Towards Technology for Learning in a Developing World

Meurig Beynon
Computer Science, University of Warwick, Coventry, UK
wmb@dcs.warwick.ac.uk

Abstract

This paper addresses a significant concern in relation to educational technology to support developing countries: the impact of the developed world's notion of ***development*** *upon its notion of* ***learning****. It argues that the very factors that lead us to regard a country as* ***developed*** *conspire to marginalize certain characteristic features of authentic learning, and naturally promote a more limited and circumscribed concept of learning ("closed learning"). Information and communications technology – when cast in its traditional role – is itself viewed as a major indicator of development, and at the same time contributes to the promotion of closed learning. To privilege closed learning is to attribute a significance to 'understanding backwards' that is deprecated by William James in his philosophic attitude of Radical Empiricism. Empirical Modelling is briefly reviewed as an alternative conception of technology for developing worlds that also enables 'understanding forwards'.*

1. Introduction

In thinking about the nature and scope of education, it is helpful to consider the range and variety of learning activities that it involves. This perspective on education, which underlies this paper, has been introduced in previous papers (cf. [1:047]) with reference to an Experiential Framework for Learning (EFL) that is depicted in Box 1. Of particular interest are the trends that underlie the transition from our first experiences of the learning domain, so subjective and elusive, to the assured practical skills and clearly articulated theoretical knowledge that serve as an objective testimony to our developed understanding. Several significant changes in emphasis are represented in this transition: from the private to the public, from the subjective to the objective, from the provisional to the assured, from the particular to the general, from the pre-articulate to the conceptual and symbolic.

private experience / empirical / concrete

interaction with artefacts: identification of persistent features and contexts
practical knowledge: correlations between artefacts, acquisition of skills
identification of dependencies and postulation of independent agency
identification of generic patterns of interaction and stimulus-response mechanisms
non-verbal communication through interaction in a common environment
directly situated uses of language
identification of common experience and objective knowledge
symbolic representations and formal languages: public conventions for interpretation

public knowledge / theoretical / formal

Box 1: An Experiential Framework for Learning

This paper relates the EFL to a model of learning associated with developed worlds ('closed' learning) that is reinforced by the conventional conception of how technology supports education. Following William James [6], it advocates a philosophical reorientation that challenges the established contention to the effect that *we understand backwards*. In conclusion, it briefly introduces Empirical Modelling (see [1]) as a technology to support learning activities across the EFL in which *understanding forwards* is prominent.

2. Closed learning

The relationship between individual learning and societal development is significant when thinking about education in relation to developing countries. There is a close parallel between the evolution of individual learning activities and the evolution of technologies

and practices by which institutions in the developed world, such as the UK rail network, came into being. In the earliest stages of development, railways supported a rich diversity of practices and technologies, and allowed a degree of autonomy to owners and passengers that is inconceivable today. In its current form, the UK railway system can be viewed as the result of a long process of collaborative learning during which the change of emphasis towards a public, objective, assured, general, conceptual and symbolic understanding has been prominent. The education and training now required of a railway employee epitomises a particular kind of learning characteristic of the developed world: learning that is deeply embedded in a robustly engineered social and technological context, from which it largely derives its significance.

A similar pattern of evolution underlies many of the central institutions of the developed world, both physical and intellectual – as represented in sciences, languages, economies and governments. Though the association that this observation expresses between such complex and subtle notions as 'developed', 'science', 'language', 'economy' and 'government' is simplistic, there is a conspicuous danger that providing education for the developing world is understood to mean promoting these established institutions of the developed world. Viewed in this way, education for the developing world entails *closed learning* in relation to a potentially alien social and technological context that frames the significant learning activities.

The notion of learning as meaningful only with reference to a developed context is reinforced in many ways. The ideas of language as primary for thought, and of reason as the hallmark of sound understanding, are prominent in this respect. The accepted conception of computing is based on these premises, and tends to promote technologies that favour closed learning models. Even the idea that all learning and knowledge is socially constructed is at risk of giving priority to learning that is being viewed and validated only within a broader context. In summary, the philosophical and methodological orientation of the developed world gives little support to the concept of learning as a personal exploratory activity that engages with confusion and admits genuine discovery.

