australasian journal of TECHNOLOGY EDUCATION

The Australasian Journal of TechnologyEducation is a peer refereed journal, and provides a forum for scholarly discussion on topics relating to technology education. Submissions are welcomed relating to the primary, secondary and higher education sectors, initial teacher education and continuous professional development, and general research about Technology Education. Contributions to the on-going research debate are encouraged from any country. The expectation is that the Journal will publish articles at the leading edge of development of the subject area.

The Journal seeks to publish

- reports of research,
- articles based on action research by practitioners,
- literature reviews, and
- book reviews.

Publisher: The Technology, Environmental, Mathematics and Science (TEMS) Education Research Centre, which is part of the Faculty of Education, The University of Waikato, publishes the journal.

Contact details: The Editor, AJTE, pj.williams@waikato.ac.nz

Cover Design: Roger Joyce

ISSN: 2382-2007

australasian journal of TECHNOLOGY EDUCATION

Volume 1, 2014

Images of Technology and Sustainable Development in Swedish Children's Literature
Cecilia Axell, Jonas Hallström, Jan-Erik Hagberg 1–8

Comparative Analysis of Research Priorities for Technology Education
Gene Martin 9–17

Theoretical Implications of Gender for Technology Education
Vicki Knopke 19–28

STEM Education: Authentic Projects which embrace an Integrated Approach
Coral Campbell, Wendy Jobling 29–38

Intervention through Design: Encouraging a creative approach to learning in Technology
Ann Mc Glashan 39–48

Exploring the Relationship between Science and Technology in the Curriculum
Abbad Almutairi, John Everatt, Paul Snape, & Wendy Fox-Turnbull 49–63

Initial Teacher Education PCK Development - Knowledge of Learners: A beginning technology teacher's journey
John Lockley, Michaela Nicholas 65–75

australasian journal of TECHNOLOGY EDUCATION

Volume 1, 2014

Intervention *through* Design: Encouraging a creative approach to learning in Technology

Ann Mc Glashan

Abstract

In an effort to enhance the education of young designers in New Zealand, this paper examines the key role of design thinking and methodology in Technology education. It suggests that the inclusion of the creative design approach will shift the current emphasis in the learning area of Technology in the New Zealand curriculum from an information gathering, declarative and procedural viewpoint towards one that develops creative and curious minds.

This paper builds on earlier research that has identified events occurring within the practice of creative designers in New Zealand. It also presents a discussion on the theoretical views to inform design pedagogy and provides an historical overview of designing as part of a school curriculum. It concludes with reference to ongoing research into customary classroom practice from the Arts that may offer a way forward to inform and re-instate the designing aspect at the core of learning in Technology.

***Key words*:** Design thinking, imagination, paracosm, student-centred, creative problem-solving

Introduction

> Each child has a spark in him/her. It is the responsibility of the people andinstitutions around each child to find what would ignite that spark.
>
> Howard Gardner

Gardner's challenge (circa 1985, cited in the 1999 National Advisory Committee on Creative and Cultural Education [NACCCE] report, p. 104) requires educators to provide learning experiences that inspire and nurture the child's innate spark, their imagination, purity of thought and freedom of expression through life's learning. Beeby (1992), while reflecting on his role as New Zealand's Assistant Director of Education, noted an encroaching seriousness in education at that time, (more than 70 years ago). He spoke of his own traditional schooling in the early 1900s noting that school was the place "you worked" and the wilderness patch behind his home was where you could imagine, "a place to play" (p. 4). This environment, where imaginative interplay was encouraged, helped mould his idea of the intrinsic "functions of a school" (p. 4), where creative play enhanced teaching and learning. How can we ensure that these ideals endure throughout a child's schooling when regrettably, creative activities, can be seen by some to take up too much time or even to waste time? In a climate where information gathering and reporting systems are demanded, hours spent in imagining are not always valued.

The New Zealand Curriculum (Ministry of Education, 2007) now offers educators scope to maintain these qualities as they nurture young minds to become "lifelong learners who are confident and creative and value innovation, inquiry and curiosity" (p. 4). The learning area of Technology's core intent is that learning should follow a student-centred, creative problem-solving approach that is set in

the context of the learner's life interests and environments. The learning area of Technology (Ministry of Education, 2007) essence statement suggests that technology is "intervention *by* design" (p. 32). Whereas early learning objectives expect children to understand that "technology is purposeful intervention *through* design" (Ministry of Education, 2007), this emphasis indicated that even the youngest learner needed to be familiar with design thinking, processing and the impact of design decisions on people. These required attributes and skills provided the focus for students to become perceptive, creative and informed practitioners. Consequently, teachers need to be able to model, support and implement learning experiences where students develop the tacit knowledge through their own creative practice.

