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Enhancing Creativity through design technology: opportunities for developing children’s creative thinking

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ABSTRACT

INTRODUCTION

Walking through the corridor the other day, a colleague said to me, “I tried to improve the children’s creativity by teaching them all the De Bono’s thinking strategies, but it didn’t work”. He was absolutely right. Research has shown that just teaching people ‘thinking’ skills doesn’t guarantee enhanced creativity. So.... the question is, “Can creativity be taught?” This chapter will describe a number of strategies which enhance children’s and people’s ability to be more creative. There is not one easy solution, but a number of approaches which, when taken together, provide opportunities for improved creative thinking.

Creative or innovative thinking is defined by Sternberg and Lubert (1999) as “the ability to produce work that is both novel (original, unexpected, imaginative) and appropriate (useful, adaptive concerning task constraints)”. It is thinking that leads to new insights, fresh perspectives, different ways of understanding and conceiving of things. Often creative products are obvious: music, drama, poetry, inventions, and technical developments. However, creative thinking can also lead to different ways to ask a question which expand the opportunities for solutions or viewing people in a different way, challenging status quo and leading to alternative solutions. In the application of creative thinking, people are said to be using their imaginations, being purposeful, using original thought and developing ideas/items which are of value in some way to someone (Barlex, 2004, p25).

Creativity, or the ability to think creatively, is a highly prized skill in our modern society. So much so that commercial enterprises, businesses, governments and various institutions are seeking ways to enhance the creativity of the people in their employ (Keirl, 2004, p80). In 1999, the English Government report “All Our Futures: creativity, culture and education” (Robinson, 1999) stressed the need for a national strategy for creative and cultural education to “unlock the potential of every young person”. Barlow (2004, p38) identifies that “ linking innovation, educational outcomes and economic development continue to emerge as priority policies of governments both nationally and internationally”. It is clear from the plenitude of reports and papers in the last decade, that creativity or the ability to think creatively is valued in many ways by various agencies and individuals within our society.
Guilford (1963) indicates that the thinking process is both divergent (generative, moves in many directions, can make jumps, seeks richness lives with uncertainty and need not be right at every step) and convergent (selective, sequential, following a prescribed path and seeks the right answer). Both forms of thinking are required for creativity to occur. More recent research by Howard-Jones (2002), Cropley and Cropley (2000) and others have sought to define the thinking processes and to offer strategies to enhance various thinking skills. In this chapter we theorize about how design technology can provide opportunities for children to develop their creative thinking skills.

**Creativity in Education**

*Creativity now is as important in education as literacy, and we should treat it with the same status.*

Robinson, 2006

Barak (2004) commented that “the development of higher intellectual skills is one of the central aims of education in general”. These thinking skills encompassed cognitive skills such as logical thinking, creative thinking and problem-solving abilities. In more recent years, school education has had a focus in the development of higher order thinking skills in students. The “thinking curriculum” presents alternative ways of teaching, with the focus on the child, rather than the content (Brooks, 2004; Chin & Chia, 2004; Meece, Herman, & McCombs, 2003). Educational bodies (such as the Department of Education and Training, 2004) promote and support teaching methods that incorporate higher order thinking and student-centred learning. Student-centred learning, student independence and autonomy, have been found to be strong factors in students’ self-motivation, learning and creative thinking (Campbell & Tytler, 2006; Rannikmäe & Laius, 2009). Prentice (2000) also links other personal qualities (or learning dispositions) which he attributes to human creative capacity. He includes: risk-taking and exploratory behaviour, a sense of curiosity, ability to tolerate uncertainty, concentration, perseverance, self-motivation, determination to succeed, flexibility and adaptability. In other studies (Isaksen, 1994; Howard-Jones, Taylor, and Sutton 2002) it has been suggested that play and humour are also related to increased creativity. The reasons for this were not clear in the research but it is proposed that a more relaxed mental state may be the reason for an increase in creativity.

