Work, Learning and Sustainable Development

Opportunities and Challenges

Edited by

JOHN FIEN

RMIT University, Melbourne, Australia

RUPERT MACLEAN

UNESCO-UNEVOC International Centre for Education, Bonn, Germany

MAN-GON PARK

PuKyong National University, Busan, Republic of Korea

Japanese Funds-in-Trust

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Editors

Prof. John Fien
RMIT University
Melbourne VIC 3001
Australia

Dr. Rupert Maclean
UNESCO-UNEVOC
International Centre for Education
Hermann-Ehlers-Str. 10
53113 Bonn
Germany

Prof. Man-Gon Park
PuKyong National University
599-1 Daeyoen-3 Dong
Busan 608-737
Nam-gu
Republic of Korea

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Chapter 9
Technacy Education: Understanding Cross-cultural Technological Practice

Kurt W. Seemann

A review of education in Australia's Northern Territory identifies the importance of developing technacy skills that are

> ... critical skills for negotiating the varying and ever changing technologies increasingly integral to daily life, even in remote [Australian Aboriginal] communities. Our social lives are becoming more and more technologically textured, ... and this demands teaching and learning pedagogies that allow students to engage authentically with our technologically constructed worlds. (Northern Territory Government, 2003, p. 56)

Technology studies are both highly visible but rarely valued in almost every national curriculum. It is often spoken about and yet it is barely understood. In addition, while technology is perceived as being the root cause of much of humanity's ills and our climate's current problems we trust in it to save our future and much of our health and economic productivity. Technology is seen in limited terms: if it is not computers then it is vocational technical training, and rarely ever is the whole spectrum of technology that constitutes its existence between these bookends made apparent, explored or debated. In the curriculum of many nations technology is portrayed as a process or thing one simply is taught to use, rather than study. It is at best the metaphor for building the skills of a labour force to given standards, and at worst it is the school subject that offers students mental recess before carrying on in the more noble studies of subjects associated closely with literacy and numeracy such as language, mathematics or science.

What is not understood is how technology presents and represents a mirror of our values, our means for building new knowledge (that is, its role in the knowledge-creation process itself) and our relationship to our eco-environmental futures. We are yet to unveil and articulate the universal characteristics in technology. Technacy is the ability to understand, communicate and exploit the characteristics of technology to discern how human technological practice is necessarily a holistic engagement

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K.W. Seemann
Desert Knowledge Co-operative Research Centre in Sustainable Desert Settlements, Southern Cross University, Coffs Harbour NSW, Australia
e-mail: kseemann@scu.edu.au

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with the world that involves people, tools and the consumed environment, driven by purpose and contextual considerations.

In the first part of this chapter I explore case studies of the way values, culture and context are implied in all technologies. To illustrate core ideas in technological practice I draw on my cross-cultural work with technical projects in remote Australian Aboriginal contexts. I argue that when technologies, technical processes or technical education curriculum are transferred across cultures or contexts, considerable potential exists to reveal the values embedded in their design. The insights that technologies offer concerning both the technology donor and the technology end user lead to an understanding of why some are virtuous in their impact and some inevitably fail. Informed by the cases explored, the second part of this chapter develops a theoretical model for the universal elements of technology. Teaching the skill of exploiting this holistic and universal approach to understanding technology is referred to as technacy education. Technacy in education is proposed as a third essential pillar for new learning alongside literacy and numeracy, one that is well-placed to help address in its own right ideas leading to a sustainable future for humanity.

Part One: Case Studies

It is significant that there are few authentic case study examples in the literature showing how values affect task performance. The available literature is largely restricted to the macro level of exploring the way that values broadly affect the development of a field of knowledge, rather than understanding how, at the micro level, values are a factor in teaching and assessment that affects task performance in technology studies. Teaching task-values is based on teaching and learning how to judge the selection and execution of tasks, based on their importance. This is especially so when task importance comes into competition with other values that learners perceive are of higher importance to them. The learner is faced with committing to matters of importance for a learning requirement, and the contestation between values and revaluing importance forms the central idea for how values drive the well-executed task.