Fundamental to the conception of 'closed learning' is a perception that is hidden in the notion of 'developed'. The very term 'developed' itself suggests closure, in keeping with the circumscribed understanding, certain knowledge and reliable mechanism that is characteristic of an established cultural, social and technological order. The educational emphasis in such a context is on communicating what there is to be learnt from past experience by way of structures, patterns, rules, methods and objects. Without doubt, development has been associated with significant insights into how mathematics, science and language can contribute to fields such as law, health and economics. The danger is that these insights delude us into acting as if all present wisdom was *developed* rather than *developing*. And whilst it can be exceedingly difficult to appreciate the limitations of current wisdom from the perspective of the present, they become quite evident from the perspective of history. To focus on wisdom solely in its relation to experience in the past attaches far too much weight to our current degree of insight. Speaking of the products of past experience as 'developed' most often reflects our inability to see the future and appreciate how limited and undeveloped our conceptions may potentially appear to those with wider experience, sharper vision and more advanced technologies.

3. Beyond closed learning

Where the EFL is concerned, closed learning follows a pattern. In broad terms, the accumulation of experience informs a transition "from the top to the bottom of EFL": from learning activities of a personal private subjective nature to activities that establish intersubjectivity, perhaps even to communication about shared experience that is symbolic in nature. This transition has the effect of identifying a context within which expectations about what can be universally validated in experience are established. Such contexts are characteristic of a developed world; they supply domains in which an instructionist paradigm is meaningful, where particular experiences and interpretations that have been mastered by a teacher can be demonstrated and explained to a pupil.

All practical experience of teaching calls the sufficiency of the notion of closed learning into question. Pupils notoriously have difficulty in aligning their experience and interpretation to that of a teacher. It has to be acknowledged that some lack the required competence – they are in some respect 'subnormal' or 'abnormal', whilst others are psychologically ill-equipped or pathologically unwilling to identify their experience with a social norm.

The prejudices of the developed world nevertheless make it hard to think of education beyond closed learning. Whilst the validity of different educational paradigms is recognised, instruction and construction are typically viewed as alternative paths to the same goal. For instance, in contrasting 'exploratory' and 'expressive' modelling as constructionist approaches to mathematics education, the key concern is typically

with how pupils are engaging with an established mathematical principle or truth (such as Newton's Laws of Motion) – the possibility of authentic new discovery on a pupil's part is effectively discounted. To acknowledge learning activity beyond the scope of closed learning is to acknowledge the existence of things that cannot be taught. This concept is completely at odds with the ethos of much contemporary education in the developed world, where the entire landscape of learning is framed with reference to explicit learning objectives. The underlying premise is that *what can be learnt* is *what can be taught*. With reference to the EFL, this is to argue that all genuine learning is validated by having its point of arrival in the objective domain of what can be shared and rationalized.

Against this background, learning beyond closed learning has a paradoxical quality. This is consistent with the accepted fact that an educational practice that is regimented cannot easily meet the special needs of exceptional pupils – the creative and eccentric, autistic and artistic. At the heart of this paradox, is a conceptual failure – a failure to appreciate that, contrary to the mindset that behaviourism first promoted, learning is predominantly concerned with the activities at the top of the EFL that cannot be effectively observed through the lens and filter of the objective, the rational and the symbolic.

4. A philosophical reorientation

To give a satisfactory account of an educational paradigm beyond closed learning, a philosophical reorientation is required. This reorientation is most cogently expressed in William James's philosophic attitude of Radical Empiricism (RE) [6]. In motivating RE, James cites Kierkegaard's observation to the effect that 'we live forwards, but we understand backwards' [6:238-9]. He goes on to remark that: “Understanding backwards is, it must be confessed, a very frequent weakness of philosophers, both of the rationalistic and of the ordinary empiricist type. [RE] alone insists on understanding forwards also, and refuses to substitute static concepts of the understanding for the transitions in our moving life”. As is well-recognised [11], though much of William James's thinking continues to exercise a powerful contemporary influence, his notion of RE has largely attracted criticism and neglect. The predominant emphasis in current education on closed learning can be viewed as evidence that the philosophical endorsement for *understanding backwards* to which James alludes has prevailed to the present day.

The implications of RE are such as to compel a reappraisal of the terms of reference in which discussions of learning are traditionally expressed. For instance, in speaking of the EFL above, reference has been made to "shared experience" and to "what can be universally validated in experience". RE invokes the word 'experience' to refer exclusively to what is given moment-by-moment in the perception of a person. As an empirical stance, it is distinguished from ordinary empiricism by its insistence that what is given in experience is more than discrete sensory elements – it also encompasses relationships of a conjunctive nature. In seeking to give a comprehensive account of human affairs, RE sets out to relate all knowledge and understanding to its origin in personal experience. But whilst it has the advantage over ordinary empiricism of admitting and exploiting a wide variety of conjunctive relations that are deemed to be given in experience, it cannot directly endorse a notion of experience as "shared" or "universal". To quote James [6:49-51], there is an unavoidable discontinuity in my experience "when I seek to make a transition from an experience of my own to one of yours ... [I] have to get on and off again, to pass from the thing lived to another thing only conceived". From a RE perspective, there is then no primitive notion of "shared experience" – such an expression necessarily has to be interpreted as referring to a complex process of social construction that is in all its aspects grounded in personal experience. This has the effect of problematising the very ingredients that provide the foundation for closed learning and – in the process – transferring the primary focus to the personal, private and subjective activities that are represented at the top of the EFL.