Creative problem-solving is considered to be an integral component of technology education in schools (Barak & Goffier, 2002; Hill, 1998). Peterson, (2001) comments that “Creativity is closely associated with advances in technology, and it is logical that an important aspect of technology education is the development of creative abilities”. He continues his discussion with a recognition that creativity in technology education relates to students being actively engaged in creating novel products and solutions to technological problems. The broad range of topics and the versatility of approaches that can be included within the technology classroom provide a range of opportunities for the technology teacher to implement programmes consistent with the higher order thinking skills – in particular both analytical and
creative thinking. A structure that employs a careful balance between content knowledge and process (Jones, 1997) but also successfully incorporates higher order thinking should be implemented within the technology classroom (Middleton, 2005).

In the technology process, it is through the imposition of the unsolved problem that stimulates the thinking student to discover a viable solution to satisfy a human and/or environmental need. This aspect of the technology process suggests that the learner seeks innovation in a practical context. Creative and analytical thinking support cognitive processing in the context of student problem-solving and therefore are compliant in sustaining the development of the technological knowledge, skills and values (Howard-Jones, 2002).

In technology education, with the guiding design-research question or design brief provided to students, we can suggest, through anecdotal accounts, that hands-on open-inquiry build children's ability to think. Knodt (2009), in discussing the cultivation of curious minds, states “not only does such a program approach inspire curiosity and innovation, it becomes a joyful time and place to share with children. Indeed, open-inquiry sets the pace and spirit for innovation”. She quotes one student as saying, "Your mind opens up and you want to do all these different things!"

The BIG question - Can creativity be taught?

In seeking an answer to the question above, we initially sought previous research relating to the fostering of creative thinking. One of the earliest recorded discussions on creativity occurred nearly a hundred years ago. Wallas (1926) in his classical study, highlighted several factors which he considered necessary for the development of creativity. These were: the preparation stage when information was gathered, an incubation stage when information was processed internally, the inspiration stage when a solution was developed and the evaluation stage when the solution was verified (Peterson, 2001, p7). Since then, many others have added insights into the creative process and new models have emerged, although many are similar (Pseck, 1996). Plesk (1996) listed these in a paper reviewing creativity models and included Rossman (1931), Osborn (1953), Campbell (1960), Kobarg and Bagnall (1981), Isaksen and Trefflinger (1985), Bandrowski (1985), Simonton (1988), Barron (1988), Fritz (1991) and Parnes (1992), just to name a few (but not all). Obviously the idea that creativity can be taught or enhanced through the application of a model is one which is strongly supported through these earlier proposed representations. Barak (2004) stated that to promote the generation of ideas, lateral thinking skills (such as advocated by Edward De Bono), mind-mapping tasks and brainstorming all assisted in people developing new ideas. Using focused thinking and well-defined criteria which aid in the early judgement of ideas can also lead to enhancement of creative solutions to problems.
Schofield (1996) conducted empirical studies around teaching creativity. He considered teacher attitudes towards innovative change, examined the effectiveness of teaching for creativity, measured the creative response in an applied technology context and sought reasons for variation in response to the measurements and tasks. His research was comprehensive in that he assessed a total of 194 pre-service teachers across four different studies using control groups and pre and post testing procedures. His first group were given opportunities for active experimentation with new technology to see if it enhanced their ability to devise solutions of problems. *He determined that this did not improve their creativity.* His second group were trained in De Bono’s CoRT Thinking program and then checked for their ability to devise a solution to a specific design task. He assessed levels of flexibility, fluency, originality, practicality and reflectivity. *Again he determined that the thinking program had not impacted on their creative thinking abilities,* although it was postulated that it may have been the ability to ‘transfer’ thinking skills from one situation to another which may have been problematic. The third group were treated to eight skill development lessons with a focus on problem-solving. Again, *there was no significant improvement in creative thinking* as measured by the pre and post testing between control and test group. However, the fourth study provided a significant and positive result in terms of enhanced creativity. This study provided students with problem solving strategies linked to specific design tasks and problems within a topic. The trial group significantly outperformed the control group in this situation. *The direct linking of problem solving strategies to specific tasks produced positive results.*

