Technology Education as Solo Activity or Socially Constructed Learning

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ABSTRACT: There is a continuing perception that current educational arrangements for technology education in modern liberal democracies are at odds with its actual delivery in the classroom (Dakers & Doherty 2003). The 'technē versus poiesis' tension (explained later) is one major contributor to this perception. Equally, the practice of 'transmission versus constructivist' pedagogies contributes to the mismatch between policy and practice.

This paper will investigate how factors relating to these two contributions affect the delivery of technological education. It will begin by discussing the derivation of the word 'technology' and how its modern incarnation has become not only amorphous, but confusing for technology education, in that the term can be taken to mean production on the one hand or process on the other. It will then explore technology teachers' perceptions (and misperceptions) of what constitutes technology education, and discuss why this can lead to confusion. It will further consider how this can affect the pedagogy adopted. It will then examine two pedagogical frameworks which result from teachers' perceptions of technology education as either; a process of internalisation of technological skills and functions as representations exclusively within the mind and unique to the individual, thus solo, or; a process of technological skills and functions embedded in sociocultural activity in which cognition is distributed across the internal mind and the external environment. Finally, the paper will offer a framework for the delivery of technology education set within a 'community of learners' paradigm.

Keywords: community, collaboration, technological literacy, internalisation, externalisation

THE ORIGINS OF THE TERM 'TECHNOLOGY'

The concept of technology is by no means new and can indeed be traced back as far as Socrates, Plato and Aristotle (and beyond). These early philosophers drew clear distinctions between theoretical and practical understanding. Whilst arguing that the 'craft' knowledge of farmers, shoemakers, and bakers, as well as physicians, is genuine knowledge, Socrates nevertheless regarded 'craft knowledge' as consisting primarily of a technical understanding, thus limiting its concern to the pursuit of particular trades or practices. Technē was thus, in Greek terms, seen to be more related to skill production which was capable of being directly taught whereas poiesis, whilst having characteristics relating to craft, related more to process and expression which was more to do with learning rather than teaching.

The actual term technology therefore derives from the Greek Technē which was variously translated as 'craft', 'art' or 'skill', and logos which refers to the study of, in this case, Technē. It also, however, has roots within the Indo-European term tekhn which appears to have been related to woodworking. In Latin usage, moreover, the term texere meant to weave
(hence textile) which evolved to mean fabrication (from fabric). It becomes apparent, therefore, that the ancient roots of the term are more orientated (although not exclusively) towards the application of the body in tool use and production.

TECHNOLOGY EDUCATION'S INDUSTRIAL BACKGROUND

Later, during the Enlightenment, when positivism became the new world order, Descartes compounded this notion of a mind/body dualism which reflected the poiesis/Technē tension. This is not to suggest that Descartes espoused the same dualistic philosophy that Plato did, it is simply mentioned to demonstrate the continued tension between the perceptions of working with the body as distinct from working with the mind. In educational settings today, echoes of these tensions are reflected in the academic/vocational divide, in which technology, it is argued, is largely positioned within the vocational strand. However, it must be noted that the tensions surrounding the confused meaning of the term technology, which will be argued in this paper, do not necessarily reflect the models or perceptions of technology found in some European languages such as, for example, German, Dutch and French. This paper will, however, argue that countries such as the UK, USA, Canada and Finland, have practitioners who regard the delivery of technology education as being either the development of a technological literacy for all citizens, or as a distinctly craft and product orientated subject area. In the former, the emphasis is on the preparation of citizens able to participate in a world where human life is entirely mediated by technology. In the latter the emphasis is on fuelling the demands of industry. This latter vocational strand can be seen to have its roots in the industrial revolution.

It was indeed not until the industrial revolution that the term technology actually changed its original meaning to become a term describing a “system of mechanical and industrial arts” (Murphy & Potts 2003, p. 3; Volti 2001). It was during this period that the term became closely associated with systems involving machine technology and technological processes. Thus technology became inextricably linked to economic development as industry grew and expanded. Clearly, new techniques were necessary for the operation of these new industrial technologies. A plentiful supply of manual workers would have to be trained in order to operate this new machinery.

