (1992: 15) explain:

> Neither human subjects nor the conceptual or material objects among which they live are any longer thinkable in their distinctness or separation from the dynamic, correlated, multipart systems within which they arise.

All aspects of life are affected, and the curriculum and management structures of higher education all over the Western world (e.g. Short 2002) are no exception. The post-war generations of young people took it for granted that the university would prepare them for the pursuit of independent inquiry in the spirit of the Enlightenment project. The value of such a programme was measured by the degree of mastery of, say, universal laws of nature or their applications, language, or social structure. Even those holding often opposing views acknowledged the consensus inherited from the Enlightenment: physicists, painters, or historians alike took it as self-evident that the purpose of knowledge is first of all knowledge itself—disinterested representations of reality. This 'reality', nature, or simply the world of things was a neutral universal referent, not just at the level of conversational socializing but as a fundamental feature of Western theoretical thought (Heidegger 1964, Vogel 1996).

What is the case today? We are told (not only by philosophers like Baudrillard (1996) and Joselit (1998) but also by the economist Castells (2000) and the geographer Harvey (2000)) that the status of 'things'—whether apples or human bodies—is 'problematic'. Of course, the history of Western thought is full of speculations about the relation between humans and nature and its manifestations in products of human creativity. However, for Marx as well as for Derrida, technology is really just an 'actualization of metaphysics', an 'instrumental action'. In much of contemporary discourse the computerization, animation, networking, artificial intelligence, nano- and geno-technologies, commodification of knowledge, and the accompanying changes in the division of labour are either rejected as inhuman or become simply a useful addition, an added value on the road to 'progress'. On the other hand, there is a highly visible minority of those thinkers who talk about Cyborgs, i.e. who see humans as 'quasi-objects' and who take the breakdown of the subject autonomy caused by new technologies and their social and cultural by-products as a starting point for their inquiry (Harraway 1991).

Learning power for citizens of a knowledge-based society

It is well known that the growth in the job market today is in knowledge-processing, -manipulation, and -transmission. This is reflected in the 'basic skills' documentation in the English National Curricula and in curriculum strands related to education for enterprise and citizenship, albeit added onto a compartmentalized and specialized basic curriculum. The key skills are mastery of state-of-the-art communication tools, confident and speedy handling of culturally and technically changing and overflowing data. This input invariably originates in (spatially, temporally, ethnically) disparate domains, where the focus tends to be on specialized knowledge- and skill-acquisition, rather than transferable skills across domains. It must then be processed for and communicated to a distant group of people using a

different vocabulary. As a result, the majority of graduates, including those with degrees in 'vocational' subjects like engineering or law, find themselves with jobs in which they cannot make much use of whatever specialist knowledge they possess. On the other hand, departmental policies in colleges and universities have always been dominated by success in specialist research and by staff ambitions that favour specialist courses preparing students for an academic career.

This is in spite of much educational rhetoric calling for a change. For example, Bentley (1998: 125) argues that, 'in all areas of life, creativity is increasingly sought after and often depends on the ability to bring together insights from different fields in order to shape new ways of doing and thinking'. In the future, continues Bentley, the key resources for the generation of wealth will be ideas, knowledge, and creativity, not the land, labour, and physical materials of the past. In light of this Bentley argues that the goal of education 'should be the development of understanding which can be applied and extended by taking it into the spheres of thought and action which, in the real world, demand intelligent behaviour' (p. 19). He proposes two tests of education:

> how well students can apply what they learn in situations beyond the bounds of their formal educational experience, and how well prepared they are to continue learning and solving problems throughout the rest of their lives. (Bentley 1998: 1)

Such findings are supported by research concerned with higher education which identifies four underlying reasons for the employment of graduates: knowledge and ideas; ability to learn; capacity to deal with change; problem-solving, logical and analytic skills (Harvey and Mason 1996).

