PROSPECTS

quarterly review of comparative education

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EDITORIAL

The role of culture in the process of social development, and thus in educational strategies, is acquiring different characteristics compared with the past. It no longer deals simply with the function of the cultural dimensions of development, some of which are indeed very important, but incorporates multiculturality and interculturality as important features in *all* societies. The spread of the phenomenon of multiculturality has been the result of various factors. Some of them have been the subject of relatively profound studies (migration, the globalization of the economy, the technological and information revolution, for example); others, on the other hand, are more complicated and are found in different forms according to particular social contexts: changes in life-styles, a better understanding of individual differences, an improvement in the domain of individual choice and alternatives.

A better understanding and respect of differences has led to a crisis in traditional forms of social cohesion based on the acceptance of a single and dominant cultural model. However, experience over recent years has demonstrated that the breakdown in traditional forms of cohesion does not automatically lead to the respect of differences, to tolerance and to solidarity, but rather more frequently means the break up of the community, seeking refuge in restrictive cultural identities and the collapse of any possibility of living together in harmony.

In this context, what is the role of education? In reply to this question, G.R. Teasdale and A. Little have co-ordinated the preparation of this edition of *Prospects,* which is devoted to an analysis of the relationships between the dominant culture and indigenous populations. This analysis helps us to understand not only the specific cases mentioned in this selection but also the general problems which arise when different cultures meet.

In the section 'Viewpoints/Controversies', Stephen P. Heyneman analyses a key aspect of current educational debates: the discussion on the economy and educational economists. In recent years, these discussions have exerted a major influence on the decision-making process. In the present context of a scarcity of financial resources for education, the decisions proposed by economists have resulted in major confrontations with other partners in the educational process, not least the educators themselves. Heyneman sums up the situation, not only on the basis of the outcomes of research on the economics of education, but also concerning the arrogance with which these outcomes have often been presented. A greater degree of modesty should be an important characteristic of scientific and political rigour in the economics of education.

To complete this edition, two articles, one on geography teaching and the other on the subject of women in Japanese higher education, represent significant trends and cases in the change process of modern education.

JUAN CARLOS TEDESCO

VIEWPOINTS/CONTROVERSIES

TECHNACY:

TOWARDS A HOLISTIC UNDERSTANDING OF TECHNOLOGY TEACHING AND LEARNING AMONG ABORIGINAL AUSTRALIANS

Kurt Seemann and Ron Talbot

This paper takes stock of Western education generally and technology education specifically. It is visionary in its approach, arguing that a creative leap from convention is necessary when transferring technical education into non-Western cultural settings. The flaws of technical education in modern industrialized societies are particularly evident in cross-cultural delivery situations, both in overseas development assistance projects and in cross-cultural projects within a nation. In response to this, our paper outlines a new framework using the concept of 'technacy education'. It is based on a holistic approach to perceiving, teaching, practising and learning technology in any culture. We have tried to identify the universals that define holistic technology education. In terms of outcomes, we seek to produce skilled, holistic thinkers and doers who can use appropriate technologies that

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are responsive to local contexts and needs. In other words, our task is to produce technate individuals, just as other educationists are striving to produce people who are literate and numerate.

Human, technical and environmental factors are elements of technacy and are considered primary to human consciousness, understanding and survival. The technacy model describes a universal framework for exchanging technical practice between cultures, and for understanding the educational value of technology in terms of the way the above factors relate to each other and to problem-solving models generally. In this sense, technacy is a model born from 'first principles', the reasoned understanding of which contributes to practical holism. Technacy therefore can be ranked as the third fundamental element of education alongside literacy and numeracy.

It will be argued that it is Western education more than indigenous education that is likely to need de-schooling and re-schooling in technacy. Holistic thought processes and their translation into holistic practice are likely to feel more foreign and awkward to individuals living in Western industrialized societies than to individuals living in traditional indigenous settings. A case study of technacy education delivered in the cross-cultural context of Aboriginal Australians in central Australia will be presented. The case study will highlight some of the difficulties experienced by mainstream Australian education agencies in coming to an understanding of technacy education, and will document the understanding demonstrated by indigenous students.