"The time has arrived when it is desirable and necessary in the education of the people that the principals of science (and technology) sic should form an important element in the tuition of all classes of the community" (Conference 1868).

A new technical education emerged, therefore, which served the needs of these new industries. This technical education retained its ‘industrial arts’ form up until the last two decades, when it became apparent that the industrial base to which technical education had allied itself was no longer
viable in what had become a technologically, rather than industrially mediated world. This new distinction between technology as industrial and technology as modern serves to further confuse the issue in the present day.

Winner (1977) illustrates this in his argument that "the word technology appears to have different meanings in academic and every day speech. Although in the past, the term had a very specific, limited, and unproblematic meaning, this is no longer the case. Persons who employed the term spoke of a 'practical art', 'the study of the practical arts', ... Most people spoke directly of machines, tools, factories, industry, crafts, and engineering and did not worry about 'technology' as a distinctive phenomenon" p. 8. (Italics in the original)

REINVENTING TECHNOLOGY EDUCATION

It became apparent in the 1980s that the industrial arts model of technology education did not reflect the new technologically mediated world we now inhabit, and a new model was seen to be required. This realisation emerged across several countries at around the same time. Technology education was seen to have, as a central tenet, the notion of technological literacy. The process of becoming technologically literate requires participants to become sensitive to the impact that new and emerging technologies will have upon their technologically mediated world. Moreover, it requires them to engage in a more critical examination of the interplay between technology and society.

Modern philosophical debates over the meaning of technology also have consequences for technology education. Mumford (1934) for example, argues that technology, or 'techics' as he terms it, is embedded in machine culture. This argument can colour the views of technology educators towards that of a production model, whereas Ellul (1964) takes a more dystopic and deterministic view of technology, or 'technique' in his terms, as being "almost completely independent of the machine" (p. 4). This view might be seen to orientate technology education more towards a technological literacy model. These two philosophical models also echo the poiesis/techne tension described earlier.

The very term 'technology' which was relatively clear and distinct in the past, therefore, has, over time become amorphous. We have micro technology; biotechnology; nanotechnology; food technology, we have technological determinism; instrumentalism; critical theory, not to mention high tech and low tech. Humans' beings can be technicians; technologists; techies; they might demonstrate good technique or be perceived as having a "technical" mind. All these terms will mean different things to different people. This confusion over what technology is, has important implications, moreover, both for the way in which it is taught and its future as a subject in the school curriculum.

The lack of a mutually constituted modern framework for defining the meaning, or rather, the several meanings of technology, encourages
technology teachers to perpetuate their own "folk pedagogies" (Bruner 1996, p. 44) of what technological education actually is. These 'folk pedagogies' can manifest themselves in many ways in a technology education classroom setting. Although arising mainly from past experience, these "folk pedagogies" will nevertheless be influenced by a variety of sources, one of which will be educational policy. Policies ultimately manifest themselves in some explicit form of rationale which sets out to define what policy makers think constitutes technology education. These rationales may attempt to define technology education as having a strong emphasis on either design, manufacture, literacy, creativity, entrepreneurial, enterprise or various combinations of these and more. However, whilst some teachers may accept the received wisdom of policy makers, a considerable number will subvert policy to suit their own particular implicit theories, based upon their own interpretation of the meaning of technology and thus, technology education. These deviations from policy may be based upon their own implicit beliefs about what constitutes technology education in particular, or even education in general. For example, a rationale for technology education may espouse, as a central tenet, the need for creative enterprise. However, the adoption of this rationale may be problematic for some teachers depending on their implicit theories, not only of technology, but of creativity in particular and learning in general.

