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Creativity in Technical and Further Education in Australia

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Abstract: Creativity in technical and vocational education is an area where little research has been undertaken. This paper examines the existence and nature of creativity within a technical and further education college in Australia. The two studies found evidence of creativity within a course on mechanical design synthesis, however, the studies also found that teaching for creativity was not a central concern of teachers involved in the study, reducing the effectiveness of the intervention employed in Study 2. The paper draws on the findings of the two empirical studies reported in the paper to synthesise a curriculum framework that could be used to increase the effectiveness of teaching for creativity within technical and further education.

Keywords: Technical education, further education, creativity, teaching frameworks.

INTRODUCTION

This paper uses two empirical studies to examine the challenges of teaching for creativity outside of the traditional schooling and higher education sectors. That is, it looks particularly at teaching for creativity in vocational education, which, in Australia is provided by the technical and further education (TAFE) sector. It outlines the traditional restrictions on teaching for creativity in this sector as well the ways in which this restriction has been both reinforced by recent policies, and yet overtaken by changes in the nature of the work for which vocational education seeks to develop its learners. It is this latter development that impels a renewed effort to understand the ways in which creativity can be incorporated into curricula in this sector as well as the kinds of pedagogies that will be effective.

The paper begins by outlining the educational context, before describing a research project aimed at examining learning and teaching for creativity in the sector. This project involved, firstly, an examination of candidate courses, an exploration of the creative thinking processes that students engaged in, and the use of mental imagery in facilitating their creative thinking. Secondly, an imagery training program was attempted in a second TAFE college. In this latter study, it was found difficult to gain teacher commitment and student engagement and the innovation was unsuccessful. The reasons for this are explored. Finally the paper discusses the implications of applying the experiences gained in undertaking these two studies for responding to the challenges in the sector, in educating for creativity. These experiences and the findings of the two studies are used to suggest important elements in a curriculum implementation framework (Fig. **1**) for teaching for creativity in the sector.

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CONTEXT

In considering ways of enhancing creativity in educational settings, a sector that is often neglected is vocational education as provided, in Australia for example, by the technical and further education (TAFE) sector (also known in various countries as the further education, or vocational education and training, or post-compulsory education and training sector). This apparent neglect may be because of the traditional emphasis of this sector on manual skills and its working class origins in developing people for the skilled workforce. Indeed, in most countries, the sector is differentiated from schooling and from higher education, occupying a middle ground that is usually highly constrained in what it can offer. For instance, the technical and further education sector in Australia has traditionally been responsible for the training of apprentices within a range of trade areas such as welding, fitting and machining, dressmaking, carpentry, in other skilled areas such as office work, as well as for some middle level paraprofessional occupations. The major emphasis of these courses has been on developing technical competency in the activities associated with each skilled occupation. The assumption underlying the content of the courses in these trades has been that all of the content and processes are known and that competence can be achieved by mastering a set of well-specified skills and associated tacit knowledge. For instance, these assumptions of specificity and predictability are built into the national Competency Based Training (CBT) policy of the Australian government, where the aim is to develop skills for tasks, groups of tasks and contingencies [1].

To compound the restrictions on technical and further education in emphasizing creativity education, in Australia, the development of creative abilities was largely seen to be the domain of the colleges of Advanced Education (CAE) sector up to the late 1980’s when these institutions were incorporated into the university sector. Nevertheless, the need for post-compulsory education to respond to the changes in work was flagged in two reports to government

[2, 3]. The Finn report [2] on young people's participation in Post-Compulsory Education and Training indicated that creative thinking was an important ability to be developed as part of problem-solving competencies. The Mayer Report [3] on employment-related key competencies for post-compulsory education and training described the key competency of problem-solving as including: “the capacity to apply problem-solving strategies in purposeful ways, both in situations where the problem and the desired solution are clearly evident and in situations requiring critical thinking and a creative approach to achieve an outcome.” [3, p. viii].

Moreover, in the years since the Finn and Mayer reports, the demand for creative skills has increased as many of the established manufacturing industries have moved to lower cost countries such as China and India and the emphasis has moved from manufacturing goods to designing goods and services. In parallel with the move from manufacturing to designing there has been a blurring of the boundaries between education sectors, with TAFE courses being delivered in high schools and a qualification framework being established that provides a clear progression from school to doctoral study that incorporates both TAFE and university programs.

This more recent move to develop creative thinking in post-compulsory education students is not unique to Australia with the desire being mirrored in overseas initiatives. In the United Kingdom the National Council for Vocational Qualifications (NCVQ) has defined problem solving (including creative thinking) as one of the core skills [4]. In the United States the US Department of Labor's Commission on achieving Necessary Skills (SCANS) [5] has described creative thinking, as a component of problem solving, as one of the foundation and basic skills that are part of what the Department describes as workplace know-How. In New Zealand problem-solving is defined in the National Curriculum as Problem-solving and decision-making skills which are regarded as part of the Essential Skills [6].