It follows that one of the outstanding pedagogical tasks facing educators today is to develop new educational practices that integrate the 'traditional' subject-driven academic skills and personal expectations into the new reality to meet the growing demands created by the emerging 'networked society'. In particular, the contemporary material condition of humanity—characterized by the blurring of the divisions between image and reality, the virtual and the material, the technological and the social, the global and the regional—must be seen both as a source of numerous benefits but also of new risks and, consequently, new responsibilities.

One of the fundamental obstacles in designing such programmes are their apparent 'trans-disciplinary' make-up and the barrier between the 'empirical' and 'essayist' traditions, often reducible to the barrier between science subjects and humanities. Furthermore, teaching and learning must be constructed as a process in which the position of the student gradually changes from that of a receptor to that of an active agent.

Recent research into the qualities and characteristics of effective learners, and the elements of 'learning power' suggests that it is possible, and indeed desirable, to create such a shift in focus within the curriculum at both school and higher education levels—that is, a shift from the acquisition of particular knowledge, skills, and understanding located within a particular domain, to a primary focus on the process of learning itself and those dispositions, values, attitudes, and skills that coalesce to form the

nature of an individual's engagement with a particular learning (or living) opportunity.

The term 'learning power' is one that has been used to describe this phenomenon (Deakin-Crick *et al.* 2002a, b, 2004). It can be defined as a form of consciousness characterized by particular dispositions, values, and attitudes with a lateral and a temporal connectivity. That is, it is expressed in relationships and it is shaped by the stories and aspirations which shape that consciousness.

Learning is a process carried out by individuals and groups. What is learned counts as knowledge or skill, which can take the form of the ability to do something which could not be done before, or a new understanding about the world, or something of spiritual, emotional, or aesthetic significance. The process may take place below the threshold of introspection in the learner's mind and remain there for many years, or the learner may be aware of the process taking place. Consistent with this perspective is Clark's (1997: 29) argument that 'intelligence/thinking/learning is a single, dynamic, multi-faceted, functional capacity that is inherent in human consciousness. This capacity may be expressed in a variety of modes.'

There are at least four broad categories that can be identified as making a substantial contribution to learning power. These categories appear to be cumulative, discrete, and interrelated aspects of learning power. They are:

- *learning capacities*: dispositions, awareness, and skills;
- *learning identity*: the beliefs, values, and attitudes about learning, self, and knowledge held by the learner;
- *learning story*: the socio-cultural formation of learners over time; and
- *learning relationships*: the quality and substance of learning relationships.

The components of each of these categories can vary in the degree of their sensitivity to domain, to time, and to social context. They may be robust or fragile depending on the context, and they are likely to vary over time and in different social contexts.

There are at least seven dimensions (examined below) of *learning power* that can be identified and assessed formatively and summatively within the learning process.

Changing and learning

Some learners appear to regard learning itself as learnable. They believe that, through effort, their minds can get 'bigger' and 'stronger', just as their bodies can. They see learning as a lifelong process, and gain pleasure and self-esteem from expanding their ability to learn. 'Having to try' is experienced positively: it is when you are trying that your 'learning muscles' are being exercised. A growth orientation includes a sense of getting better at learning over time, and of growing, changing, and adapting as a learner in the whole of life. There is a sense of history and hope. The opposite of growth orientation is fixity. Other learners appear to believe that the ability to learn is fixed. They, therefore, experience difficulty negatively, as revealing their

limitations. They are less likely to see challenging situations as opportunities to become a better learner.

Critical curiosity

Some learners manifest a desire to find things out. They like to get below the surface of things and try to find out what is going on. They value 'getting at the truth', and are more likely to adopt 'deep' rather than 'surface' learning strategies. They are less likely to accept uncritically what they are told, enjoy asking questions, and are more willing to reveal their questions and uncertainties in public. They like to come to their own conclusions about things, and are inclined to see knowledge as a product of human inquiry. They take ownership of their own learning and enjoy a challenge. The opposite pole is passivity. Passive learners are more likely to accept what they are told uncritically, and to believe that 'received wisdom' is necessarily true. They appear to be less thoughtful, and less likely to engage spontaneously in active speculation and exploratory kinds of discussion.

