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Technology in Teacher Education : Using Multimedia to Enhance the Design and Make Processes.

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Implications for future

The future of communicative teaching in China needs to acknowledge the investment required in the education (in the broadest sense) of Chinese teachers of English. It is not only their professional language-specific preparation that requires to be addressed but also the associated national educational policy directions that affect industrial matters such as their recruitment, promotion and working conditions. Imported, allegedly universal Western teaching methodologies that dismiss the local context are unlikely to flourish. Young (1987) may well be correct when he argues that educational change of any permanent consequence can be achieved only through culturally responsive reform and that externally imposed, bureaucratically-efficient methods often fail. There is obvious strength in his view that any successful application of a communicative approach to English teaching in China needs to be predicated on a careful (and inevitably slow) ethnographic analysis of the Chinese classroom context.

However, the external bureaucratic Chinese education system also forms part of the local context for Chinese middle school teachers of English and hence cannot be ignored. There are several aspects of the education system that impinge on the way teachers in China teach English and these need responses and action before English can be taught communicatively in China. These aspects are practical and industrial as well as academic. Progress has been made, especially in the national examination system, but much remains to be done.

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TECHNOLOGY IN TEACHER EDUCATION: USING MULTIMEDIA TO ENHANCE THE DESIGN AND MAKE PROCESSES

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ABSTRACT

This paper reports on the use of a multimedia journal to enhance a subject in technology education. The subject was delivered to preservice teachers studying to be primary school teachers. The multimedia journal was used to assist in the delivery of the subject and to record the progress made by students. It is argued that multimedia used in this manner complements and extends upon the teaching program and becomes an integral part of the learning process

INTRODUCTION

This study discusses the development and evaluation of a new subject in technology education, and demonstrates how a multimedia journal can be used to assist preservice teachers to further their understanding of the design and make process.

The movement toward national curricula in the United Kingdom and Australia stimulated interest in the development of national attainments that relate stages of maturity to chronological age (DES, 1985; Curriculum Corporation, 1994). This movement also revitalize interest in improving science and technology-related primary school education in Australia and the United Kingdom (U.K) (D.E.S., 1985; Australian Academy of Science, 1991). Whilst educational planners may be politically obligated to produce new primary school science and technology curricula that include tables displaying age-related attainments, they are also morally obligated to provide much more than this . To just provide teachers with written documentation and the occasional one-off professional development courses is not good enough and reflects an outmoded model of professional development (Renner,1990). As Ingvarson (1987) has stated " a few thousand dollars for a one-off inservice which could only be given to a fraction of the teachers..is crazy" (p.15). More consideration needs to be given to other means of providing inservice and preservice training of teachers. In the area of technology education relevant preservice experiences are very important and this paper outlines an attempt to employ multimedia to complement and extend the design, make and appraise process with preservice teachers.

An overview of the state of technology education in primary schools in the UK and Australia

In 1988 a centralised National Curriculum was established in the U.K. and teachers were required by law to implement strategies that would achieve attainments related to specified ages. However such legislation does not guarantee that new practices will transfer into the classroom, and Carter and Carré (1990, 1991) report that only 34% of primary teachers from a sample of 901 felt independently competent to help children fulfill syllabus goals in science and technology. Responses from this survey and previous work in 1989 (Wragg, Bennett and Carré) found that 60% of respondents were in need of in-service help. A similar study conducted in New South Wales (Ferry, 1993) showed that only 50% of teachers had taught design and make units, and 80% needed assistance in planning, implementing and evaluating units that related to designing and making. Analysis of interview data from this study showed that teachers were reluctant to teach designing and making because they had little or no experience with the processes involved.

The Australian findings are of concern as the Australian Academy of Science and the Australian Science Teachers Association recommended in 1991 that science and technology become an integral part of primary school experience for all Australian children (Australian Academy of Science, 1991). Furthermore, these groups recommended that primary school teachers should have the opportunity to develop the competence, confidence and enthusiasm needed to provide an environment in which their students can learn both the content and processes of science and technology.

It is appropriate to question whether technology education could suffer the same fate as science

education in Australian primary schools. In 1989, the Discipline Review of Teacher Education in Mathematics and Science (DEET, 1989) revealed that science education had become a low priority in many teacher education courses, and this low priority was reflected in the lack of attention that science receives in primary schools. Current research associated with technology education suggests that there is a lack of opportunity for primary teachers to train in the processes involved in technology education (Layton, 1993). Therefore teachers are unlikely to develop the competence, confidence and enthusiasm needed to provide quality instruction in technology education, and there is a danger that there will be a minimal classroom response to the inclusion of technology in national curriculum statements.