Further research by Howard-Jones (2002) proposed a model of creative cognition for supporting strategies that foster creativity in the classroom. He suggested that when thinking creatively, children generate new ideas through remote associations and brainstorming and this type of thinking is enhanced when attention is allowed to wander in a relaxed and uncompetitive environment. Other researchers (Forgays & Forgays, 1992; Puk, 1995), have also indicated that being involved in unrelated activities have promoted solutions to problems and increased children’s creativity. Larger numbers of initial ideas also increased the likelihood of children developing a more original final solution (such as using brainstorming sessions). To allow the generative state to occur, Howard-Jones (2002) suggested the use of a period of time in which student attention is not focused on the technology task. This time allows the individual to be able to sub-consciously combine concepts and produce novel combinations of remotely-associated ideas. It was this idea of a non-conscious cognitive process (NCCP) time that was tested in a study by Webster, Campbell and Jane (2005) in an intervention program undertaken in primary technology classes. Reflection on that research has enabled the generation of Figure One below that shows how the various contributing factors that precede NCCP time can be brought together to develop enhanced creative thinking. In this chapter we describe the study in order to theorize how design technology education with a built in NCCP time can contribute to children’s creative thinking.

Insert Figure One
Aims of the Research

The overall purpose of the research was to investigate the notion that children’s creativity can be enhanced through the inclusion of a non-conscious cognitive processing (NCCP) time in the technology process. The purpose of the research was two-fold. Firstly, we aimed to explore the structures, relationships and content of the technological experiences at several school settings. This exploration entailed engagement of the interpretive categories of the social, educational and professional values, beliefs and attitudes of the main participants. Secondly, we aimed to study how the children’s creativity was enhanced through the introduction of an intervention strategy – that of NCCP time.

Case study research approach

In our preliminary discussions we decided that a case study approach would be most appropriate as our basic intention was to seek to describe and develop an understanding of the setting and the children’s creativity, rather than for the research to be an active agent in evaluating outcomes or instigating change. Stake (2000, p437) called this an intrinsic case study as ‘it is undertaken because, first and last, the researcher wants better understanding of this particular case’. However, an intervention process was also required, as in discussion with our teacher participants, we realised that what we were suggesting, was something new and different to their normal classroom practice.

Accordingly we developed case studies of each of three sites – primary schools in the state of Victoria, Australia, by gathering data to describe the experiences of the children and teachers, and to illuminate the approaches to learning and the developing creativity. Both the perspectives of teachers and children were sought. Since this interpretive study was ‘bounded’ in both time and space, we identified the case study as the most appropriate research approach due to its capacity to accommodate the complexity of the situation as it actively engages the changing dynamics of the setting and its social aspects (Campbell, 2000, p80). Additionally we recognized the validity and compatibility in this study of Stake’s assertion (Bryman, 2001, p55) that ‘The utility of case research to practitioners and policy makers is in its extension of experience’; and that case studies centre on ‘…research on a single case with a view to revealing important features about its nature’.

Each setting or site we investigated was a ‘bounded system’ in several ways. From the physical perspective, the system is located as a dedicated area and described by the specificity of the technology task within the classroom environment. One school was in an urban area, one in a rural area and the third in a regional centre. Each site is also bounded in that we collected information over a specific period - a snatch in time. The research approach needed to be sensitive to the constraints and opportunities that presented within the research study. Stake (2000) discusses how researchers ‘... aim the inquiry toward understanding what is
important about that case within its own world . . .' and describes the development of the interpretations of issues and contexts as 'thick descriptions' (Stake, 2000, p439).

Reflection on the data enabled us to provide an interpretation of the learning related to enhanced creativity exhibited by the children as evidenced by the technological products they produced within the context of each site. Through this interpretation we seek to 'describe the cases in sufficient descriptive narrative so that readers can vicariously experience these happenings and draw conclusions' (Stake, 2000, p439).