However, teachers who are new to design processing are ill-prepared to model creative design practice for their students. They should be encouraged through effective pre-teacher training and in-service professional development to infuse their teaching with the ways of design that occur within creative design practice. Of late, there has been little nationwide focus of support in this area for teachers or pre-service students of Technology. This situation has been ameliorated, however, as McGlashan and Wells (2013) note that there is an increasingly large proportion of career changing specialists entering the pre-service teacher training programme with a working understanding of the creative design Community of Practice.1 They see the role of decision-maker "at the core of creative design and technological practice as second nature to these students" (p. 941). These beginning teachers are able to adapt immediately to the subject Design and Visual Communication (formerly Graphics) where creative design practice does occur. As beginning teachers, they are also able to adjust and work within the variety of school interpretations of learning about Technology. It is evident that the daily practice of creative design aligns itself favourably to the many aims of the 2007 curriculum, where human values and competencies are encouraged through inquiry-based learning.

Theoretical views to inform design pedagogy

Interpretation of what is meant by design and designing has undergone much change in New Zealand and international practice and curricula.

Debate about design methodology has been, and still is, broad ranging and complex, with early theorists suggesting a prescribed approach to design processing. Gregory (1966), 45 years ago, argued that "The process of design is the same whether it deals with the design of a new oil refinery, the construction of a cathedral or the writing of Dante's Divine Comedy" (cited in Lawson, 1997, p. 30), suggesting that each practice follows a similar approach, regardless of the intrinsic nature or purpose of each design task.

For theorists, an early imperative was to identify key stages, and the sequencing and hierarchy of these stages within design processing. A number of theorists identified stages common to a range of design practitioners. They noted sequential positioning of these stages to offer a perceived *design process* to guide the act of designing for practitioners and educators. Johnsey (1998) identified fourteen common events and perceived a preferred order to these events from initial investigation through to final evaluation. It appears from national and international research and my own observations as national assessor, pre-service teacher and teacher of Technology, Graphics and Design and Visual Communication, that the prevalent pedagogical approach to design processing still reflects this formulaic model. Johnsey himself observed a similar situation in England, when reviewing the Design and Technology teaching and learning approach at a primary level. He saw the role of a single simplified process to follow as "initially being of help to the non-specialist primary teachers," providing some guidance and security. In the longer term however, he felt that there were "dangers in representing pupils' design activities in such a simplistic way" (p. 119, cited in Mawson, 2001).

From his work with doctoral design students, Scrivener (2000) drew attention to two distinctly different approaches to design processing, depending on the nature of the task: one a linear approach he called *problem-solving,* the other a more iterative approach he named *creative-production*.

Problem-solving design processing he saw as the "testing of an emerging solution to a problem that satisfies specific norms and tests and which, in being designed to meet these criteria, contributes systematically to the development of the discipline" (p. 12). Scrivener identified a number of common events in the *problem-solving* design approach that adhered to linear thinking processes and fixed systems of testing. This approach resembles the formulaic model promulgated by the learning area of Technology in the NZ curriculum requirements represented in many school programmes. Such an approach aligns with a scientific or engineering way of problem-solving, whereas within the *creative-production* approach, Scrivener identified events that were addressed as they arose. These vary depending on the nature of the task in hand. He noted also that the thinking processes employed in *creative-production* design may be considered in terms of Schön's (1983) theories of professional practice with thinking as "reflection on emerging practice" (p. 7). Schön affirms the iterative nature of creative problem-solving as "something that … recurs throughout the process in response to difficulty or uncertainty encountered during the task" (p. 7). Schön also placed emphasis on the role of tacit knowledge developed over time and experience by the designer through competent design practice.