Values in a Cross-Cultural Technology Settings

The first case study presents learning in a vocationally oriented cross-cultural and Australian Indigenous outback technology education context. In this case example, one's values are defined as one's judgment of what is important in life. Accordingly, teaching and fostering what is important in technology education are critical to improving task performance for the technology educator and learner.

In Central Australia an innovative organization, now earning considerable research income and regard in appropriate technology, advises the Australian Government and manages a significant renewable energy programme for all desert Aboriginal settlements in Australia. This organization, the Centre for Appropriate

Technology Inc./Desert Peoples Centre is run by a handful of Aboriginal and non-Aboriginal technicians, professional engineers, architects, industrial designers and educationists. Its main expertise is cross-cultural technology transfer, education and the research and manufacture of innovations for desert settlements. It is a vertically integrated organization controlling the value chain from research, development and innovation diffusion to production and education and to government policy and programme advice. A certain realm of values thus drives the performance of this organization, rather than skills alone.

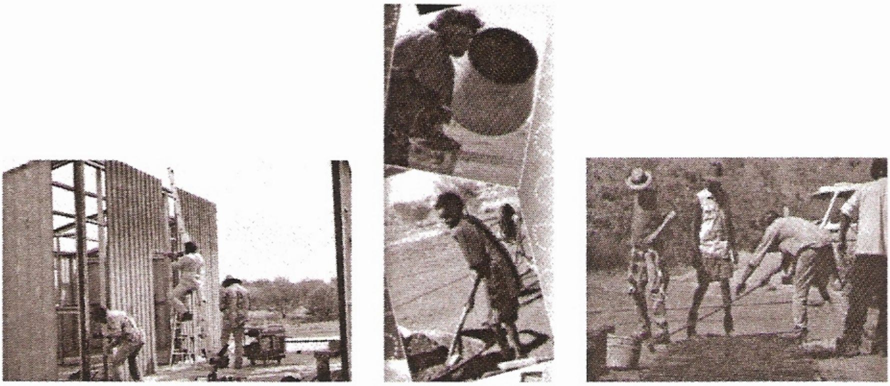
Case 1: Values for Construction With Steel Frames, Concrete Slabs and Mud Brick

The education and training programmes at the Centre for Appropriate Technology were mostly in the field of construction. The projects included stand-alone (not connected to mains systems) toilet, shower and shelter constructions. Typically, an experienced builder–trainer led the work teams where indigenous students learned on-the-job skills in construction. These teams worked on many projects and it was expected that after many hours spent in repeating the tasks task performance would improve.

It was, however, perceived that some of the students appeared to struggle with basic skills, especially on those tasks that required more sustained demands in the timing of their execution. One illustration of this emerges from comparing the value of laying concrete slabs, with steel frame construction and with mud brick construction (Fig. 9.1). The task of concrete laying required a relatively simple set of manual skills after the slab formwork was erected of in-fill concrete. However, the training crews were not initially taught about the importance and personal ethic or value of the timing of critical tasks. The Aboriginal students on occasions broke away from the task, because conflicting values encouraged them to attend to cultural family demands, leaving the wet concrete to cure just when they needed to be at hand to trowel off the surface. This task was not based on great skill or complicated knowledge but students needed to judge it to be more important than the competing cultural value of family and obligation.

In such cases the experienced builder would lament and automatically judge that the few who stayed to trowel off were better skilled than the others. However, the builder instructor had not taken time to inculcate in the students the values necessary for the task, and instead, merely showed them the industry skill and tool processes as a normal mode of pedagogy. What he failed to teach was the more important associated values of how the process of slab construction requires the slab laying process to be put above any other item of personal importance once the wet concrete has been laid. Without such a commitment the slab task is ruined and proves very costly to rectify.

In contrast, steel frame construction seemed to fit more naturally with the students having to reconcile competing family and cultural demands with the technological task. Steel frame assembly, especially where it arrives on site in kit form, permitted stop and start activity with little negative effect on the final job.



