PERSPECTIVES AND OUTCOMES OF DESIGN AND TECHNOLOGY EDUCATION

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ABSTRACT

The newly developed Design and Technology 7-10 course in New South Wales offers many opportunities for students to evaluate their own activities throughout the design process. With evaluation as the focus of the process based approach, students are encouraged to reflect upon their own learning.

This paper deals with the value of such reflective learning, and considers practical ways in which it may be achieved. It shows some verbalising and non-threatening and non-judgemental evaluation techniques that have been developed in conjunction with this course, which assist students in putting their learnings in broader contexts, taking the learnings from the classroom to community and vocational situations.

BACKGROUND

Until recent years, technology has borne the stamp of manual arts in most school systems - in France as well as in Australia and in the UK. Often along with this stamp came a lack of public appreciation and often a relegation of the subject to lower status technical highschools.

Although Craft has long been mandatory for a year of secondary schooling in NSW, the elective subjects that were concerned with aspects of applied science and technology - such as Industrial Arts and Home Economics - have in the main not enjoyed the participation of the academically able stream of students. Indeed the teachers of these subjects have perceived themselves as providing craft/trade skills and homecraft/living skills, rather than preparing students for an understanding of technology and technological processes. At the higher levels of vocational education, these low status subjects were not seen as the preparatory ground for our leading engineers and technologists.

In several countries - France, Germany, Japan but not the UK - career paths in engineering and technology have attracted some of the academically most able students of the country. In Australia, similarly able students have opted away from engineering, technology or science based careers. This situation has left Australia in a lamentable situation with respect to its potential for successful competitiveness in a technologically led world marketplace.

TECHNOLOGY EDUCATION AROUND THE WORLD

Since the 1980's there has been an increased awareness among educators around the world of the need for an effective and relevant technology education component to be included in the mandatory curriculum of every child's education.

In France (Longeot 1990) 'technologie' is seen as an interdisciplinary core subject, with an option for some A-level examination profiles. It replaced l'Education Manuelle et Technique in 1981. Considerable resources have been invested into the training and updating of teachers in this subject as well as into equipping schools with learning resources (200,000 FF per school, for about 5000 colleges).

In Germany the situation varies from state to state and also among the various types of schools, but technology studies generally enjoy a high standard of technical achievement in the elective subjects Technische Werken (technical handcraft) and Geometrisches Zeichnen (descriptive geometry). (Zankl 1990) Specialist Technische Hochschule provide education oriented towards technical and trade skills. These subjects are studied mainly by boys.

In The Netherlands, technology is taught in junior technical and junior agricultural schools (Streumer 1989). In Japan, technology education in the schools is in the form of craft studies; professional technologists and engineers are selected at University level from the ranks of the mathematically inclined, academically able students.

In the UK, the ten year old Craft, Design and technology (CDT) junior secondary school curriculum has been replaced through the National Curriculum by the subject Technology in 1990 as a mandatory component of education. Technology is taught to everyone between the ages 5-16. In secondary schools, technology teaching is implemented as a cooperative effort involving five faculties; CDT, Home Economics, Business Studies, Art and Information Technology. The subject aims at gender inclusiveness. Science faculties are not formally involved in the delivery of Technology. (UK Education 1990)

In Australia the delivery of technology education varies considerably among the states, with some specialist schools (such as the South Australian School of the Future) providing intensive technology oriented education. In Victoria, school based curricula emerged from the Technology Framework documents, with the senior Materials and Technology studies for the VCE (piloted in 1990) changing its emphasis from its traditional craft/trade orientation towards a design process perspective. (Macdonald 1991)

In New South Wales designated Technology High Schools have led the way since 1989 to the introduction of a technology focus in schools. There is also a slowly growing collaboration between industry and schools through the Schools Industry Project in New South Wales, still in its initial phases. The Tournament of the Minds, participation in the Skills Olympics, INTECH (exhibitions of selected major projects of final year Industrial Arts students) and the NSW Textiles and Design Competition encourage excellence in design and technology among selected students.

In New South Wales primary schools the K-6 Science and Technology curriculum was launched in 1991. Design and Technology in the secondary schools will begin from 1993, with a mandatory 200 hour course. This programme will make technology studies a part of every child's education for at least nine years of their lives, with ample opportunities for further extensions.

The senior elective subjects in Design and Technology and in Industry Studies are currently being developed to include industrial experience which is reported by the students in the form of case studies and applied to a major project as part of the requirements of the syllabus.

PHILOSOPHIES OF TECHNOLOGY EDUCATION

It may not seem surprising that when UNESCO published a global survey in 1986 about 'The Place of Science and Technology in School Curricula', it showed that interpretations of Technology varied from cement mixing to applied physics.

