DESIGN, TECHNOLOGY AND INNOVATION

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1 Introduction

The theme of innovation is everywhere these days – in magazines, books, articles, conferences, websites and government direction and policy. To innovate, being innovative, and innovation are all processes that have been integrated into industry thinking, education and government policy. The single most decisive factor in influencing a country's living standard is economic growth. The engine of this growth, above all else, is innovation – almost regardless of other economic factors. This innovation, along with the knowledge development and management that drive it, are the building blocks of an information society and a knowledge economy.

1.1 Australian Context

In the State of Victoria's Department of Education and Training's Blueprint for Government Schools: Future Directions for Education 2004 report, the first Flagship Strategy of Student Learning outlines the need to achieve the vision of students to be active, lifelong learners by ensuring that schools are places where students develop:

- a positive attitude towards learning;
- fundamental skills in literacy, numeracy and self-expression, which will enable them to be successful across all areas of learning;
- high level personal communication and social competencies to work independently and within groups;
- experience in innovation, creativity and problem solving;
- confidence to deal with technological and cultural change;
- skills sets in the wider community and changing workplace; and
- ability to assess information and reflect on it.

The importance of innovation and creativity as an educational cornerstone is highlighted in the Curriculum Victoria: Foundations for the Future March 2004 report as one of four key elements of a 'best practice' curriculum:

- equity and inclusiveness;
- the encouragement of innovation and creativity;
- clarity and focus in content specification; and
- assessment for learning.

The Victorian Curriculum Reform 2004 Consultation paper: A Framework of 'Essential Learning' found that students need to leave schooling with a broad range of high-level skills which they can apply creatively to the real world. The report goes on to state that the curriculum must recognise that the structure and meaning of work has changed significantly since the 1970s: students are no longer preparing for one career in life, ICT is pervasive and the economy is increasingly based on service or 'knowledge' industries.

Social and economic progress in Australia, not only in Victoria, will increasingly depend on active people with the capacity to solve problems, to create and to generate new and better ways of doing things. At all levels, our society will require creative individuals able to communicate well, think originally and critically, adapt to change, work cooperatively, and remain motivated when faced with difficult situations (Agenda for Action, 2003).

Victoria's future as a leading innovation economy depends upon its ability to educate not only designers, but also the users and purchasers of design products and services. Education needs to better equip Victorians with the flexibility, creativity and adaptability to respond to the opportunities and challenges of a rapidly changing technological society.

1.2 Definitions

Design can be seen as a vital step in transforming ideas into creative, practical and commercial realities. Design optimises the value of products and systems and is therefore an important key to economic, social and cultural development. Other very narrow definitions of design from the Concise Oxford Dictionary include: a mental plan; a scheme of attack; an end in view; an adaptation of means to ends; a preliminary sketch for picture; and an invention. Design also involves planning and organising production, and evaluating products in a real context.

Design does not necessarily require a product that can be seen or touched, design can be conceptual and/or practical and it can be real and virtual. "Design is both a noun and a verb, and has multiple senses. As a noun, it denotes a field as a whole, an end product or a thing – a designed object or entity – as well as a concept or proposal. As a verb, design denotes an action or process" (Barnacle, 2003). Digital design is the intersection and integration of digital technology with the design process and across the many disciplines of design, including architecture, engineering, new media, industrial and product design.

To be innovative is to do something different, to explore new territory or to take a risk (Lynch, 2001), while technology has been defined as "human innovation in action" (Raisen, 2003). The critical element of being innovative is newness and thus, creativity is frequently linked with innovation. Creativity has been defined as "the application of knowledge and skills in new ways to achieve a valued goal" (Agenda for Action, 2003). Innovation can often be seen as an outcome of the broad exploration of ideas, materials, and technical processes that can occur during the design process.

Technology refers to the equipment and processes used to enhance, maintain and modify the environment and resources in order to support human endeavour. It involves the purposeful application of knowledge, skills, equipment, materials, energy and data to create useful products. Technology is also about evaluating and modifying practical outcomes.

> Technological literacy has been defined by the Australian Academy of Technological Sciences and Engineering as: 'the synthesis of knowledge, ideas and skills in the

solution of identified problems and the development of innovative capabilities. In its focus on synthesis, design and invention, it embraces creativity across the full spectrum of a student's learning. In a real sense, this synthesis places technology education as a significant integrating force within schooling. It is learning through practice. It is often practiced through group or team activities and with the objective of finding solutions that are culturally and environmentally informed. It is about 'design, build and appraise' …about matching materials to purpose …about studying, disassembling the working elements of equipment and systems…it is about 'making and doing'.

