Designing and Valuing: A VALUED Model for Design Practice

Abstract
Design and technology in industry, education and society has changed in the past decade and school curriculum has changed to account for new approaches in design practice. As an outcome of curriculum change, there was a need to develop a teaching/learning model that focused on design decision-making processes. A case study was selected to examine the curriculum development that occurred in identifying skills and processes for design decision-making. The study was designed to draw upon the knowledge and experiences of designers, design and technology educators and to involve students and teachers in the curriculum development process in a practical context. A result of the study was the development of the V-, A-, L-, U-, E-, D- model, that included a process of teaching/learning for design and technology education, which utilised interactive assessment within the design decision-making process. This model has application for design and technology curriculum practice.

Introduction

Since the development of National Curriculum frameworks for Kindergarten to Year 10 education in Australia and the inclusion of technology as one of eight identified key learning areas (KLAs), technology has become a prominent subject area at secondary and post-compulsory levels of schooling. Courses have increased in number and they have changed in composition, with the integration of subjects that now make up the broader technology curriculum. Curriculum development for the National Curriculum framework in technology has implications for design and technology curriculum at the post-compulsory level.

Curriculum development in the technology area has tended to take a more radical approach than the other KLAs. Not only were existing subject areas, such as industrial arts, manual arts, home economics, computing (multi-media) and graphics, rearranged under a new name and within a new area, but also these subjects have had to accommodate rapidly changing societal and technological change. The study of technology was the study of the technologies needed in society and the subject areas included in technology education were the subject areas of food, graphics, textiles, engineering, architecture, product and industrial design and the emerging information technologies. Linking these disparate subject areas were four strands which included an emphasis on designing, making and appraising. Hanson (1997: 118) made links between the 'design, make and appraise' process which identified technology education as a cultural phenomenon, that sought harmonious relationships between human life and nature based on problem-solving and a respect for practical experience that encouraged human development.

At the national level, support for the new technology KLAs (called design and technology in some areas) was gathered from major professional education groups associated with the former subject areas. Relevant Australian design and education organisations entered into a partnership to become the Technology Education Federation of Australia (TEFA) involving the Design in Education Council of Australia, the Australian Council of Education through Technology, the Home Economics Institute of Australia, the Council of Australasia Media Education Organisations and the Australian Council for Computers in Education.

Technology education, social change and the consuming society

Technology education curriculum was intended to foster an understanding of the material world and to educate students towards developing their technological ability in relation to their changing future environment, their role as consumers and changes in employment opportunities. Change and advancement in technology has meant an unprecedented increase in the types of jobs available and the skills needed to accommodate these new and changing technologies. Such changes, along with the decrease in jobs that depended on outdated technologies, provided the rationale for some of the changes in the technology education curriculum. Pucel (1992) argued that technology education has strong links with the workplace and, as such, technology content should include, for example, common tool usage and materials, environmental and social issues, scientific principles, social values and economic factors. Pucel claimed that 'technologically literate people had common sense knowledge of technology and understanding of how technology evolved to satisfy human needs' (Pucel: 1).

Principles of technology education, according to Puk (1993), were based on changes in society that called for the empowerment of each individual with knowledge, skills and confidence, using problem-solving and the process of inquiry. The purpose was to define the generic nature of concepts in subject matter as the point to change human behaviour and break down discipline barriers through the use of a design process. It was important to approach technology as an integrated subject that encompassed industry,

Dr Judy Hodgman

physical products, human environments and environmental ecosystems. Puk made no distinction between individuals who designed products or who purchased products, 'these are equally creative enterprises that support no basis for status distinction. And they all involve technology' (Puk: 28).

Through a design and technology curriculum, students develop an understanding of different cultural and environmental needs. Linking changing social and cultural needs with technology education was seen as a way to increase understanding and prepare students for life and work in the wider community.

Changes in society and work have led to a reconsideration of the role that schools should play in preparing students to become technologically literate. The relationship of technology to society is a continuing event that requires analysis and evaluation by students and teachers involved in technology education. At the secondary level, technology education has strong links with vocational education, industry and consumerism and business. Design in industry is considered to be part of an integrated whole of the wider community as it affected social change and environmental conditions. The skills developed as a result of design education are seen to have an important role in industry. Design in industry is multi-disciplinary and inter-disciplinary in terms of practice and use (Papanek, 1995).