Technical education in Western industrialized societies

In Western industrialized societies, many scholars and teachers have devoted much of their time to analysing and debating the purpose of schooling. This of course was not always the case. The provision of education was traditionally the responsibility of parents and families and later, for some, the church. The context of human settlements generally dictated the things one had to know and to become skilled in, in order simply to live. What was taught by parents and their parents before them was sufficient. There was no pressing need to challenge conventional practices and thought. The economies, the social structures and the technologies of human settlements changed little.

During the nineteenth century, with the advent of the industrial revolution, Western societies began to change their human, technical and environmental dynamics, although some scholars have argued that the changes began much earlier when Benedictine monks introduced systematic work routines to mass-produce the Scriptures (Seemann, 1987). The rhythm of production was already in place and set human activity towards a greater degree of mechanization. The invention of the clock only helped to speed this process up. Time became a measurable commodity, divorced from the natural cyclical seasons and the sometimes chaotic patterns of nature. A growing proportion of people found themselves looking towards a clock to regulate their activities and their production, rather than towards the patterns provided by nature.

The model of a linear sequential time interval soon became the backbone of modern education. To prepare citizens for industrial life they had to become productive. People were led to believe that to have self-worth they had to regulate their working day to achieve maximum productivity. People thus became organized as cogs and functionaries for industries (Seemann, 1987). The industrial, regimented work ethic became a measure of self-worth and soon found its way into education. Schooling began to emulate the factory. The school day was regulated by the bell. It could be said that these underlying patterns still prevail today, the only changes being in lesson styles and educational technologies. In many countries vocationalism has re-emerged, placing renewed expectations on schooling and technical education to produce economically productive functionaries.

The school systems of the industrial era presented the world as generally ordered into independent subjects. This pattern so characteristic of Western education sounded warning bells for some educationists. Dewey, for example, rejected the divisions of the curriculum, arguing that disintegrated school curricula produced disintegrated minds (Seemann, 1987). The divided presentation of knowledge deskilled the mind and reduced its capacity to make integrated judgements. The powers and structures of industrial economies were inappropriate to foster the development of integrated schema of social, cognitive and material experience. It could be said that people were expected to become efficient only in the short-sighted particulars. What was not fostered was the long-sighted integration of knowledge that is needed for the implementation of sustainable development strategies.

Western education thus has become a commodity of modularized, disintegrated learning. With the aid of science and technology, it has become more important to collect data and file it in databases than to make practical, integrated sense of it all. The current explosion of the information age into global networking will no doubt produce two fundamental effects, leaving a third wanting. One effect will be an increase in the demand for database software and pocket-sized hardware, while the second will be an increase in the tendency to extract convenient data from the huge pile of changing information in order to advance private or secular gains: a kind of self-satisfying pseudo-science. The third area left wanting will be the development of expertise capable of understanding the whole, extracting the essentials, and implementing new processes that are relevant, humane and sustainable in their outcomes.

With industrialization, education became instrumental in creating new social hierarchies. Managers of industry achieved higher status while workers on the factory floor assumed subservient roles, even if highly skilled. In the school too, when manual training in woodwork and metalwork was offered, it was quickly relegated to a lowly position and so became the preserve of the slower learners. The academically-oriented subjects became more highly valued. Literacy and numeracy thus became the cornerstones of Western education, while technacy was marginalized.

In effect, the human hand was perceived and represented in the curriculum as divorced from the mind and therefore less prestigious.

The separation in the curriculum of mind from matter was the antithesis of village education in pre-industrial Europe. For many villages, the most highly prized individual was the chief artisan such as the blacksmith, the carpenter, or the stone mason. Artisans were valued not only for their skills but often as a source of practical community guidance about social issues. The prowess of the artisan was deeply embedded in a social context that directly related to the natural environment from which his/her raw materials were derived. The artisan's prowess was necessarily defined by the interdependent relationships found in the social, technical and environmental context of the craft.

The transfer of technical education to other cultures

When Western colonization and invasion occurred, the education system introduced was predominantly based on literacy and numeracy. Ghandi once criticized the imposition of British education in India as a major contributor to the demise of rural India as a dynamic region of small cottage industries. Local innovation and small-scale rural productivity not only declined, but became less valued socially. Indigenous rural production was economically viable and was undertaken in a local social context that contributed to cultural maintenance. Technical activity and innovation defined Indian culture in many ways. The introduction of non-technical activity redefined the identity and aspirations of many Indian people. Ghandi, for example, noted that British education made Indians into bookkeepers and paper shufflers, tasks requiring numeracy and literacy.