<div align="center">(Agenda for Action, 2003, p. 26).</div>

From all of these definitions it is clear that design, technology and innovation are intrinsically linked. The current world of work and global economies demands that workers become innovative, lifelong learners who are able to use a wide range of information and communication technologies. Design is pervasive in everything that we do and make. Education providers have to be able to support enterprises by developing 'designerly' ways of thinking and nurturing creativity in their students.

2   Approach

Traditional classrooms continue to provide the most economic and systematic way of educating young people. However, in order to encourage young people to generate new ideas, learning contexts should be diverse, so as to evoke and capture student imagination. Schools must create entrepreneurial attitudes to learning so that there are spaces created in which students can incubate their ideas and share their results beyond the walls of the classroom. These innovative ways are not necessarily in a physical location; at times, the space to innovate will be found within a changing mindset.

The first element required in innovation is the desire to do something differently. There needs to be a reason to change the current way of working, or a challenge that needs to be addressed. Once it has been accepted that there is a challenge then a creative approach to the solution is the next element in practicing innovation – if a solution is not creative then there is no innovation (Lynch, 2001).

Creativity can sometimes occur spontaneously but usually it needs to be stimulated in some way. Creativity and collaboration can work well together since the more people involved in finding a solution, the more chances there are of new ideas and new possibilities being identified.   The essence of collaboration is bringing a group of people together so that they can accomplish something collectively that could not have been done independently (Austin & Baldwin, 1991).

In a society where the speed and capacity of change is so great it is now time to move away from a content-dominated curriculum. It is essential that students respond to big ideas and big questions. Through hypotheses, students are challenged to create learning contexts that draw on and create a body of knowledge through which learning can be constructed and exhibited using contemporary learning tools so vital for access, acquisition and application of knowledge.

Design based learning focuses on the learner's discovery through self-awareness, motivation, relevance and action. Thinking about design is rarely implemented in schools and yet design

literacy should underpin all ages and stages of learning, be it the study of poetry in grade five, mathematics in grade twelve, art studies at TAFE or engineering at university. Design literacy is about creativity and an ability to integrate ideas: for example, how learning relates to teaching, music relates to mathematics, art relates to science and nanotechnology relates to architecture.

The key to producing better outcomes for students is an understanding that:

> If students are to learn desired outcomes in a reasonably effective manner, then the teacher's fundamental task is to get students to engage in learning activities that are likely to result in their achieving these outcomes . . . It is helpful to remember that what the student does is actually more important in determining what is learned than what the teacher does.
>
> (Shuell, 1986, p. 429)

What learning is, how learning actually takes place, and the characteristics of learners should be major considerations in the design and development of teaching and learning environments (Longstreet & Shane, 1993). We all hold views, however unconsciously they may be, of how learners learn, and this affects how we design and develop courses and programs.

Collaboration is a pedagogical style that emphasises cooperative efforts. What this implies is that learning is inherently social in nature and stresses common inquiry as the basic learning model (Austin & Baldwin, 1991). A key element in collaborative learning is its perspective that knowledge is socially constructed and as a social construct it belongs to and emerges from communities.

Knowledge is not transmitted or poured into students but rather emerges from the ongoing dialogue and social interaction within groups. Knowledge created in this way is more than the compilation or summation of each individual's knowledge (Austin & Baldwin 1991).

The constructivist approach sees learning as an active process whereby learners construct new ideas or knowledge based upon their past and current knowledge. It is learner centred and outcome focussed. The learner selects and transforms information, constructs hypotheses, and makes decisions based on a cognitive structure. This means that learning is an active process, learners actively seek and generate relationships between lesson content and prior knowledge (Rieber, 1996). How the student learns is the focus of innovative teaching and learning. Innovative learning leads to students as learners, communicators, creators, designers, problem solvers and researchers. These roles are not mutually exclusive but are meant to overlap and interconnect. Developing a sense of a learning community is an integral component of ensuring that we meet the educational needs of students. A learning community values learning; enhances understanding of being an educator and a learner; focuses on action; and encourages collaboration, cooperation and collegiality.