Contemporary theorists who concur with a creative iterative approach to design thinking and processing include Spendlove (2010) who writes about the concept of unknowing. He cautions against the reliance on the use of set models "that merely proliferate the illusion of progression and understanding" (p. 4). Baynes (cited by Norman, 2009) turns to creative design practice by recognising the significant role of the designer and the ways in which they go about design activity as being:

> … essentially concerned with human behaviour and human potential [that goes] far beyond the obvious boundaries [the development and creation] of 'things,' reaching out into the wider field of intentional activity in general. (p. 4)

Further exploration into the way of thinking involved in creative classroom practice includes Rutland (2009) in her comparative study between Art and Design and Design and Technology in the United Kingdom. She identifies pedagogic approaches within the Art and Design programmes, that assist pupils "to develop vision, confidence, a willingness to take risks … and be proactive, and an independent thinkers" (p. 65). Such learning occurs where opportunities are provided for pupils to engage in material that has relevance to their lives. Creative learning, Rutland explains, also requires "dwell" time to encourage the imaginative manipulation of ideas "inside the head" (p. 63). A robust pedagogy that addresses ongoing nurturing and development of imaginative thought and inquisitiveness requires informed planning and time. Teaching that specifically intends "to foster or enhance pupils' " own creative thinking (Rutland, 2009) has been found to engender creativity. Baynes (1989) and Mawson (2003) contribute a further way to enhance imaginative interplay when writing of the importance of recognising and encouraging the ability "to see in the mind's eye." Kimbell and Perry (2001) also see that this ability is at the core of creative practice. Hope (2009) notes an essential related element to creative processing by acknowledging the place of paracosm, explained as the imaginary world people create within their heads within a narrative context that is "fundamental to design, creativity and invention" (p. 53). These findings suggest that an international focus is required for a shift away from the outcome driven, formulaic model of designing towards an approach that better reflects the integrity of inquiry, manipulation of thought and decision making inherent in creative design practice.

Practising designers Sharma and Poole (2010) support current educational theories by providing some guidance for design pedagogy. "Design … is changing; where once it was purely a matter of signs and objects, now it has entered the realm of behaviour and perception" (p. 65). They also refer to a shift in the role of contemporary design practice as "a way of knowing through thinking and doing. … Design is not just something that is done to things – it is a way of doing things" (p. 65). This sentiment provides a view from the New Zealand community of design practice that parallels Baynes (2009) and Cross's (2001) research in the United Kingdom that saw *designerly* ways of knowing, thinking and acting as a means to meet our curriculum's vision. Such practice could preserve the childhood attributes of imaginative thought and set in context all learning in a meaningful way. Hope (2009) goes further to suggest that in the development of an informed population, "equipping children with

practical design capabilities is probably one of the most essential components of their education" and, further, that our species and planet could "depend on their design decision-making" (p. 54). Founder of the UK REthinkthings design consultancy Ilsa Parry (2011), observes that the Design and Technology "learner must be analytical, evaluative, entrepreneurial, technical, scientific, artistic, physically fit, philosophical, emotionally intelligent, mathematical and reflective" (p. 25).

Historical overview

Attempts to introduce a design component into subject areas at the curriculum level have proven problematic. Issues of ownership and a wide variation of interpretation of the nature of design and designing need resolution. Design in the New Zealand Curriculum was given independent status in the late 1980s, at senior secondary school levels of learning. Developments in the final year of secondary schooling saw Practical Art divided into five separate subjects with Design selected as one of the areas. The subject, Design, required students to define, refine and communicate their designs using design practice based on the Art inquiry model and more recently design practice. Design was also a key component of the subject Design and Technology, which evolved from workshop and Home Economics subjects to better replicate the world of design-and-make in Hard Materials, Textiles and Food Technology. This subject further evolved into *Technology in the New Zealand Curriculum* (Ministry of Education, 1995) where design was seen as an "essential component of the activity" (p. 12).

The Technology learning area of the *New Zealand Curriculum* (Ministry of Education, 2007) has seen further change into a Learning Area that mentions design in its essence statement "Technology is intervention by design" and contains in its structure implicit reference to aspects of design. Students are required to "develop, to realise, to evaluate design ideas" and "to evaluate design ideas and fitness for purpose of a range of outcomes" (p. 32). Further examination of the *Indicators of Progression*2 require students within the *Nature of Technology*3 strand to understand even at Level 1 (5 year olds) that "technology is purposeful intervention *through* design" indicating an understanding of the ways of design. Outcomes within design processing listed in the Indicators of Progression as required stages, may be seen to suggest yet another formulaic model for teachers and learners to follow. There has been little advice or support for teachers, however, in how to go about designing.