However, the various key competency documents provide limited guidance for teachers attempting to develop these abilities. None of the US, UK, NZ or Australian key competency documents provides a substantive basis for teaching creative problem-solving activities. Rather generic definitions are given of what constitutes problem-solving, with no suggestions about what is involved in contextualised practice. For example, problem-solving was listed in Australia, as a Key Competence [3] and seen to involve “clarification and framing of problems”, “achievement of appropriate completion”, “anticipation of problems, sources and contexts”, and “valuation of outcomes and processes” (p. 37). Yet, none of this is specific to creative problem-solving or the contexts where it is used [7].

For these reasons, two studies were undertaken: an investigation into the actual emphasis on creativity in TAFE teaching and learning, and an appraisal of the effectiveness of a curriculum innovation aimed at promoting visualization as a tool in creative thinking and learning. Because of the traditional emphases of TAFE curricula, reinforced by contemporary vocational education policy, it was expected that teaching for creativity might present a considerable challenge for TAFE teachers. As reported later, this turned out to be the case. As Fullan [8] argued, there is a substantive difference between curriculum implementation imposed from outside of a teaching institution and curriculum adoption which involves and includes teachers in the planning, modification and acceptance of the innovation. That is, before the adoption of a curriculum innovation, it is important for teachers to come to understand what is involved and to value the innovation. However, while attempts were made to gain the commitment of teachers to the innovation in this study, it was not successful, suggesting the need for more attention to the processes of implementation of curricula aimed at teaching for creativity.

RESEARCH BACKGROUND

In this paper, creative thinking is taken to be a kind of problem solving. An important component of successful creative thinking is the generation and use of visual mental imagery and the external representations of these images. Antonietti [9] found that it was possible to reduce the effects of a number of identified blocks to problem solving when upper primary age students were asked to solve problems that had been identified as containing blocks and where unexpected thinking was required. Finke and Slayton [10] found that when students generated their own images, they were more successful in achieving a creative synthesis that when they were presented with a selection of existing images. Larkin and Simon [11] have provided an analysis of the utility of visual representations to assist information processing and Ashton and White [12], found that it was possible to improve people’s scores on imagery tests through training, however, there is currently, no research examining the use of imagery to facilitate creative thinking in TAFE courses in Australia.

The studies reported here are based on *cognitive theory*, about the kinds of cognitive structures and processes involved in problem-solving [13-17], and *imagery theory* [18-20] about the properties of visual mental images. This is the first time that these two theories have been brought together in investigating the contribution of imagery training to TAFE student learning. They build on previous research by Middleton [21] on the use of visual imagery in complex problem-solving.

According to cognitive theory [14, 15, 17], the capacity to solve new problems involves the application of conceptual knowledge and problem-solving procedures in order to conceptualise and represent the problem, apply specific procedures to sub-problems, and to monitor progress and bring the problem to solution. These procedures are called second order procedures to differentiate them from specific (first order) procedures developed through practice over time to solve familiar problems [17, 22]. For these reasons, it is important for teachers of subjects aimed at creative activity to develop instructional practices that lead to student utilisation of second order procedures and to monitor learning environments to ensure that their curricular intentions are realised.

The thinking involved in creativity generally, and in designing, in particular, involves the use of second-order procedures, and appears to be most productive when knowledge is represented in working memory, in particular ways. Creative thinking requires that the thinker generates new ideas. However, the requirement to think creatively

Table 1. Executive Control, Exploration, Generation and Evaluation Procedures [26]

Executive Control	Exploration	Generation	Evaluation
Goal Setting Switching Cognitive Awareness Goal Monitoring Strategy Formulation	Knowledge Application Experimentation Context Shifting Attribute Finding Acknowledging Limitations	Search Retrieval Association Contrast Synthesis Transformation Analogical Transfer Categorical Reduction	Analysis Assessment Verification Trialling Criteria Fulfilment Elimination Selection Comparison Review

often prompts psychological blocks such as mechanisation bias, and functional fixedness. These blocks tend to result in people using thinking associated with known solutions when new thinking and new solutions are required [23-25].

There has been considerable recent research on the cognitive processes involved in achieving generation, exploration and executive control during creative problem solving. Based on her research, Yashin-Shaw [26] proposes that creativity involves the use of generation, exploration, evaluation and executive control processes which involve the operation of various cognitive procedures (Table **1**) which operate iteratively and non-consecutively on the knowledge base.

In studying complex, ill-defined design problem-solving, Middleton [21] also found that overall processes operate iteratively and non-consecutively in various zones of a problem-solving space. Middleton conceptualises a problem zone, a search and construction zone and a satisficing zone, in which generative, explorative and executive control processes involve the execution of a range of cognitive procedures as listed in Table **2**. These procedures are a smaller set than those identified by Yashin-Shaw, but there is considerable overlap between the two sets. In the studies reported here, the Middleton set was found adequate for coding the data.

Table 2. Generation, Exploration and Executive Control Procedures [21]

Executive Control	Exploration	Generation
Goal Setting Goal Switching Strategy Formulation Monitoring Evaluation	Exploring Constraints Exploring Attributes	Retrieval Synthesis Transformation

There has also been significant work on the facilitative effects of mental imagery on creative thinking. Creative thinking seems to be facilitated when thinkers represent problems in working memory as visual mental images [10, 27, 28]. The use of visual mental representations of knowledge has been shown to be an important component of creative thinking in the sciences, arts and invention [29, 30]. More recently the use of visual mental images has been found to improve the problem-solving performance of primary school children when presented with complex problems where psychological blocks would normally occur [9]. One objective is that the training program should assist students to avoid blocks to creative thinking such as mechanisation bias and functional fixedness.