When British colonization began about 200 years ago in the continent of Australia, one of the first effects for the indigenous peoples was the displacement of materials for hunting, tool reproduction and shelter (Talbot, 1991). Prior to the British invasion, indigenous Australian tools and trading lines across the continent were in a balanced technacy dynamic, which in turn maintained long-standing social structures.

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. 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 from desert groups to the south as local woods were less suitable. Some men held particular status because of acquired skills as trade negotiators, and because they had established friendships across vast lines of trade. Skills of diplomacy in trade gave rights to men to regulate the axe. Women were not denied the axe, it was simply a very important survival tool, the men having primary responsibility for its care. Women had similar tools that defined their own roles. To gain a traditional education in the production of axes was to develop social trading skills, technical knowledge, and techniques in assembly and selective extraction of local natural resources. One could 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 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 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 are dependent on receiving 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 technate to being technical. The steel axe without question is technically superior to the stone version, but there were no options open for people to incorporate the steel axe into their 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.

Western technical education introduced to indigenous communities was no different in its negative effects. Modularized, and taught as if technical skills are defined independently of the social and environmental contexts, Western technical education has had minimal impact in remote indigenous communities. In particular it has failed to provide them with local maintenance personnel who are able to service and repair equipment and machinery. In effect, the social lore of technology was not relevant to indigenous people living in small, remote communities. The community context was much different to that of the woodworking and metalworking rooms, and to the tools and organizational dynamics, of the technical training programmes introduced to indigenous Australian communities.

Rethinking technology education

The above analysis emphasizes the need to develop a totally new framework for technical education for indigenous people. Non-indigenous societies likewise need to reconceptualize their approach. There must be two outcomes to such a reform: it must be useful to the individual and it must be useful to the society.

Traditional knowledge has sustained the existence of indigenous Australian cultures for over 60,000 years. Technology and technical activity were inseparable from social and environmental knowledge. There was no basis to a technical knowledge framework that excluded social and environmental 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 themselves. They organize a work group, with each woman having particular tasks, including food preparation and child care. They arrange transportation to a site in the natural bush to harvest the best pandanus trees. Harvesting requires a keen, informed eye to pluck the better leaves for weaving. Roots also are collected for dye. While this is taking place, children are encouraged to watch carefully as a learning exercise, not only in pandanus harvesting but equally in the social protocols and organization of the whole day. Some of the tools for manufacture of the baskets are fashioned by the women themselves while others are purchased.

The above story is very important. The technology of pandanus basket construction could not be conveyed adequately through a compilation of segregated competency modules. Yet much of the technical education that is being imposed on indigenous peoples is still based on an industrial world view that emphasizes the compartmentalization of knowledge through modularized learning. For women in the island communities of northern Australia, learning the technical skills of basket construction is necessarily a social event deeply embedded in sustainable human and environmental relationships. The whole exercise necessarily integrates social, technical and environmental knowledge and skills. To represent the pandanus '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 developing a new framework for the technical education curriculum, then, it is important to recognize the capacity of this area of knowledge to teach students how to think holistically. Their accumulated knowledge and skills from other subjects, and their personal life experiences, now can be given meaning in the one integrating medium of the technology curriculum. This assumes that the new framework is socially innovative, and that technology education maintains a link between learning and its application in the community. Given an adequate model, there is the potential for technology education to be an enabling and empowering medium for students to integrate their cognitive, psychomotor and affective capacities, thereby enhancing their ability to make holistic judgements that lead to holistic practice.

In our own experiences with indigenous Australian technical education, some theoretical and practical problems have had to be overcome. The first was the conservatism of Australian industry. Industrial unions initially were concerned with the protection of their particular trades. Although this concern has faded during the past five years, it is still a battle in the political arena to promote successful new models in technical education, particularly amongst technical educators and mainstream educational funding bodies.