Steel Frame Concrete Mud Brick

Fig. 9.1 Values required for different technical tasks
Source: Photos courtesy Centre For Appropriate Technology Inc

Mud brick construction presented two very interesting values issues in the process of production. Mud brick is, in theory, a logical choice for the outback if the soil types prove appropriate near the site of construction. It is a cheap resource, it can be produced on site, it has excellent thermal properties for extreme temperature climates and it does not need accurate construction methods in most domestic cottage-style housing. However, it is very labour intensive and once the mud slurry quarry is created near the site, time and water factors are critical. A team effort is essential for good brick production while weather patterns permit. This work ethic in the process of mud brick production is core to the success of the task, and is much more important than the lower level manual tool skills actually taught.

The second set of values in mud brick housing is the perceived aesthetic value of the material. Mud brick construction looks unusual and for most people directly conflicts with the conventional appearance of cement block constructions that dominate the built landscape in desert communities. In theory, mud brick is a far more appropriate building technology, permitting locally sustainable constructions with good climatic properties and using lower levels of skills, so all local unskilled members in the community could participate. This applies to both its possibilities for local employment in the production of housing, extensions and renovations, and repair and maintenance. However, in my discussions with Aboriginal community members and mainstream builders in the few places where mud brick houses have been constructed, I found a common strong value bias against the technology. Mainstream builders dislike it often because of negative myths about its technology and its base in non-conventional knowledge that had not been integrated into their mainstream training. The community people were influenced both by the mainstream builders' views and their own views that it was a risky technology compared with the climatically inappropriate and limited local participation and employment potential of cement block building methods.

Values are therefore clearly determining factors in the use of a technology and are often much more important in many cases than the skills required to gain access to the technology. A final example of this is the issue of housing in some cross-cultural settings. Walker (2006) notes that 'owning a house requires you to own a set of values, and networks' when you require services. This poses a challenge to the individual, sometimes presenting a contested set of values between those embedded and assumed in the technology and those held by the householder.

> Whilst Indigenous housing suffers from overcrowding it is possible for more than four people to live happily and healthily in a house – but you have to live by a set of rules that accommodate a shared view and use of the components of the house. To get my meaning, ask yourself the following. What causes you to pick up something off the floor or to remove food scraps from the floor of a house? How did you learn this response? (Walker, 2006, p. 15)

This example from the cross-cultural context of remote Aboriginal communities highlights a general value conflict that is directly related to performing a task using a technology and house design that conflicts with one's own personal values, choices and preferred way of living in a house. Either the house technology or the user's values ought to change. This is also the basis of appropriate technology studies.

In summary, the values required to execute steel frame constructions are different to those for laying concrete slabs and mud brick construction. Steel construction is a forgiving process, permitting stop and start activity. Laying concrete is less forgiving, demanding attention to its cure-timing as a critical task value. Mud brick is highly labour intensive, demanding sustained timing on the processes and drying of bricks. However, technical modules of training do not assess or emphasize the personal values required to execute correctly the different demands of the tasks and processes involved. They focus on tools, sequence and practice, but not on teaching and assessing learners on their work process values that the nature of the technology itself demands.

Case 2: The Steel Axe

Most remote indigenous communities today use the short-handled steel axe for hunting and gathering and for crafting goods for the tourism market. However when missionaries first handed out the axes to encourage church patronage, a ripple effect disrupted long standing social structures (Sharp, 1952). The axe was traditionally a man's tool. The prized smooth stones of traditional axes were tradable items linking local groups with trade lines across the country. For groups in the far north the hardwood axe handle had to be traded with desert groups to the south as local woods were less suitable. Some men held a particular status because of their skills as trade negotiators, and because they had established friendships across vast lines of trade. Skills of diplomacy in trade gave the men rights to regulate the use of the axe. Women, who had similar tools that defined their own roles, were not denied the axe but, as it was a very important survival tool, the men had primary responsibility for its care. To gain a traditional education in the production of axes was to develop social trading skills, technical knowledge and techniques in assembling and the selective extraction of local natural resources. One can imagine that the traditional knowledge that assured sustainable axe supplies for community survival was something akin to having passed through an education in technacy. The present day antithesis of this process would be for a school to teach a module that leads to the fabrication of a traditional stone axe without genuinely developing skills in trade negotiation, and in the selective extraction of raw timber from the environment in a socially acceptable way.