While all people can produce visual mental images, there is variability across people in terms of the *vividness* (i.e. the clarity and detail) that can be achieved. There is also variability in terms of individuals' abilities to *control and manipulate* the visual images they produce. That is, individuals vary in how clear the image is as well as in how they can change variables in the image. For instance, it is possible to generate an image of an engineering system with different levels of clarity and detail (vividness) and also with differing capacities to change variables within the image such as movement, flow, current, resistance, and so on; or differences in the capacity to rotate the image or move it through space.

Furthermore, some people who can produce vivid and detailed visual mental images, habitually do not generate them or use them for tasks where they would appear to be useful [31]. At this stage, we do not know the extent to which imagery training facilitates students' creative thinking when engaging in designing. The limited existing research indicates that imagery appears to be an important feature of activities such as designing and inventing [29], and solving complex problems [21, 32-35]. Improved imagery ability is hypothesised to improve creative thinking and the ability to solve complex problems; however, there is no research evidence to support the claim.

One aspect of the second study reported here was to examine if an imagery training program influenced students' preferred processing modes such that they would, after engaging in the training, display a higher preference for imagery processes when engaging in creative problem-solving. In both studies, student imagery vividness was measured using the Vividness of Visual Image Questionnaire (VVIQ) [31] and the degree to which students were able to manipulate images was measured using the Controllability of Visual Imagery Questionnaire (CVIQ) [31]. These tests have been validated previously.

The task of the present studies, then, was to relate existing research, to an examination of the extent to which and ways in which selected TAFE teachers have been able to respond, or might respond to this change in the skills required by graduates, as well as the implications of applying these findings to the challenges of the curriculum and for the teaching of creativity in TAFE.

STUDIES OF THE TEACHING OF CREATIVITY IN TAFE COURSES

Approach

The two studies involved four stages. These were:

- Identification of courses in two TAFE colleges that involved a requirement for students to engage in creative thinking;
- An in-depth examination of the kinds of activities engaged in by students in one course with a focus on identifying creative activity (Study 1);
- Development and implementation of an imagery training program in a second TAFE college (Study 2); and
- Administration of a test of imagery capacity in both studies.

Study 1

Study 1 was an exploration of the actual teaching emphases and learning activities of students, without any curriculum innovation. It involved an in depth analyses of the cognitive processes actually used by students in solving creative problems in order to identify the ways in which visual imagery assisted their problem solving.

In Stage 1 of this study, discussions were initiated with the first Institute of TAFE and meetings were organized. The Institute has two faculties, Building Engineering Science, and Business Community Education. The initial task was to establish the extent and nature of creativity that was required in courses within the institution. Courses were sought where students would be expected to design creative products. The representatives of the Institute advised that these designing tasks would be observable within the Building Engineering Science Faculty. Subsequently many courses were investigated. This involved discussions with teachers, obtaining and reading curriculum documents and observations of classes. The courses, which appeared to encourage creative activities, were initially identified as:

Advanced Diploma of Building – CNBUIO14

ABC 101 Major Project

ABC 097 Formwork Design

Advanced Diploma of Engineering – CN940

EA060 Engineering Design Concepts

EA065 Computer Aided Drafting B

EA065 Computer Aided Drafting C

EA160 Advanced PLC (Programmable Logic Controllers)

EB703 Machine Design

EB705 Project: Mechanical Design Synthesis

EB900 Control Systems Project

EB712 Plant Layout

Access to each of these classes was organised over the period of one semester. In some of the classes, a discussion with the teacher, observation of a class and a review of the assessment was sufficient to inform the researcher of the limited opportunities for creative problem solving. For all courses other than EB705 and EB712, it was determined that the focus was not on creative problem solving.

In the case of EB705 Project: Mechanical Design Synthesis, EA065 Computer Aided Drafting C and EB712 Plant Layout, further investigation was undertaken. A number of classes was videotaped and samples of student work were collected. Unfortunately, after further investigation of the learning experiences it was found that only the subject EB 705 Project: Mechanical Design Synthesis, offered the potential for students to engage in a creative design task.

In Stage 2, six students, from a total class enrolment of eight completing the major design project in EB705 Project: Mechanical Design Synthesis, were interviewed about the processes they employed to solve the design problem. Two of the eight students declined to be interviewed for the study, but did complete the Vividness of Visual Imagery Questionnaire (VVIQ) [31] and the Control of Visual Imagery Questionnaire (CVIQ) [31]. The sample size of six students was considered sufficient for the study because the aim was to collect a rich data source from a reasonably constrained number of participants. This turned out to be the case. Furthermore, the study was exploratory in nature, given that little research examining creativity in technical and further education in Australia had been undertaken. An exploratory study was regarded as an important step in shaping the nature and direction of any subsequent larger study of the issue.