The recognition of the centrality of technology to culture becomes an influence in determining technology curricula. Zuga (1993) was of the view that for the technology education curriculum to accommodate changing societal needs, a diversified approach was needed, which meant changing the focus from a manufacturing and skills-based approach to a design-based approach (Zuga: 56). The decision-making processes needed by a lay person (consumer) to make discerning decisions concerning products and services is recognised as an important aim of design and technology education. The judgments made by consumers impact on society and on the environment. Design education needs to address issues, which are linked to consumer preferences. Consumers exercised their market choice and, as such, provided direction and justification for the market's physical system of production, distribution and exchange.

Consumers' attitudes, values and/or behaviour are prominent in any decision-making process regarding market considerations. Schwartz (1991) proposed that the decision-making process was the most important element in consumer behaviour and included the

recognition of a problem and the evaluation of alternate solutions. Value decisions concerning the design and purchase of products is linked to technology education through the process of designing and evaluating products.

Product design has close links with technology education, consumerism and manufacture. The recognition of a product's need and value is important to designers, manufacturers, consumers and educators. Product design is seen to be as much about the conduct of the society, as it is about the products of the society. As society is constantly changing, it seems appropriate, therefore, to consider design as a continual process of change. In the broadest sense, it would seem that, through 'designs' or the skills developed as a result of interaction with the process of designing, the built environment may be changed. Designers, according to Miller (1991), needed the ability to 'scrutinise products from raw material procurement, manufacturing and production, straight through to after-use (reuse and recycle) and disposal' (Miller: 63). The process of designing may include, for example, the identification of a set of needs, the initial conceptualisation of a way to meet those needs, further development of that initial concept, the engineering and analysis required to make sure it works, the prototyping of its preliminary form, the construction of its final form and the implementation of various quality control procedures and its value to the consumer.

Skills in product design and product evaluation are important to designers, consumers and educators. The argument here is that technology education, through the activities of designing, making and appraising products and services, is the mediating link between product design for industry and the value-laden, design decision-making process needed by consumers to make a product choice in the market place. Product design is linked to consumerism through the activities of marketing, selling and purchasing and to design and technology education through the design decision-making process, all of which relates to values. Scriven (1991) argued that consumer choice and marketing strategies affected 'environmental conditions' and that design education needed to account for the part of consumer choice on design decision-making (Scriven: 98). Technology education has adopted a design decision-making and problem-solving approach and within this approach personal values are seen to play an important role.

Values and the design decision-making process

The technology education teaching/learning process is important in addressing the nature and power of consumer choice and its role in the transformation of society. Teaching/learning models needed by students to evaluate and design products should, therefore, provide for the clarification of values. The notion that values were central to both the theory of education and the practical activities of schools was supported by Halstead (1996) who argued that the values that schools subscribe to impact upon curriculum delivery and 'the part schools play in the teaching of values and the part values play in the organisation of schools are closely connected' (Halstead: 3).

Technology education is concerned with design decision-making, ethics and values (Williams, 1996). A key element in a design problem-solving process is the development of design criteria that includes values. Johnsey (1994) pointed out that the inclusion of values was an integral part of the design decision-making process, as teaching in technology education was based on the need for students to make judgements about products which had been designed and made and/or the processes which had been used in designing and making.

Understanding how children develop criteria and an understanding of their own values and those of the product is important information for the teaching/learning process in design and technology education. Siraj-Blatchford and Patel (1994) claimed that values should be considered in the design and technology education curriculum, as there 'is a need to make values the subject of deliberation and critical reflection between pupils and between pupils and teachers' (Siraj-Blatchford and Patel: 58). Concepts in a value inclusive teaching strategy may include, for example, valuing children's responses, trust and respect for others' opinions, reflection, sharing ideas, group work, developing criteria and assessment and comparison of products. Individual values, according to Smyth (1996), were seen to depend on what the learner has been told (by any of the influences), what has been absorbed through experience (whether designed for that purpose or not) and 'what has been actively pursued by the learner in response to inspiration from others or to personal interests and desires' (Smyth: 57). Holdsworth and Conway (1999) suggested that a 'values-inclusive' curriculum was needed at all levels of education

Values are seen to impact on design decision-making and design evaluation/assessment.