When steel axes were handed out to uninitiated men and to women and children, in the above example, the trading skills and social status of men changed. In time a new balance was achieved where all used the steel axe. But now, rather than having artisans to sustain local subsistence economies, indigenous Australians depend on having a cash income in order to buy, repair and sharpen their axes. In effect, from a sustainability perspective, they have taken a backward step. They have had to move from being technologically competent (technate) to being merely technical. The steel axe is technically superior to the stone version, but it could not be incorporated into the socio-economic and cultural context. While the axe is a relatively insignificant example, the principles of its introduction and effects could be replicated many times over in relation to other new technologies introduced to indigenous communities since western colonization (Seemann, 1997).

Case 3: *Pandanus* Baskets

Traditional knowledge has sustained indigenous Australian cultures for over 60,000 years, during which technology and technical activity were inseparable from social and environmental knowledge, which was the only framework for practicing technical knowledge. To produce an artefact, a tool or a shelter was to integrate all three forms of knowledge. To illustrate this point consider how women in small island communities in northern Australia integrate skills to produce *pandanus* baskets or carry bags for their own use. They start by organizing a work group, in which each woman has a particular task, including food preparation and child care. They arrange transportation to a site in the natural bush to harvest the best *pandanus* trees. Each tree requires a keen, informed eye to pluck the best leaves for weaving. Roots also are collected for dye. While this is going on, children are encouraged to watch carefully to learn not only *pandanus* harvesting but the social protocols and organization of the whole day. Some of the tools for manufacturing the baskets are fashioned by the women themselves, while others are purchased (Seemann et al., 1990).

The technology of *pandanus* basket construction could clearly not be conveyed adequately by a compilation of segregated competency modules. Yet much of technical education being imposed on indigenous peoples is still based on an industrial worldview that emphasizes the compartmentalization of knowledge through modularized learning. For women in island communities, learning the technical skills of basket construction is necessarily a social event deeply embedded in sustainable human and environmental relationships. The whole exercise integrates social, technical and environmental knowledge and skills. To represent the *pandanus* basket curriculum in a series of parts would be to misrepresent the quality of the integrated knowledge these women have developed. A disintegrated curriculum simply produces disintegrated judgements and hence inadequate solutions to the project or problem at hand.

In all the cases described above, the technical does not adequately manifest itself without the social. And moreover, both the technical tools and systems employed are interdependent with the social knowledge, social organization and techniques required to execute the task. Neither the social nor the technical aspect of technological practice could have occurred without for drawing on and accessing the material consumed from the eco-environment in the task process, and we could not imagine any of the social, technical and shaped resources coming together if there were not some at least initial purpose and context for the designed practice.

Part Two: The Basic Principles of Technacy

Many approaches exist for understanding the phenomenon we label technology. Presented here is a phenomenological view to offer the reader a deeper grounding into why certain conclusions are drawn and schemas proposed. A schema gives teachers a framework in which to evaluate just how holistic a lesson or curriculum is, to guide them in the educational tasks to include and in constructing the educational context and experience that fosters holistic understanding in technology and design.

I begin with the premise that holistic technology education is a necessary, rather than a merely desirable, outcome of schooling, especially cross-cultural schooling in technology. The classical holist position in education is

> . . . to know things is to know things in relation; to know a part is to know how it connects with the whole. In the process of codification, different impressions of the same object or process are utilized so that interrelations might be recognized. It is the total vision which we call knowledge. (Matthews, 1980, p. 93)

Many teachers argue that they already teach technology holistically. However, the question we must pose is, how do we know this?

Q1: How Do We Know We Are Teaching Technologies Holistically?

Teachers' responses to this question may range from 'because my students discuss many issues in the design process' to 'I make sure they engage in social and environmental perspectives'. The problem with such responses is that what is holistic is not grounded in universal reason or a coherent schema of dependent relations. Why should discussing social and or environmental issues be included for claims of holistic technological learning? Can one choose to discuss these elements or must one connect the dependence of these elements on the technology being learned? Such musings can quickly frustrate teachers who often conclude that to teach holistically one needs to teach and consider everything. At this point some teachers may be lost and very often some revert to teaching traditional particulars like tool skills and task techniques. That is, they revert to their narrow, but comfortable zones of assessing tools and technique skills and particular knowledge for a product so that the student can take home the object as a sign of successful learning. This chapter suggests that such patterns of pedagogy should be redressed.