The interviews were conducted with the students having access to the sketches and notes produced during the designing process as reference points to provide a form of stimulated recall [36] of the design process. This approach was taken because most of the actual design work was accomplished away from the campus and thus a retrospective account was necessary. The interviews were transcribed, segmented [37] and coded according to the following schema (Table **3**) taken from Middleton [21]:

In Stage 3 all Study 1 students (8) in EB705 Project: Mechanical Design Synthesis were invited to complete the Vividness of Visual Imagery Questionnaire (VVIQ) [31] and the Control of Visual Imagery Questionnaire (CVIQ) [31]. The VVIQ measures the extent to which an individual can generate a mental visual image and the nature of its properties in terms of vividness and level of detail. The CVIQ measures the extent to which an individual is able to manipulate an image after having generated one.

All of the students had substantial capacities for generating and controlling visual images as given in Table **4**. The VVIQ consists of 35 items which are responded to on a five point scale. The CVIQ consists of twelve items which have yes, unsure or no response. Yes is scored as 2, Unsure as 1 and No as 0.

There was clear evidence of the use of cognitive procedures associated with problem solving and of the use of visual images in the resolution of creative problems across the student group. A summary of statements by five of the students who were interviewed, about the uses of

Table 3. Coding Schema for Interview Transcripts [21]

Generation		
1	Retrieval, (RE)	Knowledge from the external world or from memory
2	Synthesis (SY)	Combining knowledge/abstracts to generate a proposal to solve part of the problem
3	Transformation (TR)	Changing a proposed idea to suit the problem to be solved
Exploration		
4	Exploring constraints (EC)	Establishing the properties of the problem add to the complexity
5	Exploring attributes (EA)	Establishing the properties of the problem which define the problem
Executive Control		
6	Goal setting (GS)	Establishment of general principles
7	Strategy formulation (SF)	Indication of the use of a problem solving strategy
8	Goal switching (SW)	Changing of focus or attention. Changing from one aspect of the problem to another
9	Monitoring (MO)	Statements which precede an evaluation statement. Checking the progress of the problem solving
10	Evaluation (EV)	Typical plus minus etc

visualisation in their problem solving, is given in Table **5** (The work of the 6th student is elaborated later).

Table 4. Imagery Vividness and Control Among Students in the Course

Student	VVIQ	CVIQ
1	51	24
2	72	20
3	87	16
4	90	8
5	40	20
6	125	24
7	62	14
8	88	14

From Table **5**, as expected, students varied in their uses of drawing, sketching and mental visualisation for various aspects of problem solving. Moreover, there were many instances of using visualisation for exploring the problem, generating ideas, exploring those ideas and moving to a satisficing solution. A few students, especially with difficulties in imagery control, relied more on manifesting their images on paper as sketches or drawing, using these depictions for problem exploration and solution evaluation. The results confirm that improved capacities for imagery vividness and control should assist in creative problem solving.

For the remaining student (Student number 1), because of the richness of the data, the use of visualisation in cognitive processing is presented below in detail for one episode. For this student, the use of visualisation was described particularly in Table **6**, below.

Table 5. Student use of Visualisation in Creative Problem Solving

Student	Summary of Statements About Uses of Drawing and Visualisation in Problem Solving
1	Drawing for idea generation Drawing for exploring possible solutions Has difficulty in maintaining a constant visual image.
2	Visualisation for idea exploration Used sketching to get ideas down without change Dynamic images for exploration Drawing for exploration and evaluation
3	Visualisation for idea generation Visualisation for idea exploration Visualisation for problem satisficing No use of drawing
4	Visualisation for idea exploration Visualisation for problem satisficing Sketching for idea exploration and evaluation
5	Visualisation for idea generation Visualisation for idea exploration Drawing for presentation of solution

The frequencies of this student's use of different processes are given in Table **7**.

That is, this student found visualisation particularly helpful in monitoring problem-solving, formulating strategies and retrieving information to assist in that formulation. Imagery was then used to explore thinking further.

Study 2

In Stage 4 of the two studies, because of the difficulties of finding courses with non-convergent design tasks at the

Table 6. Use of Visualisation in Cognitive Processing by Student 1

P 4	L 29-30	this and that went wrong in this one *(MO)*
P 4	L 32	seemed easier to visualise
P 4	L 33	before I even drew it in CAD
P 4	L 34	I'd say this needs to be like this and sort of set it out in my head,
P 4	L 35	when I sit down to draw this sort of thing I'll do it from start to finish
P 4	L 36	I have to do it all at once *(SF)*
P 4	L 40-41	I started with the complete car in my head, *(RE)* thinking this is what I need, *(SF)*
P 4	L 42	then went backwards. Took the tyres off
P 4	L 43	then I was left with a cart with rims, so I thought okay what rims are on the market *(EA)*
P 4	L 44-45	they didn't seem what I needed so I took the rims off and then stuck the cart to one side of my head, *(EA)*
P 4	L 46-47	put the cart to one side and concentrated on the rim, got the rim, did the pictures for the rim,
P 4	L 47-48	got them done and then put it away.