5. Technology and learning

The discussion in section 2 shows that there is a strong affinity between closed learning and certain conceptions of technology. Railway technology and practice have developed symbiotically in the transition to an orderly objective framework for human-machine interaction. The point of arrival inhabits the public world at the bottom of the EFL; but the development of the modern railway has its origins in all manner of experimental activities whose place is towards the top of the EFL. The categories that make sense in talking about railways, such as rules, procedures, actors and objects, are commonplace in the developed world. Thinking in these categories privileges a machine-like perspective on interaction in the world, where uniform characteristics and consistent interpretations lead to

reliable performance. Enabling this perspective involves adapting the environment and the people in it.

Such a conception of technology, deployed within a closed learning paradigm, informs most computing support for education. The educational motivation to encourage creativity and discovery may be strong, but the fundamental orientation of computing – as shaped by its well-established core theory – is ill-suited to supporting any other conception. To write a program is to devise a machine whose effective operation relies upon establishing just such rules, procedures, actors and objects within the public world. As is argued at length in [1:080], this concern applies even to the sophisticated programming products (such as Boxer [9] and Imagine Logo [7]) developed in the constructionist learning tradition pioneered by Papert [10].

RE accommodates technology for closed learning within an altogether richer framework that embraces all the learning activities in the EFL. Living in the developed world can insulate us from this framework. In travelling by train, we are ideally neither required to exercise great skill in navigation, nor to make detailed observation of the passing environment, nor engage in any way with the historically significant experimental activities that fashioned the present-day railway. But whereas closed learning about railways focuses on those matters of observation and action that relate to the specific goal of travelling from one station to another, the learning agenda associated with a RE perspective is provocative in character. Specifically, by inviting the learner to trace aspects of organised human-machine interaction to their roots in immediate personal experience, RE counters the anaesthetizing influences of mass production, regulation of society, and systematization of behaviour. By way of illustration, adopting an RE stance can help to expose: the understanding required of a railway developer or manager; the cultural knowledge and personal capabilities required of a passenger or member of the railway staff; the potential for rich individual personal experiences that rail travel affords; the probable impact of exceptional circumstances on railway operation. In effect, an RE attitude contributes to the perception of the developed as potentially yet developing.

Where the closed learning agenda is readily identified with core elements of science, engineering and management, the learning activities that are associated with the top of the EFL have more affinity with the arts and humanities. The scope for developing technology to support a wide range of learning activities within the EFL has already been demonstrated in software products concerned with computer art, graphics and music, and in more specialised software designed for humanities computing applications [8]. What is conspicuously lacking in current thinking about computing is a body of fundamental principles, comparable in scope and depth to the classical theory of computation but encompassing domains beyond closed learning, that can be invoked in the design of such software.

6. Conjunctive relations

A conception of technology broad enough to address this agenda is outlined in the final section of the paper. It builds on a principle that is fundamental to RE – that all knowledge is ultimately rooted in the perception of conjunctive relations. The primitive semantic relationships that can be described in this way are quite different in character from the formal assignment of meanings to symbols characteristic of the mathematical theory of computation. They rest upon the premise that the relationship between one experience and another can itself be given in experience. Relationships of this nature have enormous diversity and subtlety. They may concern the relationship: between an object's location and its shadow; between notes of a musical score and keys on a keyboard; between a name and a pet animal; between two experiences of the same place at different times; between experiences of two places on a single journey.

As these examples illustrate, what is perceived as a conjunctive relation is not fixed for all time – it depends on the observer and the context, and can be learnt or forgotten over a period of time. The fact that a symbol is abstract is in principle no barrier to its meaning being given in experience – in developing a proof, a mathematician may acquire such familiarity with the problem context that the association of a symbol with a geometric entity is immediately apprehended. The accountant may likewise experience the association between the value of a spreadsheet cell and the state of company's finances as one.