The phenomenology of technology and knowledge development allows a teacher to use a basic principles approach to formulate a universal schema or cognitive framework. Using this approach a teacher can determine what to include in lessons and evaluations to ensure reasonably a holistic coverage in technical education. In it we also discover that technology education and practice is not only a 'how-to' experience, but also a 'know-why' experience and that the latter is fundamental to the human act of creating new knowledge itself not just using knowledge. A 'know-why' capability is important for principles development. It fosters in many different settings a knowledge of the reasons why things should be learned or done to the benefit of situational learning, and enables learning transfer or innovation to occur. Holistic education in technology can be transferred to novel encounters throughout the course of our lives, a quality lacking in much of 'how-to' training in technology particulars.

Knowing and Understanding Through Technological Practice

When can we claim we know something? Dialectics and practice are very useful reasoning tools for understanding the nature of an answer to this question in the context of technology education. Why is this important? This section of the chapter makes the case that knowing and especially understanding occurs best through holistic technological practice. The dichotomy between theory and practice in technology used in many secondary and tertiary schools is at the heart of the problem. 'Theory is taught through practice and good practice is grounded in good theory' as my education lecturer often said to me as a student. We do not really want to present technology education as separating conceptual tools (how to think skills) from physical tools (how to do skills). Theory classes should not be estranged from practical classes, nor should theory be devalued or even employed as a punishment in learning technology and design. It is not the product or the technical process we assess as educators, but the learners and their learning.

A tool is defined here as anything we value and use as an instrument. A brick or a fist is a tool if we use it as a club. A car is a tool if we use it as a means to get us from one place to another. An engineering algorithm is a tool if we to use it to determine a load on a beam. In each case, tools help us do things to manipulate a material, whether that material is at a scale we relate to in ordinary experience or something out of the realm of ordinary experience, like information and data that we manipulate with an algorithm or virtual tool.

Curriculum and pedagogy that normally segregates knowing and doing raises substantial educational concern and has so for many years. For Dewey,

> A divided world, a world whose parts and aspects do not hang together, is at once a sign and a cause of a divided personality. When the splitting up reaches a certain point we call the person insane. A fully integrated personality, on the other hand, exists only when successive

experiences are integrated with one another. It can be built up only as a world of related objects is constructed. (Dewey, 1963, p. 44)

Dewey was firm on this issue. We need to show how things are interconnected as necessary interdependencies to give the technology or technique meaning to students. This prepares the importance for holistic education. A segregated education for Dewey was not an education:

On the intellectual side, the separation of 'mind' from direct occupation with things throws emphasis on things at the expense of relations or connections ... [Education] must find universal and not specialized application. (Dewey 1966, p. 143)

Dewey's work opened out one of the differences between technology education and technical training, as the latter was geared to specialized vocational short-term task skills, while to former lifelong human capability. Our concern is technology education that shows us the basic principles for teaching technology holistically: the interconnectedness or dependencies of technologies.

Q2: What Exactly Should Be Interconnected in Teaching Technology?

Foundations of Technological Practice

The road from dialectics to practice addresses twists and turns (even head flips) from knowing as an essentially theoretical (idealistic) process to a social-material (surprisingly like the design and technology) process. We begin with Hegel (1770–1831), a German idealist philosopher born in Stuttgart for whom thought does not merely correspond to reality; it produces reality (Speake, 1979). Our thoughts are our reality, and so all knowledge can be formulated through pure reason. The 'dialectic' was Hegel's term for the pattern that thought must logically follow. Broadly, he argued that conscious thought proceeds by contradictions. Its process is by triads, where each triad consisted of a thesis, an antithesis and a synthesis. The concept of 'sharp' is thus not adequately understood without reference to an alternative, 'blunt'. Both the thesis 'concept of sharp' and the antithesis 'concept of blunt' define each other and therefore require each other. To see each concept as related, as mutually defining, is their synthesis. At this moment a new level of reasoned understanding is achieved. This is the level of conscious thought as reasoned understanding. From here, the whole triadic process may be repeated, the synthesis leading to a new thesis' and so on. This is elaborated in Hegel's *Phenomenology of Mind* (1807) (Vazquez 1977, p. 143).