The second constraint has been the language embedded in the mainstream technical education curriculum. In Australia, the English lexicon is reasonably well-equipped to name most finite bits and pieces of the world. We seem very capable of finding names to describe parts. However, we do encounter problems in assigning names to integrated concepts and modes of practice. In technology education, for example, we find people talking of technological literacy, which seems a very obscure expression. When indigenous Australians attempt to relate their community development concerns to the broader Australian community, many of them find that non-indigenous Australians either do not understand their message, or react to their requests with too much emphasis on the details. The spirit of the proposed programme is lost once it is processed through centralized legal and accounting procedures.

A third problem has been the lack of a simple, understandable model to help teachers and students to integrate holistically in design or problem-solving processes utilising tools, material forms and spaces, and techniques. Another problem has been the major constraint of simulation where the teacher, or a computer, attempts to replicate a problem or task in a classroom, while all along it is happening naturally outside the school. Learning to respond to the rich unpredictabilities of real life events provides a good environment for developing holistic skills.

Out of the above issues developed the core educational model that is now becoming known as technacy education. Technacy is a simple but powerful holistic model developed to accompany design processes in technical and general education. It is a model that, in effect, advocates that all technology practice is grounded necessarily in the dynamic interaction of its social, technical and environmental states. These three elements of technacy become both the resources and the constraints of all technical activity, and thus together their dynamic defines much of human knowledge and existence. The idea is to move the student on from developing his/her technical skills, to becoming technate. Developing one's technacy skills is as much an art as a science. We can parallel this argument in literacy and numeracy education. Just as there are levels of competence in literacy from writing one's name to writing profound poetry, and in numeracy from adding a few numbers together to compiling a fundamental formula in physics, so too there is a range in technacy from being skilled in joining materials together or repairing equipment to being innovative in the design and development of appropriate technologies and systems.

Put simply, technacy is holistic technology problem-solving, communication and practice. It is a view that perceives technology practice as value-laden. The utility and appropriateness of technologies are defined by the end-user in the local context. Technacy can be argued to be the main art, skill and knowledge of appropriate technologists.

First principles of technacy: a theoretical proposition

The theoretical model underpinning technacy has one side of its 'ancestry' linked back to Hegel, Feuerbach, Marx, Dewey, Wortofsky, Schumacher and Ihde in Western societies (Seemann, 1987). On another side its 'ancestry' is linked back through the social learning styles and knowledge frameworks of indigenous Australians, and probably of many other indigenous peoples (Walker & Seemann, 1990).

Technacy is based on a three-way 'dialectic' of necessarily interdependent parts. These are the human, technological and environmental ingredients of any technical undertaking. Each part both defines and therefore requires the other two parts. No pair can be adequately defined without inclusion of the third part.

The notion of human consciousness and social organization, and indeed of human existence, proves to be an inadequate proposition as a self-defined thesis. Human existence finds its definition in the manifestation of human technology knowledge and social material practice. However, the human technology dialectic also proves inadequate as both are partly defined by their natural environment. Humans cannot exist without drawing energy from and manipulating their natural environment. Technology software (knowledge of such fields as economics, science, computer programmes, social science) and hardware (forms and spaces including equipment, tools, houses, farms and settlement infrastructure) cannot exist without the same.

The technology-environment dialectic is an inadequate proposition as neither technology nor the environment gain their definition entirely from each other. They both interact with humans. While the environment could be argued to exist without human involvement, at issue is the definition of human knowledge and technical practice. It is thus academic to debate the independence of the environment from human existence or human technology when our concern is to understand and define the universal concept of human technical activity. Put crudely, the concern for human technology practice, and so for education, is only relevant where humans exist, intend to exist or can apply their technology.

The technacy model contrasts, or complements, one particular idiom of Western logic: Venn's logic of intersecting sets. If we represent the three context factors of the technacy model as 'human context factors', 'technological context factors' and 'environmental context factors', they would look like Figures 1A and 1B.

FIGURE 1: A. The model of a world where the parts are initially perceived as independent sets; B. The model of the integration of independent sets showing integration pairs A, B and C, and full integration at M (M = region of mutual integration).