2.1   Lab.3000

Lab.3000 – innovation in digital design is building, connecting and promoting the value of design in the State of Victoria in Australia through the integration and collaboration of design practitioners, industries, design professionals, ICT specialists, and tertiary institutions to foster innovation and enterprise. Funded by the State Government of Victoria and hosted at RMIT University in Melbourne, lab.3000 aims to position Victoria as a world leading centre

for digital design and a hub for the intellectual and creative talents that underpin the growth of an innovation economy.

Lab.3000's core business is conducted via three entities: the Business Bureau, the Tertiary Bureau and the Education Incubator. These entities have enabled lab.3000 to develop a more dynamic relationship between design professionals, manufacturing and new media industries and the strategic management of student innovation across the tertiary sector. Given the emerging need to build business expertise in the commercialisation of innovation, the goal is to create a Business and Tertiary Bureau to meet the specific needs of entrepreneurial students and emergent industries.

The lab.3000 Business Bureau and Tertiary Bureau have been influenced by a number of international tertiary sector models that successfully promote and enable industry development and technology transfer: the Arabus Model Helsinki and NovaUCD Model (an industry centre at University College, Dublin).

Lab.3000 has developed the Education Incubator in response to the Victorian Government's commitment to its Innovation and Design agendas and to articulate the goals, vision, objectives and targets of the Blueprint for Schools report through innovative design thinking and practice. This paper focuses on one specific entity - the Education Incubator. Victoria's first education incubator is a place where ideas can be tested, piloted, refined and brought to life.

2.2 Education Incubator

The Incubator is a highly creative learning environment where students discover the challenge and creative opportunity offered by digital design techniques and applications. Students engage in their own learning within a large open place space housing modern computer pods, thinking space and the latest innovations in digital software. Students are encouraged to explore their creative potential and engage in the many dynamic possibilities that are offered by a career in digital design. A few examples of student projects are the design of new footwear, a new line and style of jeans, digital graffiti, and new computer games.

Today, one of the most powerful aspects of working in a digital environment is the collaboration that comes naturally when students and staff are sitting side by side sharing something that has been written or drawn, programmed or accessed on-line. Today's collaborator and team member could easily have been yesterday's cheat. It is the process that the students' have engaged in as much as the outcomes that are important. The relationship between learning and evaluation is reconsidered in a constructivist view. Constructivists prefer to focus on outcomes that naturally emerge from the learning experience. Therefore, it is more important to understand the journey rather than the destination (Rieber, 1995). The move towards digital work has only increased the differences required of assessment strategies for student work. This is applicable across all levels of education from elementary school through to post graduate work such as online doctorate theses. Institutions and organisations are continuing to struggle with this assessment issue.

Learning contexts should be diverse to evoke and capture student imagination. The pedagogy that underpins this process needs to focus on the development of students' ability to diagnose, simulate, problem solve, negotiate, construct, work in teams as well as assuming leadership roles, to explore new ideas and exhibit their understanding. A definition of a learning environment is "a space where the resources, time and reasons are available to a group of

people to nurture, support, and value their learning of a limited set of information and ideas. Learning environments are social places even when only one person can be found there." (Reiber, 2001).

In many schools, educators and government leaders are so intent on content and information transfer, they lose sight of the importance of the learning context. Innovation and creativity demands that we create time, space, and exploration of intersecting ideas and wide ranging influences. The opportunities for learning which allow intersection and interaction are diminishing and "fact stuffing" wins out. The key concept of constructivism is that the learning focuses on problem-based scenarios, project-based learning, team-based learning, simulations and the use of technology resources (Jolliffe, Ritter, & Stevens, 2001).

The image of a chicken breaking through its shell is perhaps the most evocative image of an incubator. Over the past fifteen years, incubators have sprung up in the most surprising places. They are places where ideas can be nurtured in a space where for the time commercial benefits do not dominate the thinking process. Once the idea has matured then it is time to test its commercial viability.