Table 7. Frequencies of Use of Different Kinds of Creative Procedures

Generation	f	Exploration	f	Executive control	f
Retrieval	9	Exploring constraints	6	Goal setting	6
Synthesis	1	Exploring attributes	8	Strategy formulation	8
Transformation	1			Monitoring	2
				Evaluation	6

first college, attempts were made to identify such courses at another college in order to develop and trial an imagery training program [12]. The second college volunteered access to their Creative Industry Department to identify courses with creative problem-solving content. From an overview of various courses, the Advanced Diploma of Ceramics was chosen as a possible area for investigation, because it involved the creation of 3-dimensional artefacts and provided similar learning experiences to EB705, studied at the first college.

The researcher met with each of the teachers of a number of subjects, viewed assessment tasks and discussed the expectations of the course. However, only one teacher demonstrated an interest in the project and offered access to their classes, CER 007A Drawing – Skills and Perception. This subject is the second drawing subject that the students undertake in the course. On paper the course did not appear ideal for the purposes of the research project, however, access was offered and the teacher assured the researcher that it was an advanced course, and students would be engaged in open design activities.

However, in seeking to implement the imagery training program, most teachers were not willing to participate. For the class where the researcher was granted access, the intention was to integrate the visual imagery training program into the curriculum of the subject. However, this was not able to be negotiated with the teacher. A compromise was reached and the researcher was asked to present the training program at the start of the classes while the teacher was setting up for the lesson. Other difficulties emerged during the training program and imagery testing, including contextual distractions for the students, competing demands for student time and engagement, and an overall lack of involvement from the students.

The imagery training program was developed and implemented. Pre- and Post-tests for imagery control and vividness were undertaken, with results as summarised in Table **8**.

Table 8. Changes in Imagery Vividness and Control in CER 007A Drawing – Skills and Perception TAFE Number 2 (Including only Students Present for Both Pre- and Post-Tests)

Student	Pre-VVIQ	Post-VVIQ	Pre-CVIQ	Pre-CVIQ
1	51	54	24	24
2	72	58	20	18
3	87	82	16	10
4	90	74	8	24

Unfortunately, more than half of the results could not be used for comparative purposes as not all students presented for both pre- and post-testing. Across the few students who presented for both sets of tests, there were few gains in vividness or control and even some apparent deterioration. This deterioration is interpreted as being apparent rather than real and being due to the low levels of engagement of students in the training and testing. That is, the training overall may have been perceived by the students as incidental to the main purpose of the course and little gained

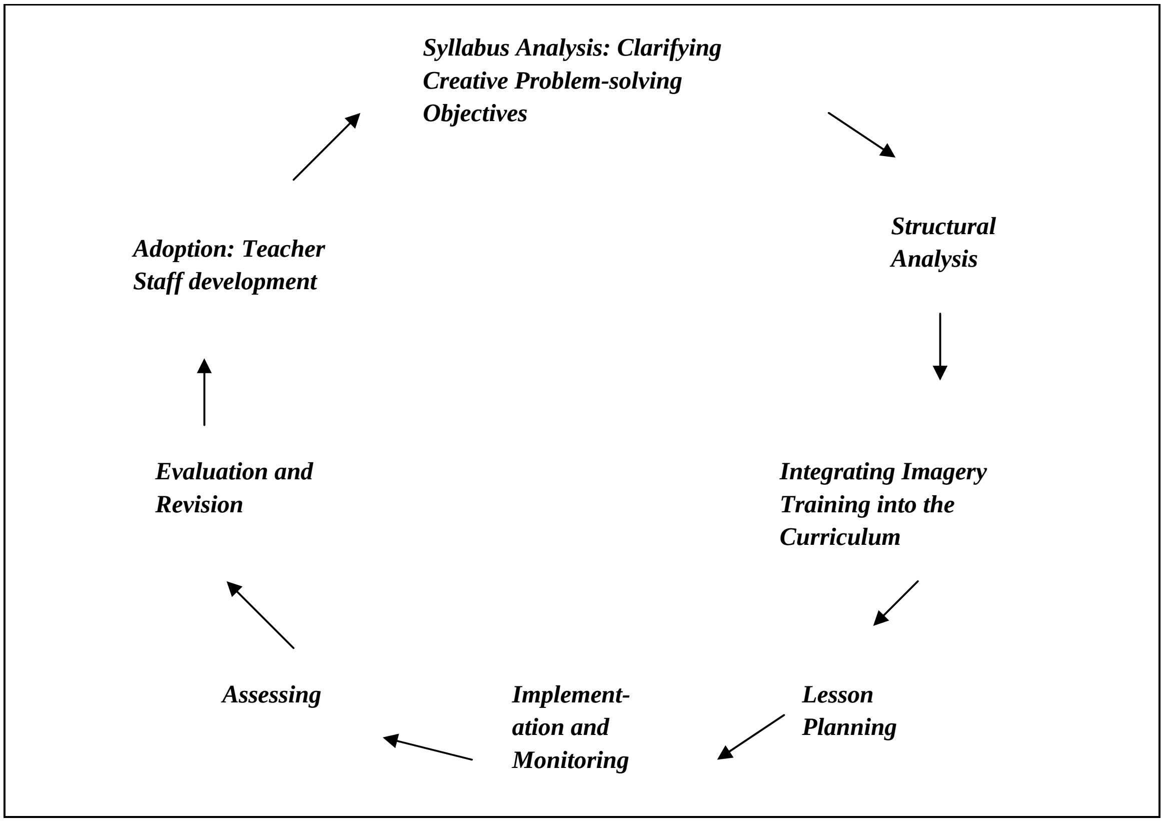

Fig. (1). Framework for teaching for creativity in TAFE [38].

from it. This reinforces the need for a curriculum implementation framework that not only develops staff understanding in the field of creativity and teaching for creativity, but that also develops a valuing of and commitment to the pedagogies that are involved.