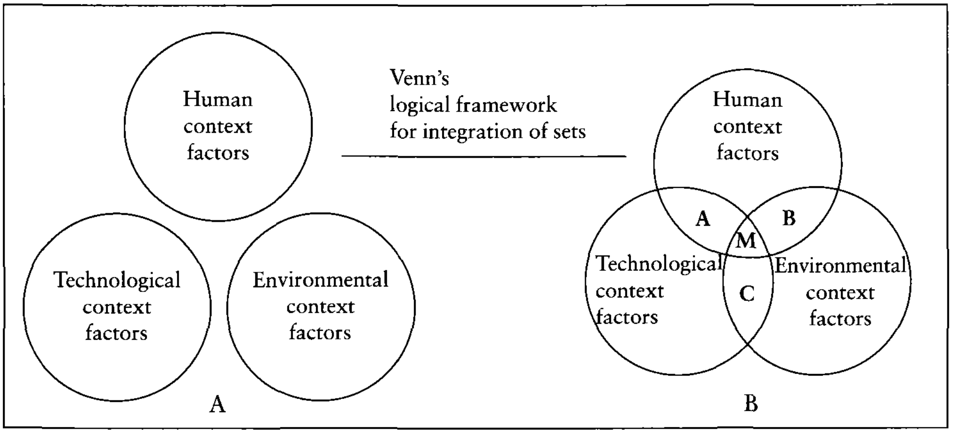


Figure 1A is a representation of a view where the sets intending to be integrated are in the first instance perceived as disintegrated, or as independent and self-defined. This is consistent with much Western logic where we tend initially to consider a problem or task as being made up of independent sets or parts. In effect we disintegrate a problem when we analyse it as our initial course of action. At this point, many of us can get lost in the detail and fail to see the overall outcome or solution to the problem we are addressing. We often lose our focus. We then attempt to put together a solution and specify a response. But in Figure 1B, the integrated solution, 'M' is not consciously or necessarily the outcome. It is possible to ignore one of the sets and produce a solution only integrating in A, B or C. Thus 'eco-tech' solutions (green technologies) could focus on 'C' outcomes, ignoring or making gross assumptions about the human, social or political consequences or benefits of their actions. Socially sensitive technologies at point 'A' risk ignoring or making gross assumptions about the environmental consequences or benefits of their actions. And socially sensitive natural environment projects at point 'B' risk ignoring or making gross assumptions about the technological consequences or benefits of their actions. Judgements in the past made in the areas of A, B or C exclusively have quite possibly been misjudgements.

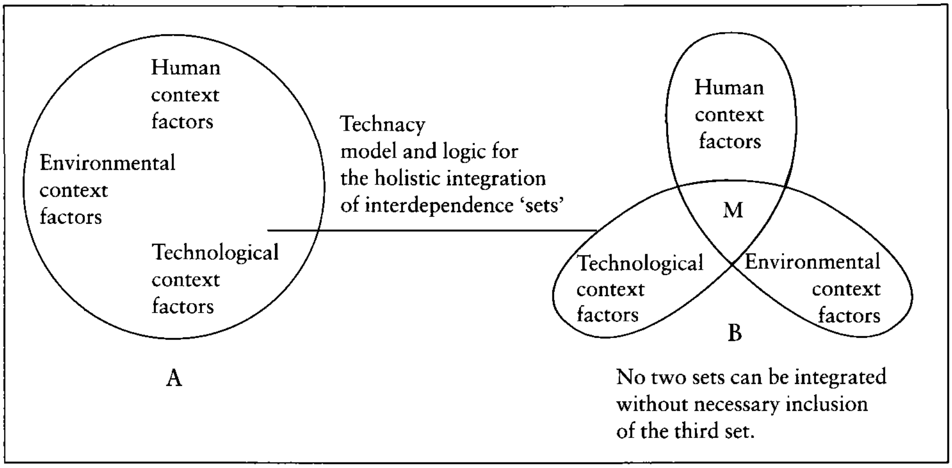
The technacy model outlined previously argued that the triad is essentially interdependent. If this proposition is true and relevant for human technical practice, how can it be possible to produce solutions in A, B or C exclusively? Indeed, how can it be possible to represent the three interdependent 'sets' within the predominantly Western logic of Venn's figure from 1A to 1B in the first instance? The proposed solution is to develop a new model to represent the holistic integration of interdependent 'sets', as shown in Figure 2A and 2B. The old Venn framework is plainly limited, not irrelevant, just limited.