"Teachers who implicitly believe, for example, that creativity is an innate talent possessed by a privileged few, or that teaching concerns control and the passing on of expertise through exposition or demonstration, or that the central tenet of successful learning is reward for success or the avoidance of failure, are likely to set up structures which will hamper the development of creativity" (Dow 2004, p. 61).

Implicit beliefs, which help to direct technology education towards a practical and 'industrial arts' model of the past, are firmly grounded in the teachers' social and cultural inheritance. Technology teachers who have themselves an industrial past will be reluctant to adopt a new modern technology education paradigm. Their focus, whether implicitly or explicitly, will be on technology education as "the development of in-depth manipulative competencies in a narrow range of technology areas (rather) than broad based, attitudinal and cognitive competencies" (Williams 1996, p. 54). Thus despite changes in policy which accommodate more broad based attitudinal and cognitive competences, this restricted definition of technology education continues to predominate in the minds of a substantial number of technology teachers today. (Barlex 2003; Dakers & Doherty 2003; Harlen & Holroyd 1996; Kimbell & Perry 2001; Peters 2002).

This restricted definition, moreover, runs counter to constructivist theories of teaching and learning. Part of the problem may be that current attempts of policy makers to intellectualise what had developed as a craft based, production- oriented subject have led to confusion among teachers who, as discussed above, determine their own epistemologically constructed framework for the delivery of a technology education. This framework does
not necessarily accord with national policy, but accords more closely with their own implicit theories of what technology education should be.

"The new broader type of technology education is more complex than that which has sufficed in the past, partly because intellectual processes are not directly observable, in contrast to physical skills" (Williams 1996, p. 54).

This problem, as Williams observes, highlights the performance/output emphasis of the applied technology curriculum. This results in the subversion of teachers' willingness to adopt the broader type of technology education promoted in the modern rationales for technology education across the developed world. This broader, and more constructivist approach to technology education, importantly seeks to engage pupils in the development of informed attitudes about the impact that existing and emerging technologies will have upon their cultural development, as well as the potential and actual consequences of these technologies on the environment, both locally and globally. This broader conception of technology education manifests itself across most western liberal democracies as 'technological literacy', where a synthesis between Technē and poiesis begins to emerge. A technologically 'literate' person is one who understands what technology is, how it is created, how societies shape it and how, in turn, it shapes societies. (DfEE 2004; ITEA, 2000; NZCF, 2004; SCCC, 1996) Moreover, "(t)o be understood properly, technology must be put into a social, cultural and environmental context" (ITEA 2000, p. 56). This is very much in line with Heidegger's (1962) synthesis for understanding technology, and thus technology education.

Unlike the 'either Technē, or poiesis' argument, where one model dominates over the other Heidegger emphasises a duality between a thesis of technology as being 'calculative thought', relating more to Technē, instrumentalism or fabrication (see Arendt 1998), and an antitheses where poiesis, or enframing (Gestell), in his terms, prevail (Heidegger 1962). He argues that we must give consideration to the essence of technology and its social and cultural implications. Out of this, for Heidegger, emerges a synthesis which leads towards an anamorphosis in technology education. The technologies that we simply accept as they are presented, are often distortions of the truth, much as the lettering used in road markings appears to be elongated and distorted from the point of view of a pedestrian. However, the same markings when viewed from a driver's point of view, which are seen head on and from a different perspective, appear, as a result of foreshortening, to be in proportion. This is deliberate on the part of the designers, but significantly, very few of us, drivers or pedestrians, are actually aware of this. It is only by repositioning ourselves that we may begin to see a different perspective which may in turn, serve to transform our previously distorted view by illuminating and clarifying the controlling logic of the technologically mediated world we inhabit. A technological literacy where the dialectics of "calculation versus meditation, objectification versus art, 'world' versus 'earth', identity versus difference" (Kroker 2004, p. 38) are explored as a crucial part of a pupils technological development.
THE PREVAILING TEACHING MODEL EMERGING FROM A TEACHERS
VIEWPOINT OF TECHNOLOGY AS TECHNE: THE TEACHER AS EXPERT.
THE STUDENT AS A PASSIVE RECIPIENT