Summary of the Two Studies

The first study found evidence for the kinds of cognitive procedures identified previously by Middleton [21] and for the use of visual imagery in idea generation, exploration of the problem, evaluation of the problem and executive control of the overall problem solving process. It also provided evidence that less control over visual imagery appeared to produce a greater reliance on the use of paper depictions to assist in problem solving. The innovation in the form of an imagery training program in the second study was not implemented successfully, possibly due to the lack of teacher commitment and student engagement. In the following section, these two sets of findings are used to develop suggestions for curriculum implementation in education for creativity in TAFE.

IMPLICATIONS OF THE STUDIES FOR EDUCATING FOR CREATIVITY IN TAFE

One aim of the studies was to establish the kinds of creative activities employed in TAFE courses. A second aim was to consider implications for curriculum frameworks for the development and employment of suitable approaches to develop creativity in TAFE students, and for these to become embedded within TAFE practices.

In undertaking both studies it was found that there was some reluctance on the part of TAFE teaching staff to embrace the importance of the development of creativity within their teaching. One way to explore the reasons for this and to provide the basis for a curriculum implementation framework is to compare the current situation within TAFE institutions and that applying within compulsory education, specifically, within the curriculum area described as technology education. The Australian curriculum is comprised of 8 Key Learning Areas (KLA). Technology education is one of the KLA's and the key feature of the technology KLA is 3 content strands (materials, systems and information) and a process strand (the creative design process). Since the introduction of the technology KLA in 1994, there has been an increased emphasis on the development of student skills in solving design problems and the importance of creativity in the problem-solving process. These creative problem-solving design skills have been regarded by educational authorities as important generic skills for all people to develop.

In contrast, the dominant policy issue within the TAFE sector over the corresponding period has been the establishment of standardised frameworks and processes to assist in ensuring predictability, specificity, codification and consistency of skills and knowledge developed from TAFE courses. One important aspect of this policy has been the establishment of Competency Based Training (CBT). An underlying assumption of CBT is that all skills that TAFE students need to develop can be specified at quite precise levels. To this end, assessment in CBT is based on 2 levels: competent and not yet competent. CBT has difficulties in accommodating the need to develop creativity. In addition, creativity appears to be not well understood within TAFE institutes, with highly convergent activities being defined as creative. This is not to say that the development of creative thinking is not possible within TAFE courses, but it is saying that the TAFE institute that was the subject of the study didn't yet seem to have a body of knowledge and experience of how creativity might be developed across the range of courses where it would be relevant. Given this, the following sections propose a curriculum implementation framework for curriculum changes aimed at developing creativity in appropriate TAFE courses.

Thus, in Fullan's [8] terms, there is now a need to focus on the *adoption* of creativity in the curricula of TAFE and this involves the development of a conceptual base on what creativity is, how it is learned and how it can be taught, before any curriculum implementation can be successful. Along with this change in understanding, is the need for an associated change in the value afforded different kinds of knowledge in the curriculum.

Synthesising a Curriculum Implementation Framework

Thus, based on the experiences of conducting the research, including the implementation of an innovation in how a TAFE course was taught, it is proposed that a curriculum implementation framework (Fig. **1**) for teaching for creativity in TAFE courses contain at least the elements outlined below.

The framework is based on Laird and Stevenson's [38] model for curriculum development in TAFE and incorporates the needed emphases on curriculum adoption and implementation argued by Fullan [8, 39]. It is further based on the difficulties in developing with teachers a shared understanding of the nature of creativity and the challenges involved in its teaching. Finally, it is based on the thinking processes utilised by learners as they engaged in using visual imagery in their creative problem solving.

Adoption: Teacher Staff development

- Staff development of participating teachers about the conceptualisation of different kinds of creative activities, the cognitive structures and processes which are involved and the role of visual imagery in assisting creative problem-solving processes;
- Gaining understanding and commitment from teachers; Staff development on the relationships among different aspects of creative problem-solving (Executive Control, Generation, Exploration) and imagery use – drawing on Middleton [21] and Yashin-Shaw [26];
- Working with teachers to develop a high valuing of creative outcomes and the learning processes needed to develop student capacities for creative activity.

Syllabus Analysis: Clarifying Creative Problem-solving Objectives

- Working with teachers in examining syllabus content and assessment provisions in order to identify any apparent emphasis on creative outcomes;
- Working with teachers to clarify whether creativity or competence on functional skills is the desired learning outcome;
- Working with teachers to clarify the extent to which 'creative outcomes' are original and the ways in which this is recognised and rewarded;
- Mapping course content in terms of propositional and procedural creative content: learning about creativity, engaging in convergent creative problem-solving, engaging in divergent creative problem-solving;
- Modifying course content, objectives and assessment provisions as appropriate to capture the design purposes of the course (Ensuring assessment for functional skills does not displace emphasis on creative problem-solving).