**Participants and research design**

The participants were primary school children and their teachers, situated in three schools across the state of Victoria:

- one metropolitan school (Melbourne)
- one regional school (Geelong area)
- one rural school (Mornington Peninsula)

Two teachers (at year three or four level) from each school agreed to participate in the study and their role was to teach a technology unit across at least four lessons. Surprisingly to us, most of these teachers had no practical experience teaching technology, although they had taught science. Accordingly, professional learning sessions were conducted with the teachers to ensure that they were aware of what classroom technology was in practice. These sessions led to a change in their approach, with most teachers incorporating some form of brainstorming at the start of the process. Another change in practice was allowing the children time during the planning and construction time to 'think through' their ideas and problem-solve with others. As identified in Figure One problem-solving thinking is an important aspect that can lead to enhanced creative thinking.

The study was conducted in an authentic setting – the normal classroom in which children’s learning occurred. The children worked in pairs or small groups to address the following open-ended design brief.

**Design Brief** - Design and make a model of a small recycling device for the home or garden. Your product should be made mainly from recycled materials.

The teachers were requested to incorporate NCCP time between session one - when the design brief was introduced and the brainstorming (or familiarisation process) was undertaken - and session two. In practice the NCCP time varied from school to school, depending on the classroom timetable and time constraints. The length of NCCP time was:
School A ~ 5 days
School B ~ 3 days
School C ~ 7 days for one class, 14 days for another class

In this way the teachers gave children thinking time or extended periods where discussions between them were encouraged. Teachers also allowed modifications after the evaluation time. Children were encouraged to document their ideas in a journal - *My Thinking and Ideas Book*, as a means of recording previous ideas and being able to return to them should they wish. The journal belonged to the child and was not assessed by the teacher as part of the process. This approach gave the journal some legitimacy in the children’s minds as a personal tool rather than a teacher requirement.

**Data collection procedures**

As it was not our intention as researchers to take an artefact focus, we studied the generation of new or different solutions as a function of creative thinking, by taking account of the children’s initial suggestions for their recycling devices, both written and drawn. Evidence of the children’s involvement in the technological process was obtained through their documentation of their drawings, ideas, sources of ideas and reflections in their journal - *My Thinking and Ideas Book*. We spent time in the classrooms observing the children as they engaged in the technological process, and listened as the children shared their technological knowledge during presentations to their peers. Informal conversations occurred naturally with the children as they eagerly shared with us how they made their recycling devices. Photographs of children’s designs were taken, both from the point of view of illustrating any novel or creative idea but also as a validation to the children of the value of the task. Once the technological unit was completed, we carried out informal interviews with the teachers who revealed their perspectives of the influence of NCCP time on children’s creativity.

**Results**

In responding to the Design Brief, most children indicated that they read books and spoke with their parents, teachers and each other, in an attempt to think of something that was new, or at least different, to what was currently available on the commercial market. Many took examples of familiar items and attempted to modify them so that they were more efficient or 'better'. Some tried to think of an entirely new way of approaching the problem or issue. As part of their routine classroom studies, the children had a strong understanding of the background information about recycling and environmental health. For most of them, the topic was sufficiently familiar that they did not need to have additional information. However, the teachers did spend some time brainstorming both the idea of recycling and discussing aspects of the design task required of the children.
The following comments are representative of the teachers interviewed.

- Children were frustrated with that [NCCP time] because they wanted to get started.
- In hindsight, a week for incubation [NCCP time] was too long.
- Once they had set up what they wanted to do...very, very rarely did they change that idea. The kids that changed mostly were the more practical kids.
- Unexpectedly several children who had not been observed showing creativity prior to the task, had generated very unusual designs.
- There were ‘quite a few’ children who needed to change their designs to accommodate functionality.
- Additionally, children had to modify their designs based on limited resources or limited personal manipulative skills. This they found particularly frustrating – having an idea but not being able to produce from it.
- There were not many new concepts that the children could generate, but there was a diversity of ideas within a particular topic.
- The children needed to have an adequate understanding of the topic. Children who possessed a broader knowledge of recycling appeared to produce devices that were different.
- Allowing children to take their ideas home was particularly helpful as this gave them time to discuss ideas with family members.
- Some children showed original, creative thinking, while others ‘shared’ ideas with their peers and then made modifications.