Meaning-making

Some learners are on the lookout for links between what they are learning and what they already know. They get pleasure from seeing how things 'fit together'. They like it when they can make sense of new things in terms of their own experience, and when they can see how learning relates to their own concerns. Their questions reflect this orientation towards *coherence*. They are interested in the big picture and how the new learning fits within it. They like to learn about what really matters to them. The opposite pole is fragmentation. Some learners are more likely to approach learning situations piece-meal, and to respond to them on their own individual merits. They may be more interested in knowing the criteria for successful performance than in looking for joined-up meanings and associations.

Dependence and fragility

Dependent and fragile learners are more easily disheartened when they get stuck or make mistakes. Their ability to persevere is less, and they are likely to seek and prefer less challenging situations. They are dependent upon other people and external structures for their learning and for their sense of self-esteem. They are passive imbibers rather than active agents of their own learning. The opposite of dependence appears to be resilience and robustness. Learners with these characteristics like a challenge, and are willing to 'give it a go' even when the outcome and the way to proceed are uncertain. They accept that learning is sometimes hard for everyone, and are not frightened of finding things difficult. They have a high level of 'stickability', and can readily recover from frustration. They are able to 'hang in' with learning

even though they may, for a while, feel somewhat confused or even anxious. They do not mind making mistakes every so often, and can learn from them.

Creativity

Those learners who score highly on this dimension are able to look at things in different ways. They like playing with ideas and taking different perspectives, even when they do not quite know where their trains of thought are leading. They are receptive to hunches and inklings that bubble up into their minds, and make use of imagination, visual imagery, and pictures and diagrams in their learning. They understand that learning often needs playfulness as well as purposeful, systematic thinking. The opposite pole is literalness or rule-boundness. These learners tend to be less imaginative. They prefer clear-cut information and tried-and-tested ways of looking at things, and they feel safer when they know how they are meant to proceed. They function well in routine problem-solving situations, but are more at sea when greater creativity is required.

Relationships/interdependence

Learners who score highly on this dimension are good at managing the balance between being sociable and being private in their learning. They are not completely independent, nor are they dependent. They like to learn with and from others, and to share their difficulties, when it is appropriate. They acknowledge that there are important other people in their lives who help them learn, though they may vary in who those people are, for example, family, friends, or teachers. They know the value of learning by watching and emulating other people, including their peers. They make use of others as resources, as partners and as sources of emotional support. And they also know that effective learning may also require times of studying—or 'dreaming'—on their own. The opposite pole is dependence. Some learners are more likely to be stuck either in their over-dependency on others for reassurance or guidance, or in their lack of engagement with other people.

Strategic awareness

Some learners appear to be more sensitive to their own learning. They are interested in becoming more knowledgeable and more aware of themselves as learners. They like trying out different approaches to learning to see what happens. They are reflective and good at self-evaluation. They can judge how much time, or what resources, a learning task will require. They are able to talk about learning and about themselves as learners. They know how to repair their own emotional mood when they get frustrated or disappointed. They like being given responsibility for planning and organizing their own learning. The attitude opposite of 'strategic awareness' may be termed

'robotic'. Learners with these characteristics appear to be less self-aware, and are more likely to confuse self-awareness with self-consciousness.

These dimensions of learning power offer both a conceptual framework and a language to support a movement towards curriculum provision that enhances the type of knowledge creation and transfer which emerges from an 'object-based, onto-epistemic educational methodology' outlined in the following sections. That is a curriculum provision which more usefully prepares learners for life in a society in which the breakdown of subject autonomy caused by new technologies and their social and cultural by-products are the starting point for learning and knowledge acquisition rather than a somewhat distant end point.