The legacy of behaviourist, teacher centred, whole class teaching, with
teacher as expert and student as passive recipient of knowledge, seems,
however, to remain the dominant orthodoxy in technology classrooms to-
day (Barlex 2003; Dakers 2004b; Dakers & Doherty 2003; Dakers & Dow

This situation is clearly manifest in technology education at present, where
the technology curriculum is effectively under attack, with instructive dis-
course prevailing as the dominant model of delivery (Dakers, J. (in press).
Defining Technological Literacy: Towards an Epistemological Framework.
Palgrave MacMillan. New York). The result of this instructive approach,
with meaning defined by the teacher, is that technological knowledge is
broken into small discrete and decontextualised components to be learned,
and subsequently tested, in total isolation from any meaningful context.
Technology in this model comprises a hierarchy of taught craft skills, the
mastery of which supersedes all other technological knowledge. The context
for developing these limited skills is defended on the grounds of having some
relevance to industry, which is clearly no longer the case. Modern industrial
methods of production have changed considerably over the past few decades.
This programmed instruction depersonalises and fragments the child’s
experience, and in its “whole class”, assembly line production of standardised
skills, estranges children from not only each other, but from society as well.

This teaching style has serious implications for a technology dependent
population, which through ignorance and apathy is becoming increasingly
unable to engage in informed debate about the way technology is shaping
and dominating society. Technology under these circumstances forms the
basis of a technological hegemony (Feenberg 2002) that, by its very nature,
is systematically destroying the democratic process. As long as technology is
seen to be a subject where the teaching of craft skills is the dominant ped-
agogy, and where no account is given to the crucial interrelationship that
technology has with society, power will rest with those who control the
technological mediation of social activities. This worldview of technology
education as more than the passing on of skills is not a recent philosophy.
Dewey expressed his concerns about this model over 100 years ago.

“Its (technology education) right development will do more to make
public education truly democratic than any other agency now under con-
sideration. Its wrong treatment will as surely accentuate all undemocratic
tendencies in our present situation, by fostering and strengthening class
divisions in school and out...Those who believe the continued existence of
what they are pleased to call the ‘lower classes’ or the ‘laboring classes’
would naturally rejoice to have schools in which these ‘classes’ would be
segregated. And some employers of labor would doubtless rejoice to have
schools, supported by public taxation, supply them with additional food for
their mills... (Everyone else) should be united against every proposition, in whatever form advanced, to separate training of employees from training for citizenship, training of intelligence and character from training for narrow, industry efficiency” (Dewey in Apple & Bean 1999, p. 50).

LEARNING AS SOLO ACTIVITY OR AS A SOCIAL PROCESS: INTERNALISATION AND EXTERNALISATION

Learning in the behaviourist sense, reduces learning in technology education to response acquisition (Mayor 1992) Within this model, the learner effectively consumes the instructional discourse offered by the professional teacher in much the same way as the sophists prostituted their expertise in order to exploit those students who required that knowledge and were willing to pay for it. This connotes a technology education paradigm which serves to commodify technological skills as a transaction in which prescribed skills are transferred from expert to recipient. In this model, however, unlike the sophists or the marketplace today, the recipient has no voice in the transaction. It is prescribed for them and served up as ‘table d'hôte’ where all items must be consumed, like them or not.

The skills acquired under these circumstances, are, by their very nature, pre-existing. They have been developed over time and have been shaped by the society which thinks them important enough to pass on, in this case, by the technology teacher to the learner. The intended result is that the learner responds to instruction, thus acquiring a prescribed set of ‘perceived to be useful’ skills, which can then, ostensibly, be transferred to some other activity outwith the context of the technology classroom.