The essence of Hegel's dialectics is 'the grasping of opposites in their unity' (Hegel, 2007 [1830]): a significant first step in building our basic principles for holistic technology education. This is the immanent goal, or telos of Hegel's philosophy. In the words of Sutchting:

So, in Hegel, Spirit is essentially rational freedom and the source of the dialectical development; the conflict between the necessity for Spirit to attain its telos and the various

> successive inadequate conditions for this to occur ... in so far as the system has an immanent telos the development envisaged is one towards reconciliation of conflicts in a larger harmony, hence, the Hegelian dialectics is conservative in its very foundations and not merely as a consequence of certain historical and personal factors. (Sutching 1983, p. 181)

In Hegel's philosophy of dialectics knowing begins, proceeds and ends at the level of ideas. For him, matter is a product of mind and all knowledge comes from pure theoretical reasoning.

Feuerbach and Hegelian Dialectics: The Head Flip

Feuerbach (1804–1872) was a Bavarian philosopher and theologian. Although he was Hegel's student, much of his work was critical of Hegel's idealism. Feuerbach was a materialist in the sense that he distinguished between consciousness of an object and self-consciousness, while at the same time connected the material object with the subject by pointing out that consciousness of the object always reveals some element of self-consciousness: 'In the object which he contemplates, man becomes acquainted with himself, consciousness of the objective is the self-consciousness of man' (Vazquez, 1977, p. 75).

This view of knowing and understanding introduced material objects (the world or environment outside the reasoning mind) as a necessary, not merely desirable, condition for knowledge, thus further building our basic principles for holistic technology education. Experiences from the environment outside the mind are now significant. For Feuerbach humans are sensual beings, not theoretical beings as the Hegel believed:

> I unconditionally repudiate absolute, immaterial, self-sufficing speculation, that speculation which draws its material from within ... I found my ideas on materials, which can be appropriated only through the activity of the senses. I do not generate the object from the thought, but the thought from the object. (Feuerbach, 1843)

It is often said that Feuerbach inverts Hegel by conceiving of mind as the highest product of matter rather than matter being a product of mind. All our knowledge comes from pure material experience.

Marx on Hegel's Idealism and Feuerbach's Materialism: Resolving the Views of Knowledge That Oppose Theory and Practice

Marx (1818–1883) was regarded by some as a social theorist, interested more in economics and history than in any particular philosophical doctrine. Essentially Marx, too, inverts Hegel's idealism, extracting and making use of Hegel's notion of dialectics, but rejecting his idealist approach. He differed from Feuerbach in his concept of materialism in terms of the central notion of human practice, specifically the social dimension of practice.

Marx rejected Feuerbach's relation between subject (the person) and object (the environment) in which subjects are passive and contemplative, restricting themselves to receiving or reflecting reality. Feuerbach's notion of knowledge was simply the result of the actions of objects in the external world and their effects upon the sense organs (Vazquez, 1977, p. 118). Marx was not, however, prepared to accept such passivity in materialism. He attempted to resolve the problems of idealism and materialism in his system of historical materialism, the central concept of which is the practical interaction that must occur between individuals and their material and social environment. As a dialectical result of such practical human socially contextualized activity, people and their environment become a new synthesis such that a new level of awareness was achieved, transforming both the individual and the environment (Vazquez, 1977, p. 193).

Technological learning has a central role to play in a society. Not only does the usefulness of studying technology have obvious applied and economic value, but, if it connects the general elements of the human (as an agent) to tools and materials (as the environment) brought together via a purpose in an applied context, then learning this system of dependencies in technology becomes a necessary feature of knowledge formation and discovery:

> ... there is no such thing as genuine knowledge and fruitful understanding except as the offspring of doing ... Men have to do something to the things when they wish to find out something ... The laboratory is a discovery of the condition under which [human] labor may become intellectually fruitful and not merely externally productive. (Dewey, 1966, p. 275)

Technology is not the slave of science or the neutral tool of design. Rather technology is symbiotically locked into science and design, as it plays an active role in knowledge formation. Holistic technological experiences are necessary in helping learners to develop new knowledge.