Project practices

Let us summarize briefly the steps we have taken so far. We argued for a radically new approach to the curriculum structure and delivery. The character, distribution, and perception of knowledge and experimentation, the way 'brains' must function today, have been radically altered, and with them the division of labour in the workplace. To account for this invasive and networked condition of material exchanges in educational practice, we invoked an archaeological, context-driven, and bottom-up learning method. The generic motivating force is an authentic, dignifying, and sustainable relation to the world of things and humans. We then moved on to describe the dimensions that add up to the totality of individual learning power. Each dimension has an intuitive, qualitative meaning but it also functions 'in translation', along a different axis of thought as a parameter in the assessment of the learner's progress.

The dynamic assessment of learning power links learners' self-awareness, ownership, and responsibility to the parameters of quality and accomplishment. In other words it links the process of learning to the outcome. For example, a summative assessment of a piece of work might look at the level of critical thinking evidenced in the way the literature and other input is accounted for. This takes account of the level of sophistication and factual detail in the treatment of a concept or event in question (e.g. 'post-modernism' in the re-development of downtown Newcastle upon Tyne in the UK), the links made with other knowledge, and the originality of the thinking involved.

These are the parameters that also measure and guide the learner's process of learning and knowledge of himself or herself as learner. For example, in the development of self-awareness, ownership, and responsibility for his or her own learning, the student may set out to develop critical curiosity, to reflect on meaning-making across the project, and to think laterally and creatively. He or she will reflect strategically on these processes and learn with and from tutors and fellow-students. He or she will be aware of his or her own personal change and growth as a learner/citizen. These awarenesses will guide his or her progression through the project as well as be manifest in the quality of the outcome. This form of formative self-assessment can be encouraged by tutors but increasingly becomes appropriated by the learner.

We can now come to describing some project practices designed to accommodate this methodology. In doing so, we will endeavour to establish links with our earlier ideas and to give credit at least to a few other scholars who have voiced analogous views in the literature.

Our approach is grounded in an object-based context-driven enquiry. It encourages students—who have gained good knowledge of, say, philosophical, environmental, or socio-cultural theory in lectures and seminars—to identify a place, a local territorial and event space, as a starting point for project work. This starting point must be personally meaningful to the student. The student begins his or her work by making a considered proposal of the project topic, sources, and work plan to his or her tutor. This initiates cycles of a personal development process which is recorded in a workbook and in which the student, tutor, and later others participate. Over the course of study students assume greater responsibility for their choice of topic and its execution. This makes it possible to motivate students without depending on 'ideological' or 'penal' methods. It requires the student to develop the strategic awareness necessary for independent learning and for developing a sense of the self as a learner who can change and grow over time. This type of self-assessment and self-awareness is at the heart of the practice of learning power, and while it can be challenging for students introduced to an open-ended learning process after the more 'closed' approaches typical of schooling, it is nevertheless a critical building-block for the development of learning power.

The student's first task is to assemble 'factual evidence' about the chosen territory. However, in addition to this routine empirical data-gathering, the student is encouraged to organize his or her findings in the way an archaeologist records the finds uncovered in a buried city. This approach entails the systematic examination, layer-by-layer, of the material domain in question without any prejudice as to the status or hierarchy of objects and marks encountered there. Whether the territory of interest is a school, a theatre, a city square, or a rubbish dump, the place then comes into its existence as an assemblage of things, people, and thoughts. For the student this place is a living place, and its ontology is a dynamic rather then a static concept. To recognize what 'it' is requires revealing its genealogy. Thus, when looking at a finding, the student must ask what the connection is to the objects and marks in adjacent layers, what would have been there in previous cultural periods, how it got there, what it was made of and why, who used it, and who benefited from placing it there.

This process is essentially about the development of 'learning power', bringing into the learner's consciousness those skills, values, and attitudes that together constitute the power to learn, to name the world, to grow and change as a person, and to engage critically in living in the world in relation to others over time. It is about 'meaning-making' as a central part of learning power; that is, not only connecting items of information and putting them together in new and creative ways, but also developing learning that is personally meaningful to the learner, through the use of personal and cultural narratives and the dynamic excavation of meaning. It requires risk-taking, lateral thinking, and imagination which constitutes creativity as part of learning power, and the curiosity to delve beneath the surface.