Design was also at the core of the subject Graphics that was developed from the precision drafting subject Technical Drawing in the late 1980s. The new subject aimed to better reflect the changing world of design practice, visual communication and digital technologies. The mode of delivery was centred on design briefs and introduced a creative problem-solving approach to align more with design practice. Graphics has recently been renamed Design and Visual Communication, with Learning Objectives: *Design*, *Visual Communication* and *Graphics Practice*. This subject has the ways of design at its core and stands with its own autonomy under the umbrella of Technology.

These developments indicate a growing awareness of the place of design thinking in learning areas such as the Visual Arts, Design and Visual Communication (Graphics) and Technology.

What can we learn from contemporary design practice?

Research into contemporary design practice provides much to inform design pedagogy. For example, we can learn from the vision and approach to practice of the design firm IDEO. IDEO is hailed as one of the world's most celebrated and innovative design firms. It promotes a continually evolving team approach to design thinking that varies according to the task in hand. IDEO promotes a collaborative, people-centred approach to design thinking and practice that could inform student-centred, inquiry-based, co-constructivist methods of learning. The gaining of such attributes aligns with the *New Zealand Curriculum* overall vision by providing students with aptitudes and dispositions that can be taken into their future lives.

Kelley (2001) explains the design methodology employed by IDEO as a dynamic, continuously

refined model that is often challenged and adapted to better align with the task in hand's unique requirements. He identifies five broad events that occur within its design approach, although these vary depending on the client and task in hand: understanding the market, visualisation, communicating ideas, evaluation and refinement, and implementation.

> *Understanding the market*, client, technology and perceived constraints; Observe real people in real-life situations to find all about what makes them tick, their likes dislikes even latent needs.
>
> *Visualisation of* new-to-the-world concepts and customers who will use them: This is the most brainstorming intensive stage. Visualization may take the form of computer-based rendering or simulation.
>
> *Communicating ideas:* IDEO builds many models, including illustrative storyboards, to prompt useful dialogue and visualize the customer experience. Video clips may be prepared to portray life with the future product before it exists.
>
> *Evaluation and refinement:* Evaluate and refine prototypes in a series of quick iterations, not getting too attached to first models, as they will change. Input at this stage may be from internal or client teams with input from knowledgeable people who are not directly involved with the project. We look for what works, what doesn't and what confuses people, to inform the next round incrementally.
>
> *Implementation:* Implement the new concept for commercialization. This is the longest and most technically challenging phase, building on all that has gone before. (Kelley, 2001, p. 4)

Research methodology

Prompted by Lawson's (1997) suggestion that "it would be much more interesting to know how very good designers actually do work" (p. 39), creative design practitioners were approached to participate in this research. Designers of note, from the domains of architecture and spatial design, fashion, product and graphic design were approached by the researcher. Three prominent New Zealand designers David Trubridge, Dean Poole, and Carin Wilson, agreed to open up their practice for critique, to inform design pedagogy.

David Trubridge has established a successful internationally acclaimed design practice and has won awards for his work on sustainable design. He has been instrumental in establishing a design incubator to support young designers in their early practice.

Dean Poole is a director of Altgroup who are at the cutting edge of graphic design. Their work is seen in the innovative re-branding of the Auckland Museum and Art Gallery. They have earned international recognition by receiving a number of the illusive *Red Dot* awards in Germany for design excellence. Dean Poole has become an invited member of the International AGI (*Alliance Graphique Internationale)*.

Carin Wilson is a celebrated designer, sculptor and carver of Ngati Awa and Ngai Te Rangihouhiri descent, who has practised his craft for over 20 years. Carin is a design lecturer in Maori Architecture and Appropriate Technologies at Unitech, Auckland.

The research followed an interpretive methodology design through case studies. The practice of each designer was viewed as a unique journey. Each designer was interviewed in their own working environment. Interviews served to understand the world of design practice from the designer's point of view, to accurately capture and record his experience. The goal as interviewer was to stimulate recollection and reflection in such a way that designers could relate their remembered practice. McGlashan (2011) found that the "most opportune time to discuss design processing was at the conclusion of a design task, when the residual influence of that project was still foremost in the

designer's mind" (p. 240).