Values are an important part of the way the decision-making process operates in practice, which draws upon a value clarification process. Scriven (1991) defined a value clarification process as 'identifying and removing inconsistencies in individual sets of values, misunderstandings and misinterpretations' (Scriven: 5). The notion of value clarification as a part of a design decision-making process in a design and technology teaching/learning model is an important consideration

Decision-making in design and technology education

The focus of technology education concerned a process of decision-making. Teachers were expected to base their curriculum on a design, make and appraise framework (AEC, 1994). The curriculum framework (Kindergarten-Year 12) offered a new context for learning as it provided opportunities for design and problem-based experiences for students. Design-based experiences were to be achieved through practical design projects, where content and knowledge were gained throughout the educational experience.

Technology education facilitated the application of knowledge and the skill of doing, making, judging, choosing, inventing and implementing through the use of a design and technology process (Pucel, 1992). The process of design decision-making needed to include the identification of an unmet human need requiring a technical solution, clarification of the specific technical problem and the identification of relevant existing technical methods and knowledge. The creation of a probable solution, occurred through the design process, involving a determination of the social acceptability and economic feasibility of the solution, modification of the solution and implementation and testing of the solution.

Technological capability, as seen by Wright (1994), was developed as a result of the design decision-making process used in technology education. Technological capability, for Wright, included certain capabilities that are the basis of the educational aims of the design and technology curriculum, such as exercising critical design evaluations in developing ideas and demonstrating questioning and critical attitudes to appropriate technological development. Khisty and Khisty's (1992) research supported these views.

In order to develop curriculum that meets the evolving needs in the design and technology teaching/learning area, research is required regarding design decision-making. What are the skills and processes required for design

decision-making in a design and technology education context at the post-compulsory level?

Purpose of the study
The purpose of the study was to examine a design process and to develop, implement and evaluate a teaching/learning model in design and technology education for use at the post-compulsory level. The development of the teaching/learning model was intended to focus on skills and processes involved in design decision-making in technology education, as determined by designers and design educators, and evaluated in a practical context with students, teachers and professional experts.

Research Questions
The research questions, which followed from the purpose of the study, were as follows:

What skills/processes do professional designers and design educators consider essential for a teaching /learning model in design and technology education?

How do design and technology students at the post-compulsory level interact with the skills and processes inherent in the teaching/learning model in an educational context?

How do teachers perceive students engaging in the design decision-making process, in a practical context, at the post-compulsory level?

How does the teaching/learning model operate in design and technology classes?

Methodology
A case study was selected as appropriate for the development and evaluation of a design and technology teaching/learning model. A case study is a bounded system and the development of a particular teaching/learning process is a 'bounded event' (Burns, 1997). The case study was organised using an evaluation model developed from Stufflebeam's Context, Input, Process, and Product model (CIPP), (Madeus et al, 1983: 129). The CIPP model enabled the case study to be designed in a four-phase process. A multi-method approach to data gathering was employed over the four phases of the study.

The purpose, research question, methodology and data analysis for the four phases are listed as follows:

Phase 1: Context Evaluation
The purpose of the Context Evaluation phase was to design the teaching/learning model. A focus group of experts was used to describe the context and examine solution strategies and procedural designs. Data included design

evaluation criteria that were categorised in terms of design skills and processes.

Phase 2: Input Evaluation
The purpose of this phase was to trial the teaching/learning model developed as a result of the Context Evaluation phase. The methodology consisted of a quasi-experimental design that used matched pairs, treatment and a post-test. Statistical data was analysed using a Wilcoxon signed Rank Test and the qualitative data analysis was time-based.

Phase 3: Process Evaluation
The purpose of the Process Evaluation phase was to evaluate the design skills and processes of design decision-making. The methodology for this phase included descriptive techniques. A questionnaire was used to gain teachers' perceptions of students' use of judgements in the design process. Data analysis included a factor analysis and correlation coefficients.