This study discusses some important issues about the preparation of teachers to instruct primary school children technology-related education. In particular it discusses the use of multimedia to complement and extend traditional methods of instructional delivery in this area.

The rationale for a preservice subject in designing and making

Technology education includes four distinct but interrelated strands: technological literacy, technological awareness, technological capability, and information technology (ASE, 1988).

· Technological literacy is defined as familiarity with the content and methodologies of a range of technologies.

· Technological awareness means awareness of the personal, moral, social, ethical, economic and environmental implications of technological developments.

· Technological capability means the ability to tackle a technological problem, both independently and in co-operation with others.

· Information technology means competence and confidence in the technological handling of information (Layton, 1993).

In primary schools it is expected that these strands would be developed through integrated, interdisciplinary investigational topic work. The technology profile for Australian schools (Curriculum Corporation, 1994) states that:

"Technology in the school curriculum combines theory and practice. It includes much that is scientific, ethical, mathematical, graphical, cultural, aesthetic and historical. It explores the synthesis of ideas and practices, and the effects of technologies on societies and environments" (p.2.)

It follows that a technology subject that introduces preservice teachers to the strands of technology education should also use an integrated, interdisciplinary investigational approach so that preservice teachers have first-hand experience with the processes that their pupils would experience. The subject also has to empower trainee teachers in the design and make process (Bonollo, 1993) and develop trainee teacher competence, confidence and enthusiasm. Competence and confidence come from first hand experiences that challenges one to extend current skills and develop new skills, but a certain amount of judgment is required in order to match the challenge to the person. This requires a negotiation and mentoring process in which lecturers and preservice teachers are fully aware of the outcomes of the subject (Lewis and Bonollo, 1994); Ramsden, 1990). If the process has been successful, then it is likely to have generated enthusiasm and confidence in the student. Hence student competence, confidence and enthusiasm may be used as outcomes to measure the success of the subject offered.

Restructuring of the four year Bachelor of Education degree for primary teachers at the University of Wollongong provided an opportunity to offer a fourth year elective subject related to technology education in primary schools. The commencement of a new science and technology curriculum in 1992 in New South Wales primary schools (Department of School Education, 1991) and the development of national profiles in technology education added further support for the need to develop such a subject. Moreover findings from previous research (Ferry, 1993) had shown that primary school teachers wanted help in designing and making. Therefore we decided to focus upon this aspect of technology education

Two lecturers shared the responsibility for this subject. It was also important to us to develop a resource that could be used in the future by preservice and classroom teachers. Two parallel processes were put in place to meet these needs: one concentrated upon the delivery of the subject to the students and the other concentrated upon the task of developing a multimedia "class

journal" that would become a resource for preservice and classroom teachers. While both lecturers involved in the subject had expertise in multimedia and technology education, it was convenient to divide the responsibilities and to collaborate on a "need to know" basis. Therefore the more experienced lecturer in pedagogy took overall responsibility for the delivery of the subject and the more experienced one in multimedia took overall responsibility for the development of the multimedia "journal".

Subject Organisation

The subject was allocated three hours of face to face teaching for one semester. It consisted of a one hour lecture and two hours of tutorials. Three compulsory assessment tasks were set. Two tasks involved the development of a prototypes of a technological solution to a problem identified by the student. The third was a responses paper to a series of process tasks related to electronics. The prototype development followed a typical technology/design process of: investigating contexts and human needs, devising possibilities and alternatives, communicating plans and actions, production of processes and products, reflection on progress and results (Curriculum Corporation, 1994).

Care was taken to present the technology/design process as recursive and non-linear, and Figure 1 shows the model that was presented in lectures.

Lectures and tutorials were scheduled to support the stages in the technology/design processes that the trainee teachers could be expected to experience as they developed their prototypes. They were required to keep a reflective journal that contained their responses to the different stages of the technology/design process. These responses were used to generate discussion during tutorials. Tuman (1992) claims that reflective journals represent a new form of "engineering literacy" and they have a legitimate place in the design and make process. Journal writing helps the student to construct knowledge (Winsor, 1990) and Johnson, Lee and McGregor (1994) argue that there is a need for engineers to write their own knowledge. The reflective journal entries also helped us to monitor the stages that most trainee teachers "were at" and to make final adjustments to our lecture/tutorial sequence so that we corresponded as closely as we could with current and anticipated future needs. Also a certain amount of negotiation took place in order to ensure that the prototype was challenging but "do-able". Thus the total process gives students the opportunity to integrate and make use of what they know and to confront new ideas and test them against their own or possible misconceptions (Boysen, 1994; Lawson, 1980)