Fundamentally, it is about students becoming aware of, owning, and taking responsibility for their own learning. It is about students managing their own learning processes and tracking their own learning pathways through the curriculum. It is in a context of learning relationships, learning with and from other learners (including dead ones), rather than being 'given' the right answer.

The end product of this enquiry can be described as a function attached to a concept. This is analogous to, but not identical or even comparable to, what a disinterested Galilean observer does when his or her measurements are crowned with success. It is analogous in that it reduces a territory of interest, such as a new bridge and its surroundings, to a set of 'observable' parameters chosen to focus learning on a particular variable or concept, such as the shift from modern to post-modern material design and technology. It is different in that it is genealogical. While the starting point is not dissimilar to the scientific method, it also acknowledges the spatio-temporal 'history' of both the concept and the thing, and seeks to capture their existence not from a static picture of what is out there, but from its context-based genealogy.

The concrete material evidence—graphic, visual, digital—is reduced to 'knowledge maps'. These are records of, for example, how a symbol, a motif, a thing or a group of thing-events came into being, evolved, and perhaps moved and decayed as the driver and energy source propelling it ultimately exhausted itself. This process not only enables students to make connections across different ways of knowing and learning—empirical, hermeneutical, and emancipatory—but also brings their learning to the foreground and facilitates self-awareness and strategic thinking about learning itself. It lends itself to the creativity that is critical for genuine new learning. This means, for instance, that when a second-year undergraduate student in 2003 chose to study the role of post-modernism in the design and development of the Gateshead Millennium Bridge across the River Tyne in northern England, she not only described the external (material, structural, geographical) features of the bridge but asked what was in that place before (fishing village, shipbuilding site), what was it made of (wood and brick), and who used it as compared to the present development (a promenade, bars, cosmopolitan art gallery, and concert hall).

From such a position, it is then possible to see a motif such as a horse's head or fish travelling from about two centuries ago to the present. It re-emerges stripped of its context and shifted in a non-linear fashion across boundaries of what were thought to be semi-autonomous domains (local folklore, fishing, art, ship-building), as a decorative motif on one of the pillar-sculptures adorning the promenade along the River Tyne. Clearly, the motif has been extracted from its origins in an old anecdote and place, removed from the communal culture. It has been isolated and physically modified by designers and engineers in the course of many different processing levels, and reduced to a bare image. Its original place and anecdotal meaning has long been forgotten. Its shape has been coloured by the post-modern fashion of spectacle, pastiche, and high-tech material giving it an entirely new look and polish.

In summary, the project is a concrete document, containing pictures, copies of documents, records of dialogues, and statements and citations, not

a mere collection of words. It is about a particular place and particular (period of) time. It naturally lends itself to being exhibited, presented as part of one's portfolio, edited or extended to join other projects grouped thematically.

Reports and presentations of the project work should:

- Identify a concept and a 'territory'—a 'living place' through which the concept is to be studied;
- Identify, evaluate, and formatively self-assess the dimensions of learning power which will guide and sustain the enquiry, starting with personal meaning-making;
- Use the concept and territory, and evidence there gathered, to demonstrate a (social, cultural, technological) change;
- Identify systems of thought, traditions, or ideologies that inform (limit) the discourse and support the argument with empirical data;
- Capture the source of 'energy' (force, inspiration) that acts as a driver for the change in question and determines its nature;
- Identify archetypal images or icons that are amenable to communicating the change in question and position them in the conceptual scheme the student has chosen to interpret the theme. Clarify sources, opposing views, and their hierarchy; and
- Identify how the project might contribute to a new attitude to nature and to sustainable life.