The skills in this case are external to the learner and exist on the social plane, whereas they are seen to be internal to the expert and therefore must exist on the psychological plane. It is through the process of transfer from more able to less able that the learner begins to internalise the skills. With practice and repetition the learner becomes more proficient until the skill is effectively internalised to the stage where it can be performed almost without thought.

Vygotsky (1978) argues that formal learning must integrate with what he calls spontaneous or tacit learning in a sociocultural setting. He espouses a model of internalisation where the social precedes the psychological in ontogenesis. This view subscribes to the notion that we are all social beings first and only develop as individuals by the process of internalisation, subsequent to sociocultural inheritance. His concept of development (technological or otherwise), centres around the mediation of socially distributed signs, external to the learner, which take the form of tools which are both semiotic and artefactual in nature, and which come together to form a representation of the culture and society into which the learner is evolving.

Matusov (1998) argues, however, that this model is flawed in that it distinctly separates the external from the internal. For Matusov, the “social and psychological planes mutually constitute each other and are inseparable”
He argues that Vygotsky's notion of internalisation, is essentially a hierarchy of one-way processes starting with the interpsychological (interaction between individuals and the environment) and ending with the intrapsychological (within the individual). This process of internalisation results in the skill residing outside the activity and inside the individual, rendering it transferable from one activity to another. Cole and Wertsch also see "(t)he development of mind (as being) the interweaving of biological development of the human body and the appropriation of the cultural/ideal/material heritage which exists in the present to coordinate people with each other and with the physical world". It is interweaving rather than linear.

A simple example may help to clarify this notion. A sawer is defined as 'one who saws'. A sawer, moreover, is usually associated with sawing wood (although not always). These 'sawing' skills exist historically and thus, on the sociocultural plane. Skill procurement of 'sawing' skills would ultimately be internalised by the learner. If the skill, when acquired, resides outside a specific activity such as sawing down a tree, or sawing which is associated with jewellery making, we must assume that the skill of sawing transcends those activities. The sawer would be skilful, at sawing, in both activities. By the same argument the sawer would also be skilful in the sawing associated with the amputation of a patient's diseased leg. This example reduces the concept of sawing to the simple psychomotor actions associated with sawing, and assumes that these skills are decontextualised mental functions contained within the individual, thus rendering these functions as meaningless. Clearly sawing involves action by the sawer upon something external. However, it is the external which gives meaning to the activity. The process involves moving the socially learned cognitive processes associated with sawing [out of the head] so to speak, and locates them in a particular activity in the environment of a particular sociocultural system. In other words, the action of sawing is only meaningful in the context of the sociocultural activity. Skills and functions are thus embedded in sociocultural activity (Lave 1988).

"The individual exists in the flow of sociocultural activities and cannot transcend them. Activity is not isomorphic to the unfolding physical time continuum because it is grounded in meaning. Meaning is distributed across time, space, and participants, interpreted and renegotiated" (Matusov 1998, p. 330).

Before going on to discuss a model of technology education structured around a community of technological enquiry, Table I summarises the points made thus far in respect of the Technê/poeisis tension surrounding technology education.

CREATING A COMMUNITY OF TECHNOLOGICAL ENQUIRY

Mediated learning

The transmission model is by its very nature a monologue, where interaction between teacher and pupil is a one-way process. There is a growing
recognition, however, that for children to learn, they have to be actively involved in the learning process. They construct meaning through the process of interaction and inquiry, which involves communicative action.

"We have been moving away from cognitive theories that emphasise individual thinkers and their isolated minds to theories that emphasise the social nature of cognition and meaning" (Resnick 1987 in Barab & Duffy 2000, p. 26). Learning then does not take place in a vacuum. Children do not learn simply by constructing their own individual realities in isolation from the cultural, historical, and social environment into which they were born. Without those factors there is no conceptual framework to work from (Resnick 1987 in Barab & Duffy 2000).

The importance of the social and cultural contexts of learning are clearly illustrated by anthropologist Margaret Mead as far back as 1964.