When we were planning the subject we were concerned that anxiety associated with assessment and the perception that engineering was a "male" subject could adversely affect the outcomes. Initially most students were very

Figure 1: A model of the processes involved in technology as it responds to a human purpose (from Fensham, 1990, p. 17)
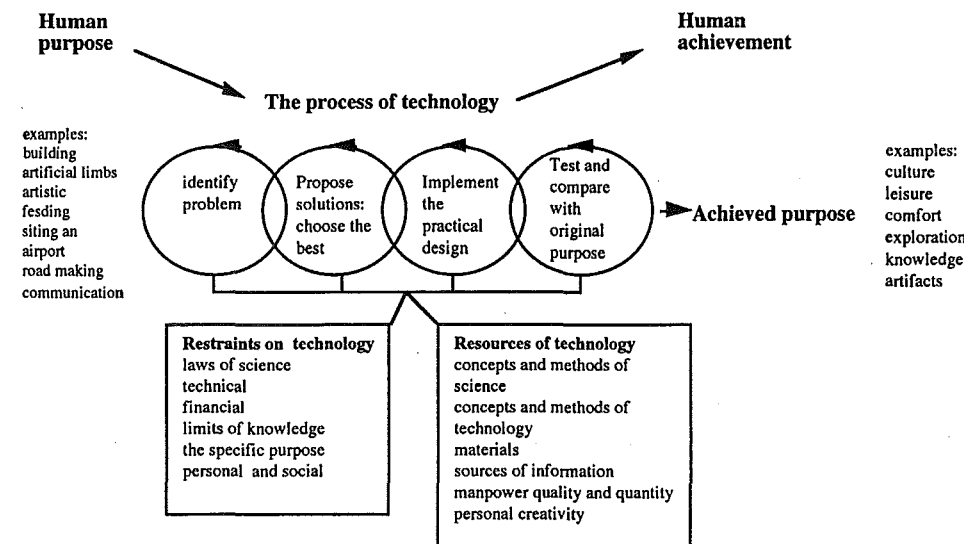
worried about how they would be assessed, and discussion centred around product assessment versus process assessment. It was agreed to give equal weight to both product and process. That is equal marks were allocated to what was produced (the artefact) and their personal journal. This turned out to be an approach that challenged students to address the whole process of designing and making rather than just one aspect. Other researchers (Boysen, 1994; Boyapati, Inglis and Phillips, 1994) also support this approach.

Another factor reported in the literature was a student perception that subjects associated with processes such as construction, design and engineering were more suited to males (Nandy, 1979; Georg, 1993; Wiley, 1992). As the majority of students were female and were prepared to enroll in what was perceived to be "a high risk subject" (Julie) it was important that both lecturers provided support and acted as mentors. Moreover we felt that we had to actively dispelled this perception.

The following transcript is part of an interview with Julie shows how we attempted to relieve anxiety and provide support. During this interview Julie was talking about designing indicators for her bicycle. She stated :

> "I was really scared about my project. ...Early in the session I came to Brian and talked about giving up. He talked me into continuing and gave me a book to show me how the indicators for my bike would work....Then my flat-mate helped me to start and a week later I had made a small working model. At this stage I was relieved because I could see that it would work."

Her feelings of anxiety were typical of both male and female students as they viewed the prototype development tasks as threatening and, like Julie, many expressed doubts about their ability to complete the task.

In an attempt to address the dual issues of anxiety and perceived gender bias we allowed students to consult with the lecturer of their choice. Some consulted with both lecturers, but overall a student tended to find the lecturer that they were most "comfortable with" and to work with that person. Even though one lecturer was male and one was female, there appeared to be no gender difference in numbers of students consulting each lecturer. Subsequent analysis our personal diary entries showed that this was the case.

The electronic journal

The electronic journal was in HyperCard form and entries were gathered during the session. Each entry contained a photograph (taken with a Canon ion camera) of the preservice teacher plus a title for their prototype. Buttons allowed the browser access to selected sound files chosen from interview tapes, photographs of various stages in the development of the prototype, and selected entries from the reflective journals. Diagrams of the electronic projects completed in tutorials were scanned and included in the electronic journal.

The HyperCard stack takes 6Mb of memory and is recorded on compact disc for regular use. We intend to expand the electronic journal as new ideas are developed. Later the compact disc will be available to classroom teachers for professional development purposes.

The navigation screen and one of the project screens are shown in Figures 2 and 3.