In question one above, this chapter initiated an inquiry into the need to learn technology holistically. In question two, the essential interconnected elements were explored for the constituents of the holistic foundations of technological understanding. To progress to the final stage in this chapter we need to establish both the structure and nature of a holistic understanding of technology that establishes its status as a study area that is essential both to knowledge development and to application. The integrating notion of practice is proposed as a useful mental tool to address the final step of synthesizing the mutual work of the elements of the individual (as agent), tools and environment over time.

Q3: How do the Applied Context, Human and Social, Material and Tool Elements Combine Holistically So That a Person Comes to Know Something of the World?

Technacy Genres: Forms of Technological Practice

Marx departs from Hegel and Feuerbach by the importance he places on actual human labour, or practice. He adopts a dialectic methodology in which he identifies the inadequacy of pure idealism and pure materialism and synthesizes them at the new level of historical materialism. This introduces the importance of time. The applied setting is subject to evolutionary influences. Both theory and practice in the applied setting are best resolved, according to Marx, through human material practice in social and historical contexts. Marx's thesis of historical materialism is essentially the foundation of praxis, or practice. Practice and technical activity require instruments and tools for the transformative experience. The contributions of Don Ihde (1979) on instrumentation are key notions to a schema for constructing basic principles in holistic technology and design education.

Practice so far has been concerned with practical human activity and the interaction of mind and matter, or between humans and the environment. Ihde's work identifies additional features of this interaction when modified by instruments or artefacts. The paradigm is shown in Fig. 9.2.

The observer in this model no longer simply gains feedback from the world, but from the world via the instrument or tool. That is, tools and technologies are values rich in their design use and context active in their causal tendency. However, Ihde points out that although this modified interaction is not neutral, this is not necessarily a problem:

> My thesis is that any use of technology is non-neutral. However, non-neutrality is not a prejudicial term because it implies neither that there are inherently 'good' or 'bad' tendencies so much as it implies that there are types of transformation of human experience in the use of technology. (Ihde, 1979, p. 66)

Ihde acknowledges that technologies need to be understood in the context and in purpose of their application. That is, different kinds of technologies and tools transform our knowledge differently just as the same tools and technologies in different geographical settings or in social and or material environments do, that is, in different world contexts.

This highlights the necessity to understand that the choice and design of tools and of world settings alter our knowledge. The context-sensitive nature of technologies is a key to technology choice, transfer and innovation diffusion. Designing tools and environments are socially and environmentally interdependent actions and to imply that technology teaching and learning is neutral as to value and context is to misinform the learner. The ability of learners to take social and environmental factors naturally into account when seeking solutions to design and technical challenges is fundamental to success. The agent, tools and the environment in an applied setting

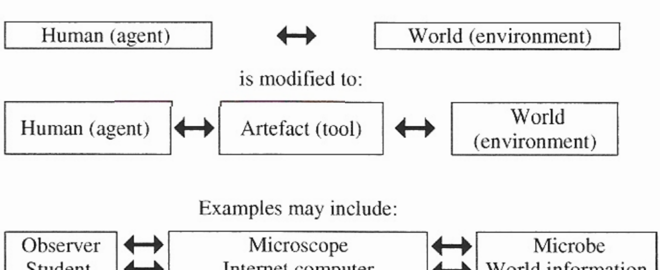


Fig. 9.2 Interaction between individuals and the environment modified by tools

are the minimum elements to any technological activity. Each element is a resource and constraint and each requires the other to produce value and so technology is their joint product. We therefore may need to understand and teach these elements and their dependent relationship explicitly.

Ihde's work shows that, although practice produces artefacts from the interaction between individuals and the environment, the artefacts themselves must increasingly be included as modifiers in this interaction. Hence, the model in Fig. 9.3 shows that, while each of the elements has its own identity (shown as a lobe in Fig. 9.3), it is necessarily mutually dependent on the other elements when it is applied.