Analysis of the data was heuristic. This approach involves intuitive questioning as a means of discovery. Moustakas (1990) likens an heuristic approach to qualitative data gathering as "to let go of the known and swim in an unknown current" (p. 13). The research design took a flexible approach to the gathering of data, allowing each interview to follow its own direction, dependant on the designer's interpretation of the question. Even the prepared lead question was changed to suit each case, and the positioning of the interview's timing within the practice observed. A range of recording methods was used: note taking, digital recording of interviews, still camera capture of images, journals (research and conceptual), models, facilities and environments. Reflective questioning in line with the conversation was employed as prompts, when needed. Each subsequent question took its lead from the nature of the conversation as shifts occurred. A thread of a previous discussion theme was caught to connect to another. An example of this approach was when Wilson spoke of encouraging a climate of risk-taking in his creative work he introduced the significance of an emotionally safe working environment. He reflected on the part "his thinking place, his studio under the puriri tree" played in his practice, (McGlashan, 2011, p. 253). This method of research enabled a building of "complex, multi-layered profiles of verbal and non-verbal data" (p. 241). Participants were given a copy of the interview transcript and supporting collected material to verify the content. Case study findings were then compared to identify key events within each practice. Findings were presented as separate elements, to represent the unique nature of each shared design story, no formal quantitative analysis was undertaken.

Findings

Conversations with the designers revealed the rich scope of their practice, with numerous points relevant to a creative pedagogical approach. The designers' stories gave insight into the way they approach their creative design projects. The material provided much that can be transferred to learning in design and technology. The research also gave valuable insight into each designer's underlying philosophies. The nature of their daily practice observed by McGlashan (2011) was developed "through a wealth of design experiences [which] was evident as a way of seeing, perceptive reflection-in-action and constantly challenging the familiar" (p. 259).

The key events have been clustered under broad headings common to the designers' processing, they have each provided focus for subsequent research. Key events identified were the design project origin, environment, times of immersion, and influences to ideation. Events noted are not intended to infer a hierarchy or chronological order, they are the events remembered and recorded as they occurred.

Nature of design project origin

The designers did not refer to any one way to go about design. Rather, the nature of each project dictated the way ahead. While discussing the origin of a design task, Trubridge said that his projects begin with "a thread or an idea, that has come from something else that has already been developed." He also emphasised the part of *play,* where "I was just playing with the material for the fun of it, and out of the play will come a whole fresh thing" (McGlashan, 2011, p. 247).

Creative working environments

Poole and Wilson described their deliberate preparation of a creative space to encourage and inspire innovative responses. Wilson spoke of his studio as a temple, a place that he had made safe, where he could think. When speaking of his company human and physical resources, Poole spoke of a selected group of different thinkers. He also described a planned creative environment and culture to think and work in. To build a creative company within that environment, he likened it to a family where both a

collaborative and individual approach is nurtured, where the approach is as varied as the nature of each project.

Times of immersion

Trubridge spoke of the need to clear his mind at the beginning of a new design focus. He noted that time spent in the mountain range behind his town where he separates himself from the cares of every day. He spoke of being in a natural wilderness environment where he can actively prepare for a time of immersion. All affirmed the need to become at one with/in the theme of the focus task. Wilson explained to McGlashan (2011) that he listened to music to fill himself "with imagery and inspiration from other sources as well. It might be "nature, going out into the reserve behind my studio and looking at the puriri or noticing something that I hadn't noticed before...it could be the form of a flower" (p. 252). It is a time where he allowed himself to *really observe.* Wilson also reflected on his work as a creative designer where he saw that to work "creatively is a privilege, like being in a constant state of metamorphosis. It has a timeless quality that deepens my appreciation of the gift of life…. When I get it right, the work takes on a life of its own."

Influences on ideation

When speaking about maintaining a creative approach throughout his practice, Trubridge commented to that the prepared mind was open and accessible to "serendipitous moments when one is not consciously working on a project, something comes along and presents itself, pushing thinking on to another plane" (McGlashan, 2011, p. 248). He spoke of being able to walk away from a project to come back to it at a later date to see something new that he had not seen before.

Further significant events were evident in the designers' accounts of their creative practice. Some events were common to all or specifically mentioned by an individual designer. These include *framing the question, asking better questions, internal and external dialogue, sentiency* and being aware of *the human interface with their environments*, encouraging *a sense of play*, *making observations, decision-making, responding to unexpected outcomes, modelling, testing* and the role of a *dialogic journal for the perpetual capturing and manipulation of thought*.

Reflecting authentic practice in the curriculum

Each event noted in design practice could be transferable to classroom situations to some degree at all levels of learning. The following table offers interpretations of events within creative design practice to inform teaching.

All three designers identified key events within their practice that, when transferred to classroom situations, could nurture curiosity, encourage creativity and enhance learning, and provide focus for effective teacher professional development.