Structural Analysis

- Working with teachers to identify learning tasks which involve creative problem-solving. Identifying cognitive processes: e.g. generation, exploration, executive control and sub processes e.g., monitoring, formulating strategies.

Integrating Imagery Training into the Curriculum

- Working with teachers to contextualise imagery training using these identified tasks and cognitive processes and sub-processes. Design of teaching activities directed at developing student abilities for imagery control and vividness in creative activity, incorporating:

A series of imagery training activities;

Need for relaxed engagement without disturbance;

Embedding training within processes of generation, exploration, and executive control;

Identification and discussion of events where creative problem-solving requires the withholding of procedural automatisation.

Lesson Planning

Ensuring

- Teacher commitment to the training and its value are communicated to the students;
- The imagery training is integrated into the curriculum rather than marginalised to the beginning set-up periods;
- The imagery training is conducted in quiet areas, free of distractions, with clear teacher expectations of full student engagement.

Implementation and Monitoring

- Working with learners to ensure generation and control of visualisation during creative problem-solving, especially targeting generation, exploration, evaluation and executive control cognitive processes.

Some strategies would include those suggested by Collins, Brown and Newman [40]: exploiting collaboration, exploiting competition, and so on.

Assessing

– Making provision for evaluation of student creative processes and outcomes in terms of the cognitive processing involved and the products generated.

Evaluation and Revision

– Revising the syllabus, structural analysis and lesson plan in the light of the teaching and learning experiences and assessment.

CONCLUSIONS

The context of teaching for creativity in technical and further education has been highly restricted traditionally and by recent policy changes in the sector that emphasise competency-based training. Yet technological and social changes are compelling this sector to prepare learners for work that is unpredictable and frequently requires the creativity that is immanent in design and innovation. This latter development impels a renewed effort to understand the ways in which creativity can be incorporated into curricula in this sector as well as the kinds of pedagogies that will be effective. Moreover, the blurring of the boundaries across educational sectors is reinforcing this move.

This paper has begun this process by outlining related research and a recent research project aimed at examining learning for creativity in the sector. This project involved an examination of candidate courses, an intervention and an exploration of the creative thinking projects that students engaged in, and the ways in which mental imagery was utilised in facilitating their creative thinking.

In both studies, it was found that there was limited emphasis on creative thinking in courses in these TAFE colleges and a lack of understanding of what is involved in creative thinking, learning for creative thinking, the role of visual imagery in facilitating creative thinking, and teaching for creative thinking. Despite efforts to involve the teachers as fully as possible in the implementation of the innovation, this lack of understanding and commitment seems to have impeded its success, with no gains in imagery vividness or control. However, despite this limitation, even without the intervention, learners in Study 1 were found to be engaging in creative thinking and this was found to be facilitated by the use of mental imagery especially for engaging in the executive control processes of the creative cognitive activity.

Thus, based on the research, it is apparent that much needs to be done in changing the culture and practices of the TAFE sector if teaching for creativity is to become fully effective. Currently it seems to be vicarious, without any formal attention to developing the thinking processes that are involved. In order to improve the situation, the concept of creativity needs to be more fully understood, a more explicit emphasis is needed on the cognitive processes involved in creative activity and the pedagogies needed to facilitate such activity. Moreover, curricula need to be re-developed to promote this emphasis.

Because of current limitations, this paper suggests a curriculum implementation framework for moving towards these goals. It seeks to address the need for a cultural shift in the sector, that involves a need for staff development aimed at facilitating the adoption and implementation of curriculum innovations in this area; and the development of personal understanding of what is involved in educating for creativity.

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CONFLICT OF INTEREST:

None declared.

REFERENCES

[1] The National Training Board. National Competency Standards: Policy and Guidelines. Canberra: Author 1992.

[2] Finn B. Young people’s participation in post-compulsory education and training: Report of the Australian Education Council Review Committee. Canberra: Australian Government Publishing Service 1992.

[3] Mayer E. Key Competencies: Report of the committee to advise the Australian Education Council (AEC) and ministers of Vocational Education, Employment and Training (MVEET) on employment-related Key competencies for post-compulsory education and training. Canberra: AEC & MVEET 1992.

[4] Jessup G. NCVQ research & development project report no 6, common learning outcomes: core skills in A/As levels and NVCQ’s. UK: National Council for Vocational Qualifications 1990.

[5] US Department of Labour Secretary's Commission on Achieving Necessary Skills. Learning a living: a blueprint for high performance. A SCAN's report for America 2000. Washington DC: Author 1992.

[6] The Ministry of Education, New Zealand. The National Curriculum of New Zealand: A discussion Document. Wellington: Learning Media 1991.

[7] Eteläpelto A. Contextual and strategic knowledge in the acquisition of design expertise. Learn Instruct 2000; 10 (2): 113-36.

[8] Fullan M. Research on the implementation of educational change. Res Soc Educ Socializ 1981; 2: 195-219.