The technacy model in Figure 2A and 2B is only a model, but we consider it a very useful one. Its purpose is simply to guide conceptual development and holistic technical education practice. However, it does show how Western Venn logic has limitations in its capacity for guiding true integrated technology practice: i.e., for the attainment of 'M' solutions.

Figure 2A shows that no one aspect of human technology practice can be defined and analysed without necessarily including the other aspects. Holistic technology practice exists at 'M'. Holistic technology education therefore must foster the capacity to function creatively in 'M'. Thus, technology practice and technology education have their performance regulated by how well they have been tailored to the human, environmental and technological contexts of the end-users of technologies and technical training programmes.

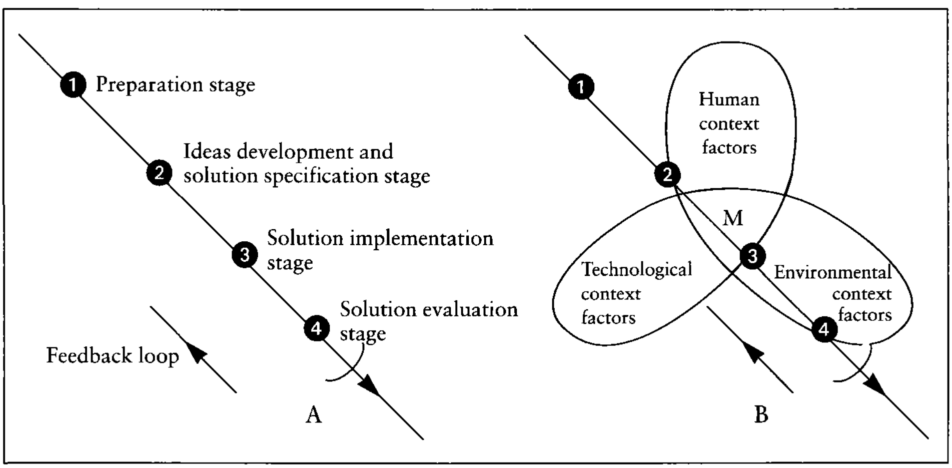
The technacy model for guiding curriculum and educational practice is static on its own. There have been four major developments in technacy education, all resulting from the input of indigenous Australians. The first development was to embed the technacy model in all stages of designing and problem-solving education. The design process has been analysed in many texts for its educational value, but was missing a framework to guide students and teachers in their efforts to

FIGURE 2: A. Model of the world where the parts are initially perceived as members of a whole; B. Model of the holistic integration of interdependent sets showing integration at M.



design and produce holistically-integrated solutions: hence the technacy model. Figure 3A provides a model of the stages one progresses through in the course of designing. In real life, designing is much more of a chaotic exercise with designers naturally jumping backwards and forwards in the design process, for designing incorporates individual creative thinking patterns. Nevertheless, the model of the design process adequately represents the overall logical sequence of the art and science of designing. Figure 3B shows how technacy underpins all stages of the design process. This ensures that technacy education is focused on the development of holistic technology practice.

FIGURE 3: A. Basic problem solving and the design process; B. The technacy model is written into every stage of the design/problem process to foster holistic technology problem-solving skills.



The second development was to organize the application of technacy education around the functions in remote settlements that determine their viability and utility. A study of several remote indigenous communities across central and northern Australia showed that most of the technical breakdowns in communities that are often linked to poor health environments occur in five key settlement functions: water, waste and sanitation, shelter and space usage, transportation and communication. Each involves a particular social and technical dynamic for its maintenance and development. These five settlement functions were consistent across all communities. They became the five strands of the technacy course that feature in the new curriculum. All students have to practice their design and problem-solving technacy skills with projects in all of the strands. In this way they will gain broad experience of how their community functions from a technacy perspective. Energy, like economics, was seen to transcend all these functions and so was classified as part of the hardware and software of the technacy model. Learning about energy only has value when it is applied to something meaningful such as transport, shelter or communication technologies.

The third development was to make the curriculum *project*-based rather than *tool-specific* based for learning outcomes. The latter skills were included throughout the course but only on an 'as needed' basis determined by the students, in collaboration with their educators and occasionally with their communities. The process of undertaking applied technacy design projects in water, for example, required students to identify a project that was meaningful to them and where possible to their home community.