Phase 4: Product Evaluation
The purpose of the Product Evaluation phase was to evaluate the teaching/learning model developed as a result of the Context, Input and Process phases. Methods used for the collection of data consisted of the use of descriptive techniques, including unstructured interviews with students, student self-evaluation schedules (learning outcomes criteria) and an expert panel judgement. Data analysis included the use of formative evaluations and qualitative analysis by pattern discernment.

The researcher was involved in the study, as a teacher of design studio classes and as data gatherer for Phase 4. There is a concern regarding potential bias with the researcher's involvement in the study in this way and this is acknowledged. However, the possibility of bias was balanced against the need to ensure that the model was presented to students in a consistent manner. It was decided that the researcher being involved in Phase 4 of the study meant she is in a position to ensure consistency in the way the model was presented to students and that this should be assessed against the disadvantage of a potential for bias.

Results
The results of the study will be presented in the form of the VALUED model that was the outcome of the study. The acronym, V-,A-,L-,U-,E-,D-, is a summary of the six stages of the teaching/learning model and the acronym is used to emphasise the importance of values.

The V-,A-,L-,U-,E-,D- model

The V-, A-, L-, U-, E-, D- model was based on the need to attend to characteristics

identified as important to design decision-making/problem-solving in design and technology education. Results of the three phases of the research investigation indicated that characteristics of a teaching/learning model for design and technology education included values clarification, self- and peer-evaluations/assessments, design evaluations/assessments and goal setting. The importance of value clarification (in the form of evolving/changing design/assessment criteria) guiding decisions was an innovation.

Stage 1 – Values Shared (V)

The first stage of the students' design decision-making process concerning the design problem was described as 'values shared'. During this initial stage, students were expected to clarify their values concerning the design brief. Pre-formative, design evaluation/assessment criteria were then developed by the students for design/assessment purposes.

During the first stage, pre-formative design evaluation criteria for design development purposes were listed. Students used formative and summative design evaluations to develop and reach a solution to the design problem. Students clarified their values (as they applied to the design problem) as well as those of others. The design evaluation/assessment criteria were used for teacher and student design evaluation/assessment purposes. The design evaluation/assessment criteria may change as the project progressed. In this way, values are integral to the design solution and the design evaluation/assessment process.

Stage 2 – Assessment/Evaluation Criteria Developed (A)

This stage was described as 'assessment/ design evaluation criteria developed' and refined. The chosen criteria were used to refine ideas concerning the project (product). During Stage 2, students progressed through their design project work, discussing their ideas with their peers. Students continued to examine the 'values' intrinsic in the product and their personal values concerning their design. These are reflected in the criteria they chose. They provided advice and criticism for other students in terms of students' choice of design evaluation/assessment criteria.

Stage 3 – Linking Assessment/Evaluation Criteria (L)

As criteria were needed for evaluation/ assessment purposes (summative and formative), this stage was described as 'linking' design evaluation/assessment processes. Students interacted with the design and assessment process through their choice

of criteria. They made links in understanding between the two processes.

Stage 4 – Understanding Assessment/ Evaluation Criteria (U)

By the fourth stage of the V-, A-, L-, U-, E-, D- model, students needed to become familiar with the design evaluation/assessment criteria chosen by their peers. Students' choice of criteria were discussed with all other students in the group. Students required an understanding of these criteria and how they related to each student's individual design projects in terms of the values inherent in the design. This stage was in preparation for peer-assessments. Discussions relating to design evaluation/assessment criteria took place between students and teachers and students and students. Students shared and discussed their 'understanding of design evaluation/assessment criteria' with their teacher and fellow students. By this stage, students needed to demonstrate an understanding of the design/assessment criteria chosen. They share their understanding of assessment criteria with their teacher and their peers.

Stage 5 – Evaluation of Assessment/ Evaluation Criteria (E)

This stage was described as an interaction stage of evaluation/assessment processes. During this stage, students were required to clarify their criteria with their peers and their teacher for self- and peer-assessment purposes. Interaction, iteration and active listening were required at this stage as students needed to gain an understanding of their peers' criteria.