[9] Antonietti A. Why does mental visualisation facilitate problem-solving? in: Logie RH, Denis M, Eds. Mental images in human cognition 1991; pp. 211-27.

[10] Finke RA, Slayton K. Explorations of creative visual synthesis in mental imagery. Memory Cogn 1988; 16: 252-7.

[11] Larkin JH, Simon HA. Why a diagram is (sometimes) worth ten thousand words. Cognit Sci 1987; 11: 65-99.

[12] Ashton R, White K. The effects of instruction on subjects' imagery questionnaire scores. Soc Behav Pers 1975; 3: 41-3.

[13] Anderson JR. Problem solving and learning. Am Psychol 1993; 48(1): 35-44.

[14] Glaser R. Expertise and learning: how do we think about instructional processes now that we have discovered knowledge structures? In: Klahr D, Kotovsky K, Eds. Complex information processing 1989; pp. 269-318.

[15] Glaser R. The reemergence of learning theory within instructional research. Am Psychol 1990; 45(1): 29-39.

[16] Gott S. Apprenticeship instruction for real-world tasks: the coordination of procedures, mental models, and strategies. Rev Res Educ 1989; 15: 97-169.

[17] Stevenson JC. Cognitive structures for the teaching of adaptability in TAFE. In: Evans G, Ed. Learning and teaching cognitive skills 1991; pp. 144-63.

[18] Kosslyn SM, Thompson WL, Alpert NM. Neural systems shared by visual imagery and visual perception: a positron emission tomography study. Neuroimage 1997; 6(4): 320-34.
[19] Nugez L, Nagel D, Hoffman H, Canavan AG, Wist E, Humberg V. A mental route to motor learning: improving trajectorial kinematics through imagery training. Behav Brain Res 1998; 90(10): 95-106.
[20] Finke RA. Principles of mental imagery. Cambridge MA: MIT Press 1989.
[21] Middleton HE. The role of visual mental imagery in solving complex problems in design. PhD [dissertation]. Brisbane: Griffith University 1998.
[22] Stevenson JC. Adaptability: theoretical considerations. J Struct Learn 1986; 9(2): 107-117.
[23] Jansson DG. Smith SM. Design fixation. Des Stud 1991; 12(1): 3-11.
[24] Maslow AH. Emotional blocks to creativity. A source book for creative thinking. New York: Chas. Scribner 1962.
[25] Luchins AS. Mechanisation in problem solving: the effect of Einstellung. Psychol Monogr 1942; 54 (Whole No 248), 1942.
[26] Yashin-Shaw I. Developing creativity. In: Stevenson J, Ed. Developing vocational expertise. Principles and issues in vocational education. Chapter 7, 2003.
[27] Ward TB, Smith SM, Vaid J. Creative thought: an investigation of conceptual structures and processes. Washington DC: American Psychological Association 1997.
[28] Greeno JG, Simon HA. Problem solving and reasoning. In: Atkinson RC, Herrnstein RJ, Lindzey G, Luce RD, Eds. Stevens handbook of experimental psychology, 2nd ed. New York: Wiley Interscience 1988; vol. 2.
[29] Weber RJ, Moder CL, Solie JB. Invention heuristics and mental processes underlying the development of a patent for the application of herbicides. New Ideas Psychol 1990; 3: 321-36.
[30] Shepard RM. Externalization of mental images and the act of creation. In: Randhawa BS. Coffman WE, Eds. Visual learning, thinking and communication. New York: Academic Press 1978.
[31] Richardson A. Individual differences in imaging: their measurement, origins, and consequences. New York: Baywood Publishing 1994.
[32] Kaufmann G. Imagery effects on problem solving. In: Hampson PJ, Marks DE, Richardson JTE, Eds. Imagery: current developments. London: Routledge 1990.
[33] Kaufmann G. Mental imagery in problem solving. In: Sheikh AN, Ed. International review of mental imagery. New York: Human Science Press 1984; vol. 1.
[34] Kaufmann G. The functional significance of visual imagery in ideational fluency performance. J Mental Imag 1981; 5: 115-20.
[35] Kaufmann G, Helstrup T. Mental imagery and problem solving: implications for the educational process. In: Sheikh AA, Sheikh KS, Eds. Imagery in education: imagery in the educational process. Farmingdale NJ: Baywood Publishing 1985.
[36] Meade P, Mc Meniman M. Stimulated Recall: An Effective Methodology for Examining Successful Teaching in Science. Aust Educ Res 1992; 19(3): 1-11.
[37] Ericsson KA, Simon HA. Verbal reports as data. Psychol Rev 1980; 87(3): 215-51.
[38] Laird D, Stevenson J. Curriculum development in vocational education. Australian and New Zealand of Vocational Educ Res 1993; 1(2): 71-92.
[39] Fullan M. The new meaning of educational change. London: Cassell 1991.
[40] Collins A, Brown JS, Newman SE. Cognitive apprenticeship: Teaching the crafts of reading, writing, and mathematics. In: Resnick LB, Ed. Knowing, learning, and instruction: Essays in honor of Robert Glaser 1989; pp. 453-94.

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