The children’s creativity manifested itself in several different ways. Firstly, the way the children actually approached the development of the design of the product indicated an engagement with the creative ideas. The novelty aspect was evident in some of the children’s designs. One of the Year Four teachers commented that “some children came up with their own, original ideas (e.g. theme park for worms!). Some of the designs involved a variety of processes (e.g. crushing, rolling etc.) that were creative”. The designer of the worm farm wrote the following in her journal.

‘Worm palace’

*Session 1: My worm farm recycles food scraps. It has a playground and a sorting belt that sorts out scraps. I was thinking how to construct my model and what to use.*

*Session – Evaluation: The worms break down the vegetables and turn it into compost. My worm farm looks good because it’s different to everyone else’s project. It is different to what I’ve seen because it involves my own ideas. If I had different materials I would make an*
improved version. I think my project is a great success and I'm proud of myself (Year four girl).

Secondly, throughout the construction of their devices, the children were actively involved in a problem-solving process – often having to devise new solutions.

Sometimes we found that children created novel ideas, but were hampered by the limitations of resourcing and even expectations of their age group. One child had a very creative idea to clean a cat litter tray using a magnetic force. Unfortunately, practicalities forced her to abandon her original creative idea and to move to something which was 'do-able'.

Another child, at a different site, wrote in his journal that he was frustrated by not being able to complete his fire-log maker machine as he wasn’t allowed to use electricity and didn’t know how to do that part anyway. In the end, he created a box with specific instructions on the outside, but no content as he could not include any machinery.

Figure Two – My Thinking and Ideas Book - entry for the Fire-log maker
Discussion

Creativity Processes observed

Although in the initial study, we were focusing in strongly on the NCCP time, what emerged was a recognition of many of the other factors that enhance creativity in any classroom situation. We saw, in practice, many of the factors identified in Figure One as integral to the classrooms we visited and to the production of creative solutions to the technology task.

It was clear that at all sites, teachers took time to introduce the task, to brainstorm or to undertake familiarisation activities prior to the children commencing the project. Time was spent clarifying with the children what the design brief and the specifications meant. Teachers were aware to leave the task as open-ended as possible so that they would not impose further restrictions or specifications outside the design brief itself. This allowed children to interpret the task in their own mind and by their own set of understandings and experiences. We observed that students already had strong content knowledge of environmental education – refuse, reduce, reuse and recycle was a theme that had already been introduced to the children previously. Allowing children to talk with peers and family members provided them with opportunities to strengthen, broaden and deepen their knowledge of content and processes.

As indicated in the results, some children expressed frustration at limited resources and materials. Peterson (2001) comments that rarely would children be able to produce creative products that are useful at the societal level. However, he indicates that the creativity exists in the idea, not necessarily in the final construction.

Social creativity and NCCP time

During the interviews the teachers commented that allowing the children to discuss their ideas with family members was beneficial. This valuing of community orientation to learning rather than viewing learning from an individual’s perspective is consistent with Gordon’s phenomenological study of eight families involved in Starwatcher activities. Gordon (2006) found that engagement in learning was enhanced through experiential learning when children and adults participated in hands on activities associated with astronomy (cited in Fleer & March, 2009). Our study identified that the provision of time between sessions allowed children to discuss their ideas amongst their peers and family members, thus deepening their content knowledge (as a prerequisite for creative thinking – see Figure One) and allowed NCCP time to be activated. In so doing, shared expertise and social creativity came into play. In her study on expertise and creativity, Reilly (2008) expanded the notion of expertise by not restricting it to being situated in an individual. Rather it “can emerge from a system of shared experience” (p59). Our study revealed that the path from the initial introduction of the design brief to ideation involved two or more people over an extended period of time. The non-
conscious cognitive process (NCCP) time was occurring outside these social interactions, but providing further ‘new ideas’ to be discussed with others. Thus the shared time can facilitate social or collective creativity. Barrett (1999) points out that “Social creativity has come to mean the functional and dialogic relationships between persons concerning a task embedded in a specific environment, which is nested in a socio-historical frame” (cited in Reilly, 2008, p64). In our study, when the children worked together in pairs or small groups on the technological task, language became a tool of creativity. Therefore dialogical interaction in the context of technological activity can foster creativity. Solutions to problems can emerge through conversations between group members. So the ‘copied’ ideas that are then modified can be viewed as part of a social creativity process. Even for those students who tended to work alone and appeared to generate their own novel ideas, the social context would have provided additional stimulus for creativity.