This link between the academic and contextual, the universal and local, the objective and the subjective, has been sorely missing in university studies both in sciences and humanities, and in education and schooling in general. This is in spite of much educational commentary demanding it. For example, Kincheloe and Steinberg (1998: 12) complain that schooling continues to be dominated by a style of teaching that imparts facts to students: 'Such teaching fits seamlessly into the dominant epistemology of western science that has fragmented the world to the point that many people are blinded to particular forms of human experience'. This, they continue, undermines human capacity to recognize the connections between actions and surroundings, between the subjective and the objective, and between personal development and achievement. 'Contemporary schools still emphasize quantities, distance, and locations, not qualities, relationships, or context' (p. 12). This feeds an assessment culture that focuses on the summative assessment of learning outcomes rather than the process of learning itself. Yet there is overwhelming evidence from around the world that the current, and dominant focus on high-stakes summative assessment and testing actually depresses students' motivation for learning. It creates a pedagogy in which teachers teach to test and focus solely on the pre-packaged knowledge to be imparted rather than on the quality of learning itself. It encourages a transmission-oriented rather than a learner-centred pedagogy (Harlen and Deakin-Crick 2003).

More recently, the consensus among the educational establishment has been gradually shifting towards recognition of advantages in a broadly based baccalaureate-style education perceived as a lifelong project rather than a one-off performance on well-known set pieces of knowledge. Such a shift

would undermine the traditional emphasis on the subject-based curriculum, particularly at the upper end of secondary education (e.g. the English AS and A levels). The object-based context-driven integrated approach described above (and implemented in a degree-level programme) greatly benefits from a broader baccalaureate-style education. It goes further in that it takes the student from a selection of well defined 'traditional' subjects and the 'specialized' knowledge (of, say, sociology, aesthetics, or biology) to a process of researching and acquiring knowledge via the unfolding of concrete findings integrated within and limited by a 'place'—a bounded physical and conceptual territory and a genealogically grounded Being. The meaning of general ('universal', top-down) social and physical theories is recovered through a deep knowledge of, and identification, with a place and the associated space-time, through a theme, and the method of 'archaeology' rather than in a master class, although both lead inevitably to critical examination of authoritative texts.

The RSA Curriculum Project 'Opening Minds' (2003) is another example of an innovative approach to the curriculum for school-aged students that aims at integration, rather than a subject-based and thus fragmented approach to knowledge. It lends itself to a more holistic and learner-centred approach that encourages interdisciplinary enquiry, the stimulation of learning power, and the acquisition of transferable skills.

Such integrated approaches open fresh intellectual space for different methods of continuous formative assessment and evaluation. How is learning power, the 'intuitive' dimensions of learning power, growth-orientation, critical curiosity, meaning-making, resilience, creativity, learning relationships, and strategic awareness identified directly within each stage of the process of project implementation and not via set pieces of performance at the end of the project? In that way the assessment process is integrally combined with knowledge-acquisition, and with the formative processes of learners who are able to take responsibility for their own learning. The assessment then aims at establishing the quality of learning power as the learner proceeds, in the course of curriculum delivery, along the sequence of acquiring (conceptual, factual, technical, methodological, etc.) knowledge constituting the academic domains (e.g. physics, philosophy) in question. This sequence—which in the traditional delivery of the subject curriculum amount to the '101' set pieces of performance to be reproduced in the examination room—is being recovered by close examination by the student of the empirical (concrete, visual, documentary) material, via a process of personal archaeological uncovering, layer-by-layer, of the content (conceptual, factual, documentary) of a material site.