"The social structure of a society and the way learning is structured – the way it passes from mother to daughter, from father to son, from mother’s brother to sister’s son, from shaman to novice, from mythological specialists to aspirant specialists – determine far beyond the actual content of the learning both how individuals will learn to think and how the store of learning, the sum total of separate pieces of skill and knowledge...is shared and used" (Mead 1964, p. 79).

Resnick (1987) in Barab and Duffy (2000) further reinforces Mead’s argument by comparing learning in schools to the acquisition of knowledge metaphor, and makes an important distinction between this and the spontaneous learning which occurs outside school. She found that the contextualised, concrete and in particular collaborative form of learning that takes place outside the context of school, engendered a much richer learning experience than that encountered inside the school context in which learning was prescribed, largely decontextualised and as a result, abstract in nature.
Learning is fundamentally constituted through interactions and relationships in a given sociocultural system (Cole 1996; Engestrom et al. 1999; Lave 1993; Lemke 1997; Matusov 1998; Rogoff 1990; Vygotsky 1978; Walkerdine 1997; Wenger 1998; Wertsch 1990). This system comprises, at the micro level, a variety of particular cultural identities situated in a particular environment, whether natural, social or artifactual, where a community of practice, and thus learning, is constituted and where "(p)practice is not conceived of as independent of learning" (Barab & Duffy 2000, p. 26).

In relation to technology education, the importance of collaboration is further stressed by Fouet and Nouria (1995) who argue, that in terms of the made world, that all that could be designed by an individual...has been designed. The made world as we know it today is a collaboration. "It took 52,000 people to create the space shuttle" (p. 2). This paper, although it may be perceived as an individual endeavour, is nevertheless clearly influenced by the authors cultural inheritance, prior art and discussion with colleagues, all of which have served influenced its outcome.

A further example of this can be demonstrated by considering the practice of architecture which involves, within a micro context, learning about the practice called "architecture" within a community of architects. However, an architect cannot claim to know all there is to know (Nor can anyone else for that matter). Consequently, before an architect can design an airport for example, there will be a requirement to learn about the culture that constitutes the meaning behind airports. The task is not undertaken out of context. The architect must take what constitutes architectural knowledge and situate it within that of the concept of an airport. To do this necessitates taking the skills of architecture into a newly formed community which is in the business of designing and building an airport. Likewise, many other communities of practice, such as civil engineers, electronic engineers, airport specialists etc., come together to form this macro community. For Lave (1993) the process of developing an identity in a community, whether micro or macro or both, correlates simultaneously with the development of knowledge and skill. Thus, the process of forming an identity within the community constitutes the motivation, shaping and meaning, which subsequently informs individual development (Lave 1993). Upon completion of the project, the architect (and others) in our model, eventually leave the community, having developed in the process, a variety of new skills as a result of participation in the macro ‘airport’ community. These skills and more importantly, the resultant collaborations formed, will inform further practice in the future at a meta-level.

In technology education the formation of an identity within a community of practice requires to be situated in a context which is both meaningful and authentic to the learner (Lave 1988). The formation of a proper community as described above is, however, difficult in a traditional technology classroom setting. The end product will be limited and devoid of any authentic meaning if the community does not extend beyond the classroom walls. Problem solving set entirely within the classroom will be contrived whilst
skill development will be abstract and consequently have no sociocultural significance to the learner.

As a possible solution to this dilemma, Senge (1994) postulates the idea of ‘practice fields’ where learning is situated in real or authentic practices that have been constituted in the word outside the school setting. As the term suggests, “practice fields” are authentic situations that have occurred and have been solved, and are now used as true representations of authentic practice rather than some decontextualised activity ‘invented’ by the teacher or the learner. This follows Brown et al’s concept of students as practitioners where they learn as demonstrated in Table II.