The Incubator environment is a place for learning that defies the traditional instruction, content-based approach to teaching and learning. The following physical and attitudinal elements are essential to ensure students can experience their capabilities:

- Create space where construction can be real and virtual
- Employ teachers who are risk takers and facilitators
- Create possibilities
- Use digital learning tools including design based software (Micro Worlds, Web construction, CAD, animation tools and peripherals)
- Access industry and higher education
- Visit diverse design/creative environments
- Explore unique combinations
- Encourage students to explore unfamiliar mediums and integrate these
- Permit experiments over and over
- Cultivate vitality and momentum
- Use multiple approaches
- Represent ideas graphically
- Plan strategically
- Build teams
- Design assessment pedagogy

As Rieber (2001) points out a "person's interest in school learning rarely compares to the commitment that characterizes their learning outside of school". A learning environment can be created that enables people to devote effort and emotion to a task. The Digital Design Incubator has created such a place. "Play is a suitable and respectable way to describe intense and meaningful adult learning" (Rieber, 2001). The Incubator is an open plan facility with different spaces for the students to use during their time. There are modern computer pods, quiet spaces, meeting areas, conversation areas for food and drink, small group work areas, and presentation spaces.

2.3   Educational Programs

When new programs and opportunities for learning become available, learning how, when and where to use them often becomes a process of trial and error. Digital design literacy is critical for teachers as well as their students. There needs to be an avenue whereby teachers, industry professionals, and community groups can access resources and tools that can assist learners in developing design capabilities. Professional programs are developed in consultation with teachers, industry and community groups in response to the unique and changing curriculum needs of schools and the constantly evolving nature of design. Participants become learners, working with highly experienced and skilled educators and mentors, delivered through the lab.3000 Professional Development program.

The Visiting Schools Program is designed to meet the needs of individual schools or school clusters across the State, and are conducted for small groups of students and teachers. Each program is unique whereby digital design techniques are integrated into the chosen theme or approach. For instance, one current project is developing around water and conservation, which is contextual since the State of Victoria has been experiencing a severe drought and most areas are on different levels of water restrictions. There are currently over eighty students from a cluster of schools participating in programs.

The Once Upon a Time – Digital Storytelling program is a highly interactive educational program that excites the imagination and lends a strong personal voice to individuals. Once Upon a Time provides the tools and methodology through which students can assume the role of narrator to offer a glimpse or insight into their own personal world. The flexible and dynamic nature of digital storytelling, which encapsulates aural, visual and sensory elements, utilises the multitude of cognitive processes that underpin learning - from Verbal Linguistic to Spatial, Musical, Interpersonal, Intrapersonal, Naturalist and Bodily-Kinaesthetic.

Summer and Winter Schools are available to students of all ages who are eager to explore digital technology in an immersive and creative playing field for learning. Students use digital technologies to enhance their understanding of digital design through programs exercising analytical and simulation skills. Teachers in training and experienced educators can also benefit from the interactive group learning activities.

2.4   Outcomes

At the heart of the Incubator programs is creative expression and appreciation. By inviting a range of educators, artists, architects, animators, and curators into the Incubator, many students who have become disaffected with traditional and predictable pathways have a chance to learn, and grow and in time mentor others. Visitors and guests to the Incubator over the past two years have included an animator from the movie series Lord of the Rings, architect, small business owner in web design, photographer, graphic artist, games developer, and multimedia developer. When these visitors come they work directly with the students on their projects and have made themselves available for ongoing electronic communication with the students.

As Richard Florida states, "creativity is a broad social process and requires teamwork. It's stimulated by human exchange and networks; it takes place in real communities and places." (Florida & Tinagli, 2004, p. 11). The incubator is the place where students go to communicate, collaborate, be excited and create. It is a place that is safe, where divergent thinking and continuous try-outs are the way.

By bringing students together in a context where subjects do not bind them, they are able to wrestle with ideas across cultures, music, art, mathematics, science, technology and so on where a vast array of concepts could and do emerge. The common link for the students in the Digital Design Incubator is that they are learning and applying their learning on their own projects using a variety of digital tools and concepts.

Educational environments today have flexible tools with the potential for everyone – students and teachers to learn alongside each other. Multimedia or multiple-media has become the learning currency. Students can draw upon a wide range of digital resources, and interpret and exhibit via their own website, a place where their current project is being constructed. Within a digital school environment, the only limit to the learning is the imagination, capacity, motivation and access to contemporary technologies.

Unlocking the potential of learners as designers is premised on the shifting role of the teacher from instructor to facilitator. As a facilitator, the teacher can help unlock student design by using learning technologies and questioning strategies that explore different ways of looking at a problem, and by encouraging children to explore the unfamiliar. Such a curriculum is based on productive thinking where problems are explored by asking, "How many different ways can I look at this? How can I rethink the way I see this and what designs can I come up with?" Productive thinking can lead to various designs via multiple approaches. Teachers can encourage children to design by giving them the freedom to think, argue, make mistakes, go to different places and find ways of finding solutions rather than grasping the first seemingly correct answer.