Current interpretations of the subject as taught in various developed countries emphasise an integrative approach.

Technology education in Germany , in the UK, in France and in Australia involve a broad vision, where social concern is interwoven with practical problem solving skills and commercial awareness.

The emphasis in Germany is towards practical and scientific competencies as well as social and industrial awareness, in the UK towards creativity and problem solving (Traebert 1989), in France towards high-technology (Archambault 1990) and in Australia it involves the UK approach enriched with a commercial and industrial orientation (NSW Board of Studies). Scotland shifted emphasis towards technical/technological skills and industry interactions. All developed countries emphasise the social and environmental implications of technological solutions to human needs.

For the purposes of curriculum design in New South Wales, technology was defined according to the UNESCO definition, taking technology to be the means whereby human beings use tools and other resources to improve the quality of their lives. This broad definition includes both high technology and low technology, male and female, home and vocational, private and public oriented concerns. Its implied applications range from the making of objects and systems to the designing of plans, to the creation of networks among people. It is a process based study.

Ideation, graphic and verbal communication, collaboration, organisation, planning and reflection are important components. Although learnt in an applied, project based learning environment, these thinking skills tend to overshadow the craft skills traditionally associated with technology studies. The goal has been seen as the need to produce graduates who have the ability to recognise opportunities, exhibit flexibility and creativity in their thinking and who are able to transfer learnings from one area of application to another.

While computers have been treated as a tool (one of many) to be used in the process of design, 25% of the learning time has been designated to be concerned with them in some way. This reflects a similar concern with information technology in the UK, in the Unites States (where technology high schools are almost synonymous with computerised learning packages and individualised learning) and in France.

In all these countries as well as in NSW there are several concerns informing directions in technology education -

- that there be a broad based appreciation (and well informed critical evaluation) in the community of the role, the power and the potential of technology

- that there should be more skilled, practical, creative, opportunity finding and problem solving talent in the nation

- that professionals in the engineering and technology fields should have a wide outlook and an appreciation of the impact of their professional output on society.

- that the community should hold engineering and technology professionals in high regard

- that the students who take technology subjects to the senior level should be among the nation's most capable talents

- that the nation should benefit from the creativity and productivity of its technologists and engineers in a competitive international marketplace.

IMPLEMENTATION OF TECHNOLOGY EDUCATION

The success of the curriculum hinges not only on its philosophy, but on its implementation. In order to achieve the above goals, technology education in NSW is delivered as a three tiered system.

First there is now a general technology education available for all, to make the whole of the next generation feel comfortable with technology.

'Technology education for all' takes place from kindergarten to year eight . This inclusive education is designed to increase the creativity, adaptability and the confidence of students to recognise opportunities and to take up challenges in many different practical situations. It provides a socially and environmentally responsible, future oriented perspective on technology for all.

The second tier is less inclusive, tending towards specialisation of interest. In senior years, elective technology education plays an extended role - partly building on the creative, entrepreneurial spirit established earlier and partly extending the professional skills and capabilities of the students in this area, enabling them to achieve at a higher level.

The third tier of technology education takes place in the TAFE and University systems, yielding specialist graduates in particular technical and technological areas of expertise.

The first, inclusive aspect of technology is taught both in NSW and in the United Kingdom as combination of Design and Technology, with the design process serving as a useful framework for learning experiences that result in technological skills, knowledge and attitudes.

THE PROCESS OF DESIGN

The design process has been variously represented as linear, helical and iterative. Whatever its conceptual form, whatever its particular terminology, the implication of the design process is to make or create something - an object or a system or an idea - and then to evaluate and improve it. The outcome of the design process might be in itself an alteration of an existing item, always with a potential for further change, further striving to meet requirements as they are perceived.

The following representation of the design process shows that evaluation is at the heart of all the components of the design process.

VERBALISATION

Actions - and especially the act of designing - result in outcomes; traditionally these outcomes are products. Marshall McLuhan said - 'The medium is the message'. The medium of design and technology education have traditionally been products made from a variety of materials. The message was 'craft skills are learned here'.

By making evaluation the medium of the learning experience by the student, technology education should broadcast a new message - a new consciousness of the management, critical thinking, commercial and social concern that are the real outcome of the design and technology courses. This new outcome is achieved by reflection.

REFLECTIVE THINKING

When a person thinks about their own actions, their own thoughts, their own responses, then that person engages in reflective of meditative thinking. With reflection comes a heightened awareness of the thought processes, an ability to learn from the events and a valuing of the learning that has taken place.

In designing, conscious awareness of the stages in the design process creates opportunities for the designer to engage in reflective thinking at various points during the design activity.