The concept of practice fields or situated learning (Lave 1988) allows pupils in a school setting to engage with actual situations which occurred outside the school environment. This type of practice field model was pioneered in PBL (Problem-based-learning) by the medical profession. Under this model students are presented with authentic patient cases which have occurred in the past, and asked to diagnose them. (Barab & Duffy 2000). It is significant to note that, whilst a diagnosis would have been made and subsequent treatment would have been prescribed by the professionals involved in the case, there are nevertheless no clear and absolute ‘correct’ outcomes or solutions to the problem. The students’ diagnosis is subject to discussion with tutors and fellow students and this forms the basis of an interpretation of the scenario based upon the students experience to date and reinterpretation resulting from discussion with others. In this way the structures are set up which enable students to form their own community of practice which is located in the real world.

A similar model for technology education may be adapted from Barab and Duffy (2000). This is proposed as a way of developing communities of practice within authentic contexts for the technology curriculum.

Undertaking domain-related practices

The scenarios in technology education should be based upon some authentic practice that has occurred and can be replicated within the resources available in the technology classroom setting.

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<th>Students</th>
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<td>Act upon</td>
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<td>Resolve</td>
<td>Well defined problems</td>
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<td>Produce</td>
<td>Fixed meaning</td>
<td>Negotiated and socially constructed meaning</td>
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Ownership of the enquiry

The pupils must have a sense of ownership of the scenario and must be given scope to develop their own solutions. This is important. If the students are persuaded to adopt a solution to suit the school, which tends to be the prevailing model, they will then identify with a model which requires a teacher-based solution. Given this scenario they will act strategically. Whilst this teacher imposed structure offers stability to some students who find security in an instrumental system which promotes a “do this – get that” (Sternberg & Williams 2002) culture, many others fall into a “widespread generation of negative identities...(which serve to enculturate)...institutionally disapproved interstitial communities of practice” (Lave 1993, pp. 78–79).

Coaching and modelling of thinking skills

This requires a pedagogical shift in which the teacher’s role changes from that of a subject specific expert to that of an expert in creating effective learning environments. The teacher’s role in this model is to question and challenge the learners and to encourage the learners to do likewise.

Opportunity for reflection

Time must be given for learners to reflect and cogitate. There is a constant pressure on curricula to deliver a large amount of content within very tight time scales. This produces activities which are more focused on performance outcomes than on learning outcomes. (Ames 1992; Dweck 1999). Time should be created for learners just as time would be created for professionals to consider their proposals, For example, if students are involved in the design of some artefact, their design solutions are likely to involve sketching activity which involves an iterative process between hand and mind (Kimbell 1997) where internalised concepts from within are externalised in the form of a sketch or perhaps a model, considered, re-sketched, reformed, reconsidered, re-sketched, discussed, reconstituted etc. It is through engagement with the student as a process of intersubjectivity that the teacher can coach and model the thinking skills mentioned above.

Ill structured dilemmas

“The dilemmas in which learners are engaged must either be ill-defined or defined loosely enough so that students can impose their own problem frames” (Barab & Duffy 2000, p. 32). This suggests that where the dilemma is pre-existing, the teacher must reconstruct it such that the edges are blurred enough to enable the learners to take ownership of the problem as discussed earlier.

Support the dilemma rather than simplify the dilemma

“(T)he problem presented must be a real problem. Students should not start with simplified, unrealistic problems because this would not be reflective of a
practice field but rather would reflect the more traditional building blocks
approach to instruction characteristic of the representational perspective”
(Barab & Duffy 2000, p. 33).