Indeed, today every subject is made transparent by the availability in the public domain of the 'best' answers to such set pieces (in physics, the likes of the pendulum period or the wavelengths of the hydrogen spectra; in philosophy, the Aristotelian syllogism or phenomenological reduction, etc.). This public transparency makes a mockery of assessments which reward not so much to the individual's talent, creativity, and pragmatic fitness but to the degree of mental and financial 'adjustment' to social norms (wealth, conformity) that can purchase in an acceptable manner access to such answers. The result is that the technical mastery of such set-piece answers can at best

be the necessary but no longer the sufficient outcome of any learning programme. Both the process of acquiring knowledge and also the assessment procedures must address the importance of the context in which knowledge is acquired and used; in fact, the process of recognizing the way knowledge must fit into specific contexts and limits as a way of making use of knowledge is becoming more difficult to master than the 'objective', technical content of knowledge readily available from data-banks. *The student must learn to recognize this contextualization, its dynamics and its impact on what knowledge actually 'is' and how it is used*.

What then are the 'translations' of the intuitive and personal dimensions of learning power that may be helpful in monitoring knowledge acquisition? The baseline is set at the level where the student provides bare description of what is before him or her both in physical and conceptual material. The scale then moves from 'bare-to-good' description in which he or she lives up to the vocabulary and meaning-acquisition level of the sources, to the evidence of ability to separate the concepts from the narrative imported from the literature, and finally ('very good to excellent') to the evidence of independent handling of several alternative scenarios, their distinctive and overlapping features, a measure of completeness and limits of applicability. Additional credit is then due to a work showing substantial evidence of independent reading and its relevance, balance between detail and generalities, high level of conceptual treatment, novelty of the way the work is conceived and organized compared to models available in the literature, and the handling of discursive aspects of the work.

To attain at this level, the student would have been using all of the dimensions of learning power, and to a large extent self-evaluating his or her capacity to use them formatively. The student will have been reporting on them as an integral part of the construction of the product. Clearly, such a scheme of formative and dynamic self-assessment of learning power assumes that the student has acquired the basics as a preliminary, necessary starting point. This form of assessment is then an attempt to assess what the student can do with whatever he or she knows. This is an evaluation of the process, and of the student's appreciation of the subjective and objective properties of knowledge acquisition, not of any particular answers. The process and its evaluation are transferable from one theme to another.

The ultimate practical measure of the success or failure of the programme is whether the student can remain in the niche he or she chose in the course of a project or some related field either as an employee or as a researcher, or whether he or she fails to make a strong enough bond with it and has to (wants to) look elsewhere. The goodness of the pudding is in the eating, not in the correctness of the way it was prepared and packaged. The latter seems to be the way the performance of education—particularly of higher education in the UK—is being assessed.

Research agenda

We are not yet in a position to evaluate in empirical terms our experience with implementing the approach we describe here. However, we have

implemented it both in schools (15–16-year-old students) and in undergraduate programmes at Newcastle in both science and the arts, in particular the baccelauriate single-honours programme in philosophical studies of knowledge and human interests. We can state with confidence that we have been successful in motivating staff and students. The student independence in handling abstractions as well as their sense of self-development and 'reality' have also increased significantly. However, we are well aware that there are several questions that require concerted research effort.

On the delivery side, we have to clarify, formalize, and make more specific new teaching and assessment practices that would be comparable in quality to those familiar with traditional programmes. In particular, we need to assure the level of difficulty and the definition of boundaries of the specialist information that must be fed into the project work, the transparency of the variables determining the aims and objectives of the project, and the effectiveness of the feedback from the project part of the programme to the delivery of its explicitly taught specialist components. The bottom-up archaeological-genealogical method brings to the surface several conceptual problems that in the case of traditional programmes of instruction remain buried under the rumblings borrowed from the 'established' theories of social and scientific developments. What is it that—in the absence of 'grand' traditions and ideologies—drives the current social and technological practices? Is the mathematization of nature being extended to that of the mind? What is the value of models of the world—derived directly or indirectly from the sciences? How does science 'frame' the social (and vice versa) in a democracy? What new ways of ordering and specificity of thought do current material exchanges—such as those studied in the learning process—impose, and how do such 'ways' find their place in programme? And, most crucially, how do academics go about preparing a new generation of educators willing and capable of delivering such a programme not only to strong students but across the widest ability range?

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