One student identified his grandfather's traditional land in the arid zone of central Australia as needing a more sustainable way to store rainwater. The student was aware that he could have gone to a retailer of fibre-plastic rainwater tanks, but decided against it. Considering the technacy model, he argued that *technologically* such a tank would be difficult to repair out in the bush should it be damaged, and that fibre-plastic technology was much too expensive for the scale of the local economy at his grandfather's camp. *Human* issues included a desire to keep skills in the camp and not have outsiders coming and going all the time to install and repair the tank, leaving no reusable skills behind. *Environmental* issues included the fact that the land at his grandfather's camp was sparse, with little timber, but had plenty of desert sand. He grappled with several ideas and finally decided he wanted to try and construct a ferro-concrete water tank using 'bush sand' from the camp site. He had no skills in cement mixing and as a result the educator included in his learning experience a short module dedicated to cement mixing techniques. The end result was a very functional and locally repairable water tank for his grandfather. The student had commenced his journey of empowerment in holistic technology practice through the production of technologies appropriate to his grandfather's particular context. It should be noted that the student not only gained skills in specific technical processes, but also in the overall organizational skills required for getting the job done in a culturally, technically and environmentally appropriate way.

The fourth and most recent development has been to structure the technacy and applied design course in an overall career path that maximizes local knowledge yet links to other courses. The technacy course was earlier given the name of the Aboriginal Technical Worker programme. This has since been abbreviated to the ATWORK programme. It has many parallels to community health worker programmes, but essentially provides primary technical care for the physical aspects of communities. Graduates are known as ATWORKERs and now have a four- level training and career path to progress through if they so choose. The highest level is technology-management oriented, with the option to specialize as a community educator in technacy. The certificates are nationally recognized across Australia and lead to a qualification in 'Applied Design and Technology'. The basic focus is on applied holistic problem-solving in technacy, and on the development of appropriate technological solutions to community problems. The ATWORK course differs from the conventional output of technical training in many ways, an important one being its emphasis on appropriate solutions as an outcome, rather than on a technical skill as an input.

The ATWORK programme: a case study in technacy education

The ATWORK programme delivers technacy education by and for indigenous Australians. The programme is run by the Centre for Appropriate Technology (CAT) in Alice Springs, which is managed by an indigenous Australian board whose membership is representative of central Australia and of CAT operations. The CAT functions as a non-governmental organization dedicated to the research, design, development and teaching of technologies appropriate to remote communities. The organization is often involved in pre-feasibility studies for Australian government aid projects and programmes for developing countries including Africa, China, Asia and the South Pacific.

The ATWORK programme at CAT is the mainstay of three of the indigenous councils in central Australia, with a fourth council seeking to access it in the near future. The ATWORK course has only been available for two and a half years yet has attracted considerable interest in this short time. Most students take eighteen months to complete it although some finish sooner and others later. It is the first and so far the only nationally-developed technical vocational curriculum targeting indigenous community needs in Australia.

The educational goal

The aim of the ATWORK programme is to develop students' practical skills and self-confidence, and their awareness of technological options and applied design and technacy skills that support and influence indigenous Australian community functions and lifestyle choices. Considerable effort is directed towards imparting skills, knowledge and techniques that enable students to participate in taking control of their community technologies through an understanding of the natural, constructed and social context in which the technology exists. This is achieved through:

1. Course modules that are community design-project driven; students draw their learning resources from the actual issues, problems and developments taking place in their own communities;
2. An emphasis on the integration of a variety of technologies, materials and cultural knowledge in order to produce appropriate responses that actually support community functions and cultural activities;
3. Giving students skills in identifying, preventing and solving technological problems in their communities; i.e., preparing them to become practising, applied designers who investigate problems of a technological nature and take steps directly to make judgements and changes regarding the choice and design of technologies that support their chosen lifestyle.

The course is therefore directly involved in supporting the process of community development through technological empowerment with technacy education.

A student project example of technacy in practice

As part of the waste strand in their training, a group of students negotiated to investigate the problem of flush toilet breakdown in a selected number of communities. They followed the design process (see Figure 3A) and spent considerable time and effort in the preparation stage. While in the field, they spoke to the people using the technology, checked with the local plumber, and followed up with those involved in the administration of such infrastructures.