Every designer is a lifelong learner, building upon the lessons of past experience. 'We cannot know anything that bears no relationship to our experience' (Langer 1953). Lifelong learning cannot be passive - it is an active, personal construction of the designer's knowledge in areas of both functionality and aesthetics. Therefore, reflective thinking (a guided example of which follows) can build a basis for lifelong learning.

The evaluation activities that are associated with each of the stages of the design process can serve as convenient trigger points for reflective thinking. In this way reflection - and hence conscious learning - is facilitated by a conscious structuring of the process of design.

REFLECTIVE THINKING IN DESIGN AND TECHNOLOGY EDUCATION

'We use language to make sense of our experience both as we reflect-in-action and in retrospect' (Peacock 1990).

Reflection then, can be enhanced by verbalising about our thought processes as they happen, keeping journals and written records of the events and thoughts throughout the act of designing and realisation. Visual records of thoughts through sketches can also trigger ideas and memories for later reflective thinking.

Keeping a journal or a folio record of the designing events is no guarantee of associated reflective thinking. A clear programme of activities must be designed to make use of the resources in these records and apply them to purposeful reflective activity. One such reflective activity can be the act of thinking about the value of work done, about the quality of the processes that were undertaken during the project.

So, while any particular representation of the process of designing can rightly be seen as arbitrary, the milestones formed by the act of dividing the process into identifiable stages which are associated with evaluative activities can be a valuable aid to the process of reflection and hence to learning based on experience.

REFELECTIVE THINKING AND SELF EVALUATION

In order to guide the students into successful reflective learning, the evaluation activities must be carefully devised to avoid judgemental pressures. The evaluation must not consist of 'good' or 'bad''. Non-threatening, outreaching formats, pointing to flexible future alternatives should be devised for the evaluations.

On the one hand, the terminology used for the evaluations needs to be simple, making assessments of the situation in the language of the student. On the other hand, the learnings from the act of designing must be clearly identified, and expressed in a language that carries high value both in the community and with the student. This enhances the valuing of the learning itself.

The following example illustrates part of such a scheme for self evaluation by the student, as an aid to reflective thinking throughout the design process.

SELF EVALUATION BY STUDENT
Students are to construct self evaluation sheets, after discussion of the brief; items can be added at will as the project progresses

DESIGN I got some interesting ideas
DEVELOPMENT through brainstorming q q q
Thinking of 5 different designs was difficult q q q
I practised sketching q q q
I found sketching ideas was easy q q q
I enjoyed designing on a computer q q q

COMMUNICATION Our group had some great designs q q q
We had great discussions q q q
I was quiet q q q
I listened well q q q
Some liked my drawings, others didn't q q q
I could explain my ideas well q q q

CONSTRUCTION I learned ways
SKILLS of drawing accurately q q q
I made the pieces fit well q q q
There were some gaps q q q

MANAGEMENT Finished on time q q q

EFFICIENCY Had to be pushed q q q
Did not finish q q q

QUALITY OF Should be better organised q q q
PLANNING Should have tried another plan q q q
System worked well q q q

PRIDE IN I enjoyed taking care q q q
CRAFTSMANSHIP I am pleased with the result q q q
People liked what I made q q q
It is worth taking time and q q q
trouble to get a good result

TRANSFER I can use my design skills at other
times as well q q q
Now that I have done some
evaluating, I will be able to evaluate
other peoples' designs q q q
I am learning how to explain different
ideas with drawings q q q

In this example, the capital letters on the left hand side indicate 'high value' terms, identified as parts of the design process. The central column in lower case letters is in student language, referring to actual actions and thoughts of the student. The phrasing attempts to avoid value judgements; the evaluation exercise is not marked except maybe for genuineness of response. Throughout the evaluation sheet there are implications for alternatives, for decision making by the student, for learning from action.

The evaluation sheet above has put into words many of the actions carried out by the student as part of the design process. By being named, the actions gain a value, and are more likely to be recognised as learning and more likely to be owned by the student than if the verbalisation would never have taken place.

All the stages in the process of design have thus gained value. By reflecting on their learning, the students become conscious of their own knowledge; they gain confidence to apply their knowledge in new situations.

CONCLUSION

If the goal of education is to produce adaptable, flexible, creative, responsible citizens, then reflective learning is an important way of achieving the desired outcome in technology and design education.

Student self evaluation can serve as an effective tool for reflective thinking during designing. Verbalisation helps the identification of learning and promotes the transfer of learning to new situations. Other aids to reflective thinking are the journal and the folio with its collection of thoughts, sketches, samples and ideas. Without reflection, these aids can become mechanical responses to course requirements. With reflective thinking, they can be used in a structured but non-threatening manner to enhance the construction of knowledge and a recognition and a valuing of learning by the student.

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