We now have a basis for determining the absolute minimal conditions of holistic technology education (Seemann and Talbot, 1995) of technological processes and evaluations and for making design decisions. In the words of Dewey, the interconnectedness of knowledge constitutes a key feature of education:

> Any experience is mis-educative that has the effect of arresting or distorting the growth of further experience ... Experiences may be so disconnected from one another that, while each is agreeable or even exciting in itself, they are not linked cumulatively to one another ... Each experience may be lively, vivid and 'interesting', and yet their disconnected-ness may artificially generate dispersive, disintegrated, centrifugal habits. The consequence of formation of such habits is inability to control future experience. (John Dewey, 1963, p. 49)

The basic principles of holistic technology education now appear to have structure, articulated elsewhere as technacy education (Seemann and Talbot, 1995). When teachers can without hesitation claim to include social (human) factors, technical (tool factors) and environmental (material) factors in their lesson for specific applied settings, they have good reason to believe their pedagogy is heading towards being holistic. However, holism cannot be delivered in a general way. The interconnections need to be spelt out in explicit detail, highlighting the necessary

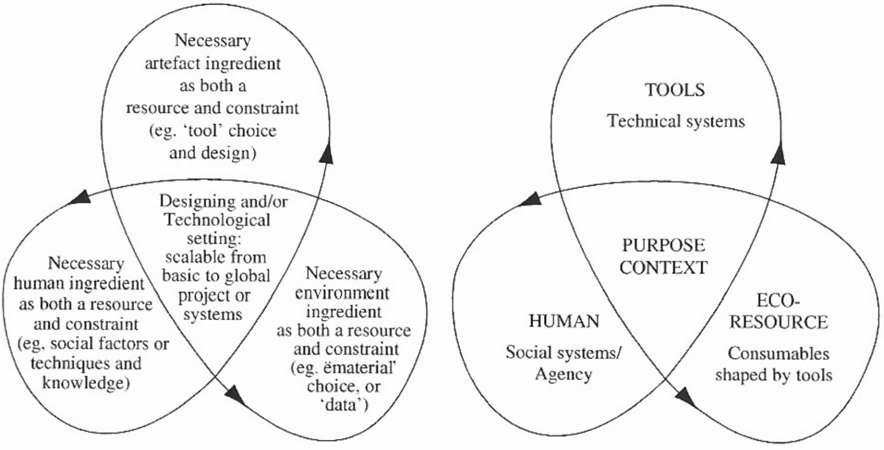


Fig. 9.3 Technacy genres showing the essential four elements and their particular relationships of interdependence

and specific dependencies in each case. A key requirement is to set learning experiences and assessment tasks for each lesson and unit of work that not only address highly specific links that define the elements in relation to each other, but also lead to grasping their total effect as a design and technology solution in their practical application.

Conclusion

In the first part of this chapter I introduced examples of how technology as a phenomenon in human activity and intellect appears to consistently demand that we recognize certain characteristics in order to better realize its value. With reference to cross-cultural values, these examples offered insight to our own bias not only as teachers of technology but also as designers, users and transferers of technologies into the context of other cultural groups.

In the second part I provided a brief outline of key ideas about the theoretical and philosophical foundations that allow us to understand technology as the interaction of at least four key elements. This is especially important in our collective future where we all, in every vocation, need to understand the links between all technological choices and designs and with the environment, the people involved and the technical tools chosen. The outcome, it is hoped, will be society-wide learning in technacy, along with literacy and numeracy, to better guide rounded and creative judgements for a sustainable future. Understanding technology practice and choice, whether for our own ordinary consumption and choice of products, technical design and accountancy investments or for innovations across different cultures and geographies can all be improved with a technologically oriented perspective. The talents of our future will be more secure if society is in agreement in using a richer understanding of technologies than that which is currently accepted. Technacy education is thus not merely a subject in which you learn the know-how, but one in which you also must learn the know-why. Only then may we make reasoned claims to learning technology holistically. Peters provides a fitting end to round off this idea:

> We would not call a man who was merely well informed an educated man. He must also have some understanding of the reason why of things. The Spartans, for instance, were militarily and morally trained. . . . But we would not say that they had received a military or moral education; for they had never been encouraged to probe into the principles underlying their code. (Peters 1970, p. 8)

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