The students' initial response was to react in a technical way by suggesting certain repairs and maintenance to be carried out. In other words, their initial findings and responses reflected only the technology aspect of the technacy model and ignored the people and environmental aspects or constraints. They therefore were sent back to take a more holistic look at the problem. They were encouraged to find out more about the human side of the problem, and especially the cultural and social issues at play, and the knowledge possessed by the user group of the flush toilet technology. They also were expected to understand the environmental constraints such as the location of the toilets, their distance from the nearest service centre, their exposure to the elements, and whether they were for public or private (i.e. home) use.

Following the more holistic path of the technacy model, the students discovered that the main problem related to cultural/social factors: apparently, some short-term visitors from other remote communities, while under the influence of alcohol, carelessly misused many of the toilets. This situation would occur from time to time. The students became aware that the problem had mainly human and environmental constraints and therefore demanded more than just a technical response involving repair work.

Once the problem had been clearly articulated, the students set about developing ideas and design options. They responded in a variety of ways. They experimented in both technical and social ways by strengthening and modifying parts of the toilet, and by developing an education programme. However, given that there was a need to respond quickly to the issue, most efforts were focused on developing innovative ways to strengthen and protect the existing toilet technologies in ways that were acceptable to the local community council.

The required educational outcomes are not necessarily achieved through assessment of the final product (or solution), but more through ensuring that the design and technacy processes have been demonstrated by the students. Quality of the designed solutions is achieved through the integration of technacy into the design process combined with the integration of the students' own skills, knowledge and values. While the design and technacy processes are important it should not be forgotten that valuable technical training also occurred during this design project. Technacy and the design process gave meaning to a selected range of conventional technical competencies. Students learned measuring and marking-out skills (numeracy), rapid graphics and interpersonal communication skills (literacy), plumbing skills, sheet metal skills, material planning and purchasing skills (basic budgeting) to name just a few.

Conclusion: a creative leap from convention

This paper has argued that the evolution of Western education generally, and technical education specifically, has not moved beyond the compartmentalized and mechanistic delivery of knowledge. Indeed, in recent years, with short-term vocational pressures, ever more finite divisions have been introduced to the curriculum. This disintegrated model has been transferred to other cultures during colonization. Most of these transfers have yielded little benefit to the recipients, and very often destroyed their ancient stock of techniques, knowledge and wisdom.

Educational reforms have done little more than rewrite curriculums that are perpetuating the compartmentalization of knowledge. Most curriculums appear crowded, disintegrated and directionless. Many students are unable to see the overall value of their accumulated knowledge and wisdom for they have become buried in a mass of modularized learning. Technacy education acknowledges the useful role of modularized learning, but couches this role in a universal curriculum model that seeks to begin and end learning with integrated education applied to the real world. It seeks to develop holistic integrators. Rather than simply adding to or rearranging the curriculum, we argue that the curriculum needs to be rebuilt on an alternative foundation using holistic learning that is responsive to community needs. Theoretical understanding is essential in the new curriculum, but we believe that a good theory is also a practical one!

There is a missing element in basic education. For many years literacy and numeracy have been the cornerstones of Western industrialized education. Many people have questioned the adequacy of this cornerstone for the new technological age. In addition to literacy and numeracy there are basic skills in technology and problem-solving which are required to support a technological lifestyle. The need to reform the understanding and practice of technology education is just as urgent in Western industrialized societies as it is in developing countries and indigenous communities. Wherever an educational programme exists, there too an education in technacy should exist. Where technacy does not exist, or where conventional technical education or design process education is active, there should be an overhaul of the quality of the judgements derived from such programmes.

The most developed literacy and numeracy programmes will provide neither the skills nor the rounded judgements necessary for an integrated approach to technology. Nor will the most effective technical training programme yield people capable of producing appropriate and locally sustainable innovations. Somewhere these programmes need to re-orient themselves towards an education in technacy. Technacy education is in its infancy. It works well, but there is a long way for it to go before educators find a consistent method to teach others how to integrate holistically, and how to gain competence in holistic technology practice through technacy. There is a need to generate a new universal curriculum. There is a need for a creative leap from convention.

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