Students who have participated in the educational programs at the lab.3000 Education Incubator have found their experiences to be rewarding, particularly for the freedom that it allowed them in bringing their creative talents to the program.

The different learning environment in the Incubator and its subsequent impact on learning styles has made significant changes for the students. As students have stated:

- I am able to think more creatively
- I've had to make a few big changes to my way of thinking
- A program like this is so different from what I'm used to
- Since I started coming here, I have found that I haven't been in as much trouble as I was in at school
- I've concentrated a lot more compared to when I was at conventional school
- Just more confidence
- It has made me look at the digital design industries totally different
- I have a better understanding of digital design
- The program has made me a different person
- I have benefited much more from this program and all my friends think so too.

The State of Victoria in Australia has earned an excellent reputation for its initiatives in education both nationally and overseas. However, it is clear that the prevailing paradigm for learning is defined by pedagogies and regulations that do not challenge students. It is time to change the face of learning.

Digital schooling is at the centre of the revolution of learning; however, it is not just about computing technology. Digital schooling requires a commitment to preparing our children for

their futures and ensuring that schools are places where children love to go. The Education Incubator is such an environment.

3   Conclusion

The Education Incubator was established to provide both a real and virtual space for young people to collaborate. It is a dynamic place where some students come and go and others stay. The Incubator is a space where individuals can express their creativity, explore new ways of thinking and find new ideas through the collision of the unfamiliar. If innovation means to bring into relationship, that which has not been previously related, then the Incubator provides an unique place where new approaches to teaching and learning are being experienced and shared.

For individuals to explore new possibilities and opportunities, sometimes they need to be in a 'space' where there is permission to be different, to experiment by bringing together ideas that do not normally relate.

The experiences gained in lab.3000 have direct relevance to engineering design education. Social and economic progress will increasingly depend on active people with the capacity to solve problems, to create and generate new and better ways of doing things. Design conceives and defines all the means we employ to satisfy our many intricate needs. It covers our cities, factories, hospitals, schools and houses, together with all those products we use within them.

References

[1]   Austin, A. & Baldwin, R., "Faculty Collaboration: Enhancing the quality of scholarship and teaching", ASHE-ERIC Higher Education Report No. 7. Washington, D.C.: The George Washington University, School of Education and Human Development, 1991.

[2]   Barnacle, R., "Mapping Design Research @ RMIT", Prepared for Pro Vice Chancellor (Research & Innovation), October, RMIT University, Melbourne, AU, 2003.

[3]   Commonwealth of Australia, "Australia's Teachers: Australia's Future, Advancing Innovation, Science, Technology and Mathematics. An Agenda for Action", Department of Education, Science and Training, Canberra, AU, 2003.

[4]   Florida, R. & Tinagli, I., "Europe in the creative age", Alfred Sloan Foundation, DEMOS, 2004.

[5]   Jollife, A., Ritter, J. & D. Stevens., "The online learning handbook: developing and using web-based learning", Kogan Page, London, UK, 2001.

[6]   Longstreet, W. Shane, H., "Curriculum for a new millennium", Allyn and Bacon, Needham Heights, MA, 1993.

[7]   Lynch, G., "Towards Innovation", Executive Excellence, 18 (8), August, AU, 2001.

[8]   Raisen, A., "An Analysis of the Technology Education Curriculum of Six Countries", Journal of Technology Education, 15(1), 2003, p. 29- 47.

[9a]   Rieber, L., "Designing learning environments that excite serious play", Annual meeting of the Australasian Society for Computers in Learning in Tertiary Education (ASCILITE), Melbourne, AU, 2001.

[9b]   Rieber, L., "Seriously considering play: Designing interactive learning environments based on the blending of microworlds, simulations and games", Educational Technology Research & Development, 44(2), 1996, 43-58.

[9c]   Rieber, L., "Using computer-based microworlds with children with pervasive development disorders: An informal case study", Journal of Educational Multimedia and Hypermedia, 4(1), 1995, 75-94.

[10]   Shuell, T., "Cognitive conceptions of learning", Review of Educational Research, 56, 1986, 411-426.

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