Conjunctive relations have many qualities that are particularly significant in respect of capturing learning activities beyond the scope of the closed learning of the developed world. The highly personal nature of the perception of conjunctive relations echoes the diversity of perspectives that prevails prior to the rationalization of processes and the adoption of advanced technologies. The apprehension of a conjunctive relation needs no additional explanation – it is enough that this person is able to experience this connection between one experience and another, just as it seems that an *idiot savant* might "experience" a complex computation in a manner that is beyond dispute, yet

also beyond explanation. Conjunctive relations can operate in the realm of the pre-articulate, as when a skilful exponent of an art knows how to frame an action so as to achieve an effect, or an experimental scientist builds an artefact to embody patterns of behaviour observed in interaction with an unfamiliar phenomenon [4]. Their semantic content is potentially extremely rich and wide-ranging, as is illustrated in many different ways by the following passage from the 19th century essayist Hazlitt [5]: "If from the top of a long cold barren hill I hear the distant whistle of a thrush which seems to come up from some warm woody shelter beyond the edge of the hill, this sound coming faint over the rocks with a mingled feeling of strangeness and joy, the idea of the place about me, and the imaginary one beyond will all be combined together in such a manner in my mind as to become inseparable."

7. Empirical Modelling

The benefits of development are not in doubt, but these must be realised in ways that complement rather than compromise those attitudes and attributes of the developing world that defy closed learning. This concluding section briefly reviews an alternative perspective on educational technology, associated with Empirical Modelling (EM), that assists this realization. By supplying principles and tools to liberate the personal elaboration of conjunctive relations [1:078], EM gives computing support for concepts complementary to the rules, methods and objects that pervade developed worlds. Unlike conventional conceptual frameworks for computing, it privileges personal agency for exploration and experiment.

In EM, the modeller fashions a conjunctive relation between experience of a computer-based artefact and a complementary experience to which the artefact refers. This activity is creative, iterative and experimental in character. The artefact is developed in the form of a family of definitions, or *definitive script*, whose variables are the counterparts of observables in the referent, and whose definitions correspond to the dependencies between these observables that are typically identified through interaction. As such an artefact is being experimentally developed, it comes to embody the modeller's expectations about the consequences of interaction with its referent. In this way, it serves a role in capturing the modeller's personal understanding as it evolves. Illustrative examples of EM are beyond the scope of this paper, but an account of EM principles and tools together with over a hundred models are available online [1], as are posters describing a variety of educational models [2].

Just as RE aims to account for all phenomena with ultimate reference to conjunctive relations apprehended in personal experience, so EM sets out to show that modelling with definitive scripts can account for even the most complex forms of concurrent systems modelling. This entails generalizing from a situation in which no change of state occurs except through the direct intervention of the modeler to a situation in which many state-changing agents are potentially active. Activities similar to those concerned with establishing intersubjectivity in the EFL feature in this generalization – their significance is similar to that of the interactions and interpretations that conditionally allow notions such as 'shared experience' to be meaningful in the RE perspective (cf. section 4).

EM is much closer in spirit to modelling with spreadsheets than to conventional programming, and is similarly well-oriented to educational use, especially in a constructionist idiom [3,9]. Whereas programs are developed with specified goals and strict conventions for user interaction, EM artefacts are always open to extension and reinterpretation that is constrained only by the human interpreter's capacity to apprehend appropriate conjunctive relations. The undeveloped and developing world is the natural habitat for EM: where programming may be seen as the counterpart of railway engineering, management and use, EM is more akin to walking or bird-watching, where rich contextual awareness and human engagement is of the essence.

8. References

[1] EM website and publications as indexed at the url: http://www.dcs.warwick.ac.uk/modelling

[2] http://empublic/projects/kaleidoscopeBeynon2005/

[3] Baker, J.E., Sugden, S.J., Spreadsheets in Education - the First 25 Years, e-Journal: *Spreadsheets in Education* **1**(1): 18-43, 2003.

[4] Gooding, D.. *Experiment and the Making of Meaning*, Kluwer, 1990.

[5] Hazlitt, W., *Essays on the Principles of Human Action*, London: John Miller, 1835

[6] James, W., *Essays in Radical Empiricism*, (first published 1912), Bison Books. 1996.

[7] Kalas, I., Blaho, A. Imagine… New Generation of Logo: Programmable pictures. In Proc. WCC2000, Beijing, 427-430, 2000.

[8] McCarty, W., *Humanities Computing*, Palgrave MacMillan, 2005.

[9] Papert, S., Harel, I. Situating constructionism. In S.Papert, I.Harel (Eds). *Constructionism: Research reports and essays*, Ablex Publishing, pages 1-11, 1991.

[10] diSessa, A.A., Abelson, H., and Ploger, D. An Overview of Boxer, Journal of Mathematical Behavior, pp. 3-15, 1991.

[11] Taylor, E.I., Wozniak, R.H., *Pure Experience: the Response to William James*, St Augustine's Press, 1996