Table 1: Four classroom activities informed by creative design practice.

Design community activity	Classroom practice activity
Creating a supportive learning environment that encourages creativity.	Create a space where young designers feel safe and their ideas are valued. Each class sets, displays and adheres to codes/rules that encourage self-expression without fear of put-downs.
	Consider the natural and artificial lighting, wall and fitting colours to enhance the immediate environment.
	Display relevant images and props that align with the focus theme or topic.
	Provide areas of comfort for student-selected times of withdrawal to gather ideas from contemporary publications and internet.
	Provide music to the theme or to inspire.
Creating a state of immersion in the situation or theme.	Time set aside and planned for learners to 'live in' the narrative or moment in their imagination.
	Music, images and role-play, both at the onset of a design task or throughout to maintain creative focus.
Framing the question.	Provide learning experiences in which students learn to prepare questions using pedagogical taxonomies to ask deeper or different questions of an object, person, idea or environment.
	Prepare resources with generic prompts so that questions may be asked in a range of applications.
Encouraging reflective practice through dialogic journals.	Encourage the skill of immediate capture of all ideas as they arise, through rapid visualization from an early age. This not only provides the student with an outcome to describe and discuss. Students are encouraged to keep their journal nearby for ongoing reflection, thought manipulation and record.

Conclusion

The role of the designer, which may be seen as the human element at the centre of design (and technological) practice, who orchestrates connections and communications, needs to be learned. To prepare for creative practice, there is need to plan for times where the mind can become immersed in a theme and play with a topic to fully identify with the human situation and interface with the task in hand.

How, and at which stage of a learner's development, should such sensitivities and perceptions be introduced? The early learner is receptive to a human interactive approach.

Carson's (1956) observation speaks of actual learner needs, in:

> that it is not half so important to *know* as to *feel*. If facts are the seeds that later produce knowledge and wisdom, then the emotions and the impressions of the senses are the fertile soils in which the seeds must grow. [And it is] important to pave the way for the [learner to] want to know rather than to put him/her on a diet of facts that he/she is not ready to assimilate. (p. 45)

The ideal situation would be to develop creative problem-solving skills in early learners through the learning area of Technology. The Technology learning area offers a most fitting environment to introduce a way of learning through inquiry towards *knowing through thinking and doing* (Sharma and Poole, 2010). Recognition of the place of creative design at the core of learning about Technology at best proffers a diverse and flexible approach to student-centred problem solving. The subject Design and Visual Communication provides the opportunity as a separate subject at senior levels of learning in New Zealand. Such a learning environment where students could develop tacit knowledge of the ways of design to mirror creative design practice, would prepare students for future careers in the broad field of design. Our current secondary school climate of non-integrated learning, requires a separate subject where undiluted, faithful coverage of the ways of design is assured. This will eliminate the dilution that occurs when the key content of a subject (design) is lost within the curriculum and assessment demands of another (Technology).

Furthermore, innovative programming could see the creative design approach as a thread to link or dissipate the silo segregation of secondary school learning, where at present each subject has its own seemingly sacrosanct time-table slot. A flexible approach to time-tabling with collaborative planning could encourage a pedagogy that worked across subject boundaries to provide creative problem solving opportunities for all learners.

Affilliation

Ann McGlashan
Senior Lecturer
Technology and Design and Visual Communication in the Postgraduate (Primary) and Diploma of Teaching (Secondary).
School of Curriculum and Pedagogy
Faculty of Education,
The University of Auckland
a.mcglashan@auckland.ac.nz

References

Baynes, K., (1989). Beyond design education. *Journal of Art and Design Education*, *1*(1), 105-114. Retrieved from http://onlinelibrary.wiley.com.ezproxy

Beeby, C.E. (1992) *The biography of an idea: Beeby on education.* Wellington, New Zealand: The New Zealand Council for Educational Research.

Carson, R. (1956). *The sense of wonder.* New York, NY: Harper & Row.

Cross, N. (2001). Designerly ways of knowing: Design discipline versus design science. *Design Issues, 17*(3), 49-55. Retrieved from http://www.jstor.org.ezproxy.auckland.ac.nz/stable/1511801

Gregory, S. A. (1966). *The design method*. London, England: Butterworths.