Stage 6 – Design Outcomes/Solutions Assessed

Students use the criteria (provided by each student) to assess each student's individual project. This stage was described as 'design outcomes/solutions assessed'. Students presented a written, oral and visual explanation of their final design and the criteria they had used to develop their design. Students' values and goals are discussed. During this final stage, students use other students' chosen design/assessment criteria for peer-assessment purposes and their own for self-assessment purposes. Each specific set of criteria is unique to the individual designer/student.

The Evolution of the V-, A-, L-, U-, E-, D-model

The Context Evaluation phase provided a list of skills that needed to be developed as part of a design decision-making process. These

included, for example, goal setting, design evaluations/assessments and values clarification. The expert focus group identified assessment of design skills in an educational context as an unresolved issue. The lack of clarity in the way in which teacher assessments/evaluations interacted with students' assessment /evaluations during design decision-making influenced the design of the Input Evaluation phase and Process Evaluation phases of the CIPP model (Phases 2 and 3). The Input phase sought information about the way students used assessment/evaluation in their design work and the Process phase sought information about the way teachers perceived students' understanding and use of assessment/ evaluation in the design process.

The results of Phases 1, 2 and 3 suggested that a teaching/learning model was needed that focused on the interaction of design evaluation/assessment processes (teachers' and students'). This finding influenced the design of the V-, A-, L-, U-, E-, D- model that was trialled in the fourth evaluation phase of the CIPP evaluation model (Product Evaluation).

Values Clarification
The V-, A-, L-, U-, E-, D- model (Valued Assessments Link students' Understanding of Evaluation and Design) was designed for use in design and technology classes at the post-compulsory level.

The V-, A-, L-, U-, E-, D- model differs from previous design teaching/learning models in design and technology (see, for example, Brady, 1988) in that it promoted interaction between students' values, a design process and teachers'/students' evaluation/assessment processes. Brady's model, while recognising the need for evaluation of students' work by teachers and students, made no provision for the integration of these assessment/evaluation processes. The opportunity for students to develop, use and change criteria as design work progressed is a feature of the V-, A-, L-, U-, E-, D- model.

In the V-, A-, L-, U-, E-, D- model, criteria for evaluation/assessment purposes were developed, used and changed by students throughout the design decision-making process and used by students for self- and peer-evaluation/assessment purposes. Evaluation/assessment criteria, self- and peer-assessments and goal setting as well as collaborative, interactive discussions and 'brainstorming' were some of the learning outcomes of the V-, A-, L-, U-, E-, D- model that were reported by an expert panel of judges and the students who trialled the model in practice.

Although values have been attended to by designers and educators, the V-, A-, L-, U-, E-, D- model in practice brought values into the design assessment process whereby students examined their values and negotiated these values within the constraints of the design brief. They developed criteria for design, self- and peer- evaluation/assessment purposes and set their own goals. The first stage of the V-, A-, L-, U-, E-, D- model was where students were shown to develop design evaluation criteria that were identified as value-laden. Students developed value inclusive pre-formative design evaluation criteria for design development purposes and these were reflected in their assessment of design outcomes (assessment criteria) and in their design outcomes (products).

Students' reflective evaluations and those of an expert panel of judges suggested that the V-, A-, L-, U-, E-, D- model facilitated the exchange of ideas and personal values. For example, 'I discussed my ideas about recycling and got some good ideas back.' Design problems were considered by students and an expert panel of judges to be interpreted and discussed in terms of the product's 'value' and students' personal values, as they applied to the problem. For example, 'I could gauge my own standards and values against theirs.'

The V-, A-, L-, U-, E-, D- model in practice revealed the use of values as a 'negotiating tool' (a term used to describe the interaction between individuals, teacher and group in discussing criteria). An individual's values were reflected in the criteria chosen for the purpose of designing products and these were discussed and negotiated with other students and with the teacher. An expert panel of judges reported that, in terms of negotiation, 'they [students] got plenty of opportunity to discuss and clarify ideas'.

Students' criteria became the 'negotiating tool' for decisions concerning design development and design outcomes. These criteria were discussed with all other students and evolved and changed as the design decision-making process proceeded. Students' values were reflected in their choice of criteria and in the values inherent in the product. This finding supports those of Holdsworth and Conway (1999) who suggested that students needed the opportunity to clarify their values at all stages of a design process and this helped them to think about their values in relation to others.