**Social creativity and Problem-solving**

In Jane’s (1995) qualitative study of children’s perceptions of technology studies one of the most creative products generated in a class of year five children was a small crane. Liz’s design for her toy crane differed in some ways to her final product because she experienced problems making it and modifications had to be made. Below Liz describes how she solved these problems.

*I had a couple of problems along the way. First of all I couldn’t get a handle so I changed that. I changed the size of the string a couple of times. I had to get Dad to help drill a hole for the string instead of the big square of wood. Also Dad is getting me a heavier hook. Instead of the handle – we drilled a hole and put a circular wood in that can turn (R.J. 2, p146, 13/9/93).* (Jane, 1995, p186)

In this example, problem-solving was a creative process that was social in nature as it involved dialogue between Liz and her Dad. The solution they came up with was a modification of the original design so that it worked more effectively. The social context for creativity is important, as noted by Fleer and March, 2009 “Children engage in activities within their social world and through the interaction work collectively with others, often above what they could do independently” (p35). It is doubtful that Liz could have achieved such a successful crane without the help of her Dad. Social creativity is therefore an interdependent process where ideas are generated in a joint process of thinking and shared dialogue. In this context, the problems that arose served to generate discussion that opened up possibilities that precipitated solutions. Creativity can be defined in terms of two key dimensions: purposefulness and novelty (Csikszentmihalyi, 1996). In Liz’s example, the crane had a specific purpose that had to be met. The modifications made so that it would work added to the novelty aspect of the product. In Figure One, problem-solving thinking is identified as one aspect that precedes NCCP time. In design technology problem-solving
thinking also occurs during the producing phase and leads to modifications to the design that generate novelty in the final product.

CONCLUSION

In undertaking this research, our initial aim was to ‘enhance children’s creativity through the inclusion of a non-conscious cognitive processing time (NCCP) in the technology process.’ This was a distinct intervention. However, at the time, we were not fully aware that this simple intervention, when coupled with the other factors identified in Figure One, would provide conclusive evidence of enhanced creativity. We acknowledge that the other factors such as brainstorming, task criteria, children’s knowledge, learning dispositions, social interactions and higher order thinking practice all aid a child in the development of their creative thinking. These other factors became apparent at the time of talking with the children and teachers about the entire process. While we can definitively state that the inclusion of NCCP time enhanced creativity, the other factors were present as part of normal classroom practice. This is a very positive outcome of the research – that many of the pre-conditions necessary to enhance creativity are already present in some classrooms.

However, if we return now to the BIG question “Can creativity be taught?” we need to answer in a more reserved manner. Teaching skills such as problem-solving, or using brainstorming techniques, as well as teaching children how to apply some of De Bono’s thinking strategies, can assist creativity. Creativity can be enhanced, thinking creatively can be enhanced, generating more creative and novel ideas and products can be enhanced. However, the use of the non-conscious cognitive processing (NCCP) time cannot be ‘taught’, rather it is activated at the individual level through free-flow mental states. Remote mental connections can be made non-consciously which produce unusual and original ideas. The implication of our study for teachers is that when NCCP time is allowed for in curriculum planning, and incorporated as part of the technological process, novel ideas and creativity are enhanced. With the provision of NCCP time comes a period of non-task time when children are given opportunities to informally share their fledgling ideas in a social context. Teaching design technology in this way can contribute significantly to enhancing children’s creativity.

REFERENCES


Figure One – Enhancing Creativity

Brainstorming and Mind-mapping tasks assist in the development of new ideas.

Well-defined task criteria aid in the early judgement of ideas.

Learning dispositions & personal attributes

Higher-order thinking: teaching strategies for lateral thinking and task-focused, problem-solving, allow for flexibility of ideas.

Content and process knowledge provide a strong platform to build ideas on.

NCCP time
Non-conscious cognitive processing time. Brings all other aspects together.

Enhanced creative thinking