Hope, G. (2009). Beyond knowing how to make it work: The conceptual foundations of designing. *Design and Technology Education: An International Journal*, *14*(1), 49-55. Retrieved from http://jil.lboro.ac.uk/ojs/index.php/DATE/article/viewFile/200/175

Kimbell, R., & Perry, D. (2001). *Design and technology in the knowledge economy*. London, England: Engineering Council.

Johnsey, R. (1998). *Exploring primary design and technology*. London, England: Cassell.

Kelley, T. (2001). *The art of innovation: Lessons in creativity from IDEO, America's leading design firm*. New York, NY: Random House.

Lawson, B. (1997). *How designers think: The design process demystified* (3rd ed.: rev.). Oxford, England: Architectural Press. Retrieved from http://www.informs.org.ezproxy.auckland.ac.nz/

Mc Glashan, A. (2011). Designer stories: A commentary on the community of design practice. *International Journal of Technology and Design Education*. *21*(2), 235-260. doi:10.1007/s10798-010-9116-6

Mc Glashan, A. A., & Wells, A. W. J. (2013). The road less travelled: A pre-service approach towards the technology teaching profession. *International Journal of Technology and Design Education*, *23*(4), 939-952. doi:10.1007/s10798-012-9218-4

Mawson, B. (2001). Beyond design: A new paradigm for technology education. Paper presented at the *Australian Association for Research in Education Conference,* Fremantle, WA, Australia. Retrieved from http://www.aare.edu.au/01pap/maw01574.htm.

Mawson, B. (2003). 'Beyond 'The Design Process': An alternative pedagogy for technology education. *International Journal of Technology and Design Education, 13*, 117-128.

Ministry of Education. (1995). *Technology in the New Zealand curriculum.* Wellington, New Zealand: Learning Media. Te Kete Ipurangi. Retrieved from http://www.tki.org.nz/e/community/technology/

Ministry of Education. (2007). *The New Zealand curriculum*. Wellington, New Zealand: Learning Media. Te Kete Ipurangi. Retrieved from http://www.tki.org.nz/e/community/technology/

Moustakas, C. (1990). *Heuristic research: Design, methodology, and applications*. Newbury Park, CA: Sage.

National Advisory committee on creative and cultural education. (1999). *All our futures: Creativity, culture and education*. Wales, England.

Norman, E. (Ed.). (2009). Models of change: The impact on designerly thinking on people's lives and the environment. *Design and Technology Education: An International Journal*, *14*(2), 3–6. Retrieved from http://ojs.lboro.ac.uk/ojs/index.php/DATE/article/view/243/183

Parry, I. (2011). Design and technology forum. *Designing, 88,*(Spring), 24-25.

Rutland, M. (2009) Art and design and design and technology: Is there creativity in the designing? *Design and Technology Education: An International Journal, 14*(1), 56-67. Retrieved from http://ojs.lboro.ac.uk/ojs/index.php/DATE/issue/view/34

Schön, D. A. (1983). *The reflective practitioner: How professionals think in action*. New York, NY: Basic.

Scrivener, S.A.R. (2000) Reflection in and on action and practice in creative-production doctoral projects in art and design. *Working Papers in Art & Design* **1**. Retrieved from http://www.herts.ac.uk/artdes1/research/papers/wpades/vol1/scrivener2.html

Sharma, P., & Poole, D. (2010). It's not what design is, it's what design does. *The Design Management Institute, 20* (4), 64-74. doi:10.1111/j.1948-7169.2010.00038

Spendlove, D. (2010). The illusion of knowing: Towards a curriculum of unknowing. Proceedings of the *Technological Learning and Thinking: Culture, Design, Sustainability, Human Ingenuity conference* at the University of British Columbia, Vancouver. Retrieved from http://www.learningcommons.net/

Wenger, E. (1998). *Communities of practice: Learning, meaning and identity.* Cambridge, England: Cambridge University Press.

[1] *Communities of Practice* are seen by Wenger (1998) as those where three key dimensions of mutual engagement, joint enterprise and shared repertoire are present.

[2] *Indicators of Progression* - developed initially as a means to gauge a learner's progression through levels of learning, they have been adapted to provide guidance to programme content and planning at all levels of learning http://www.technologyonline.org.nz/curriculum-support/index.htm.

[3] The Learning Area of Technology in the NZ Curriculum has as its structure three strands: *The Nature of Technology, Technological Knowledge* and *Technological Practice.* Coverage of these strands and their components in school programmes is said to develop Technological Literacy in students. http://www.technologyonline.org.nz/curriculum-support/index.htm.