It is argued that the V-, A-, L-, U-, E-, D- model in practice focused on the links between examining values and developing and using assessment criteria. Students' self-evaluations formed part of the data collected for Phase 4. This data suggested

that assessment criteria developed by students were used for product assessment purposes and product development purposes. Students were shown to gain an understanding of how these two processes were linked. Students' evaluation schedules suggested they perceived that they used and developed design evaluations/assessments during design project work. This data also suggested that the evaluation/assessment processes in this study interacted in an on-going manner. Students were seen to be active participants in the design evaluation/assessment process and this promoted a motivational context and interaction with others and increased confidence in learners. Goal setting was shown to be closely linked to values as was evidenced by students attempting to develop their own design evaluation criteria as part of the V-, A-, L-, U-, E-, D- model. For example, one student reflected that 'choosing my own design criteria helped me to concentrate on the main thing – designing the hand-held machine'. Students were shown to set their own goals and participate in self-assessment and peer-evaluations/assessments.

Data collected for the Product Evaluation phase of the study supported Khisty and Khisty's (1992) research findings that when students were provided with an opportunity to develop criteria for assessment purposes and to reflect on those criteria, they expressed an increased confidence in design problem-solving. Khisty and Khisty showed that students' confidence in working independently improved as a result of students developing criteria for their design project work. The students in this study suggested that the criteria for design and evaluation self-assessment and peer-assessment purposes were important to them as learners. They claimed that self-assessment and peer-assessment increased their understanding of the learning process, as distinct from teacher-driven assessment.

Self-assessment and peer-assessment strategies were shown to facilitate student-centred, interactive assessments as students took on the role of planner and organiser and, by this approach, developed personal goals. Students in the fourth phase of this study were shown to participate actively in the external assessment of other students work during the 'D' stage of V-, A-, L-, U-, E-, D- model (design outcomes assessed). Students in this study suggested that their understanding increased as a result of this experience as they used the same criteria to design and assess products. It is argued that the V-, A-, L-, U-, E-, D- model afforded insight into students' design decision-making processes.

The V-, A-, L-, U-, E-, D- model adopted a teaching/learning approach whereby students' value-laden criteria were developed and changed as the problem-solving process proceeded and that they were used to evaluate/assess design outcomes. Educational outcomes of the V-, A-, L-, U-, E-, D- model were seen in terms of 'promoting independent learning and evaluation, self-assessment and recognition of personal values and in developing critical design evaluation skills' (Wolffe et al, 1999).

Conclusion

The research reported in this study examined the design, development, implementation and evaluation of a teaching/learning model – the V-, A-, L-, U-, E-, D- model. In order to design the model, preliminary investigation was carried out to identify the skills and processes required to design products, the way in which students interacted with these skills and processes and teachers' perceptions of the way in which students engaged in design decision-making processes. The methodology used for the Input Evaluation phase included a quasi-experimental design that used matched-pairs treatment and a post-test as well as descriptive techniques.

The methodology for the Process Evaluation phase of the case study used a survey to gain teachers' perceptions of how their students interacted with design assessment/evaluation processes at the post-compulsory level. The high level of 'unsure' responses reported by the teachers surveyed indicated that more research is needed to examine teachers' perceptions of how students engaged in the design decision-making processes (students and teachers) at a number of different educational levels.

It would be useful to probe the views of teachers who have implement a V-, A-, L-, U-, E-, D- model, as there is a need to gather evidence from a broader range of students in the design and technology area. Further research should be undertaken to test the V-, A-, L-, U-, E-, D- model in respect of its use as a negotiating tool and as a tool for providing insight into design decision-making and for advancing discourse concerning the model.

This study was exploratory in nature as it was concerned with the development of a teaching/learning model in design and technology at the post-compulsory level. The model was further trialled at the tertiary level of education with students in a different discipline area (Faculty of Architecture, University of Delft). The model was shown to provide pre-service design and technology teachers with strategies for developing an

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understanding of their personal values and the product's value. It is argued that the model extended the use of values into a new field in design and technology education, in that criteria which are value-laden are developed, used and changed by students for product design evaluation/assessment purposes and that this strategy encouraged goal setting, values clarification and the use of formative and summative design evaluations.

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