Work is collaborative, meaningful, authentic, and social

Meaning, as has been discussed, is socioculturally embedded. It is thus a social
process and subject to constant negotiation and renegotiation. An understand-
ing of the views of others as potential users or objectors of the project will
promote technological literacy. Learners must have time to discuss, cogitate
and reflect on the issues surrounding the activity. An example of this type of
learning environment in technology education is given in the US Standards for
Technological Literacy (ITEA 2000, p. 64). In this scenario, the teacher
introduced discussion on issues relating to the development of a new airport
near the school. The class decided collectively, that it would be interesting to
design their own layout for an airport and compare it with the actual proposal.
As part of the process, the students became aware of the kind of impact that
the airport would have on the school and the community at large, as well as on
the environment. There was a realisation that residents would have to be
relocated, that large areas of wetlands and their ecosystem would be de-
stroyed, and of the consequential pollution that would follow as a result of
locating an airport on this site. As a result the students negotiated a com-


unity of practice which involved the class visiting other airports, discussing
issues relating to the impact an airport has on a community, good and bad and
collaborating with a biology class from the same school who undertook an
impact study of the wetlands. The whole process concluded in the production
of a comprehensive impact study that could be presented to the responsible
authorities.

“This project provided a firsthand experience for the students to observe
how technological activities can affect society and how society can affect the
development of technological activities. Also, the activity represented a
practical problem of meeting human needs in relation to cultural and eco-
nomic consequences” (ITEA 2000, p. 64).

Other scenarios might include biotechnologies such as cloning, exoden-
genious transplantation (using animal organs for transplantation), designer
babies etc. Learners, however must be introduced to dilemmas. They cannot
always be expected to invent scenarios. On the other hand, as imposition of
scenarios should be avoided, the teacher must negotiate and guide the
learners. It is important to both motivate and challenge learners to move
beyond their comfort zones.

DISCUSSION

The arguments presented in this paper attempt to challenge the extant
orthodoxies that espouse a technology education paradigm which is
referential rather than experiential. This is rooted in a ‘commodication of predetermined skill procurement’ epistemology, which purports to enable the transfer of acquired technological skills from the culture of school to that of industry. This model blurs the edges that serve to distinguish between technology education and vocational education. Research carried out in America by Hansen (in Hansen & Lovedahl 2004) found a dichotomy of opinion between teachers views as to the purpose of technology education. Teachers who considered themselves as teachers of technology education, thought technological literacy was the purpose, whereas those who saw their role as teachers of technical subjects saw career preparation as the purpose.

Whilst the implicit beliefs of technology teachers are difficult to change, a community approach for the delivery of technology education, would enable the adoption of formative processes which would not have prescribed outcomes designed in advance, would at best adumbrate but never enforce its results, which would be essentially an open ended process, "concerned more with remaining open-ended than with any specific product, and fearing all premature closure more than it [would] shun the prospect of staying forever inconclusive" (Bauman 2003, p. 139). A community of learners approach would, moreover, facilitate the paradigm shift required by teachers, far more easily. Both explicit and implicit beliefs, involving all members of the community, are externalised as part of the process. In other words, whatever belief the teacher held would be open to question. To exclude the free exchange of ideas and opinions from the classroom prevents the participants from becoming people who, through a natural curiosity inherent in all human beings, interact with the community by interpreting, repudiating or affirming experiences, creating instead reactive, conditioned, and at best, trained individuals. Kuhn (1991) supports this viewpoint. "Argumentative dialogue with others externalises argumentative reasoning and offers the exposure to contrasting ideas and the practice that may facilitate its development." (p. 294).

Rather than taking the prescribed, standardised learning outcomes contained in the various arrangements produced for technology education around the world, and creating teacher led projects and activities which incorporate them, a community approach would essentially reverse this process. Issues relating to the made environment can be discussed, and from this initial discussion various projects and activities will emerge. In the early stages it is likely that these activities will be blurred and ill thought out. However, as the activity is discussed, negotiated, and re-negotiated between peers, teachers, parents and the wider community, realistic and authentic activities will emerge into which the teacher can then incorporate the various prescribed learning outcomes.

The scenario described above where the students produced an impact study regarding the construction of a proposed airport in their own community serves as a good example of technology education in a meaningful context. This method, which involves an authentic discourse about technology will liberate students and teachers alike from, in Heidegger’s terms, a
technological "flight from thinking consequent upon the triumph of calculative thought' (in Kroger 2004, p. 38).

REFERENCES


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