The navigation screen

Nine buttons are available to the student and these are labelled help, course selection, background to this subject, other activities, project results, evaluation, theories behind the practice, and student briefing. The buttons that students used the most were project results and the evaluation. When students click on these buttons the screen displays selected images of projects plus relevant excerpts from written journals. This display provides students with some photographs of the stages involved in a specific design and make project, plus a photograph of the final product, and the designer's evaluation comments about their project.

The journal entry

The screen was organised as shown. The slide icons indicate that a photograph of the project can be viewed. These photographs were viewed by most students. The loud speaker icons indicate that a sound file can be accessed. When the a student clicks on a sound file, an interview question appears on the screen and then the response is played through the speakers of the computer. Access to a student photograph proved to be a popular option as current students often contacted students from the previous year's cohort to seek advice.

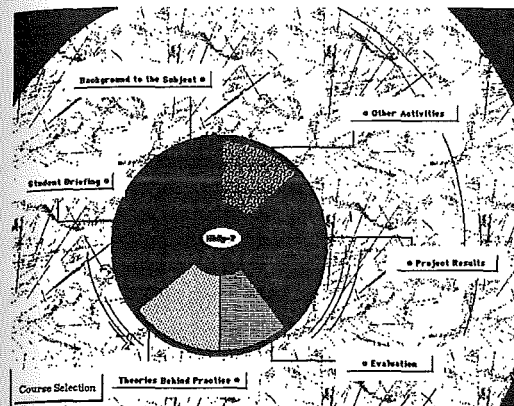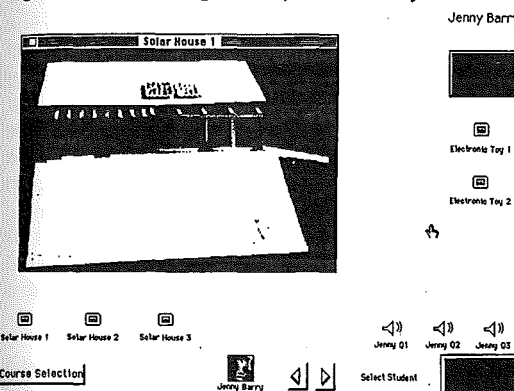Figure 2: The main navigation screen of the electronic journal

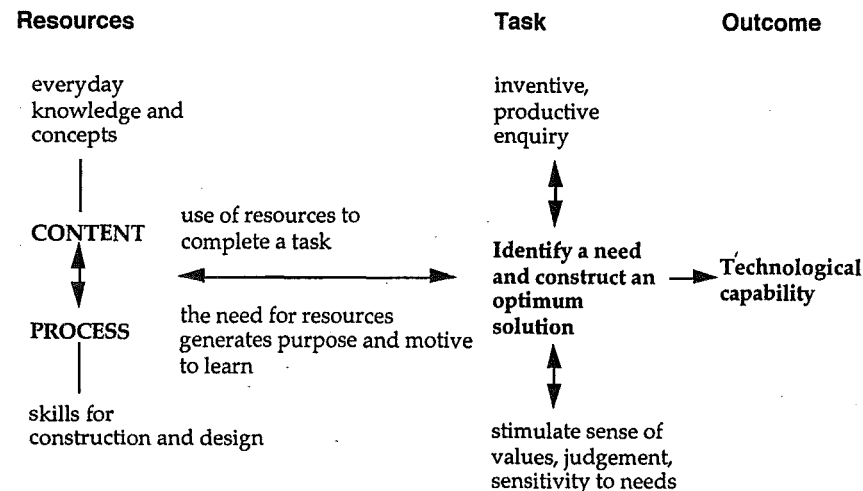Figure 3: An example of a journal entry

The Theoretical Model of Technology Education Employed

Figure 4 summarises the theoretical model of technology education presented in lectures. The purpose of this model is to provide preservice students with a broad vision of the outcomes that they can expect to gain from the subject.

We were very conscious of the fact that the trainee teachers had little previous experience with the design and make process, and the tasks of developing the prototypes would be very challenging for them. A decision was made to be available for informal consultation at specified hours during the week, and this was of great benefit to those who were reluctant to ask for help when part of a large group. During these consultation sessions we assisted students to locate themselves on the recursive model of the technology/design process shown in Figure 1 and to use this to identify their current needs. They were then given guidance about what might be the next stage in the process.

As a project was completed, two sessions called "show and tell" were organised. During these "show and tell" sessions trainee teachers presented their completed projects to peers. While these sessions were informal, participants were required to explain why they had chosen their project, the design brief followed, the processes followed (by referring to Figure 1), what was achieved, and how they could continue to improve their project. Each individual presentation ended with constructive suggestions from peers and a brainstorm activity that

Figure 4: A model of technology education (in Fensham, 1990, p. 16)

Resources		Task	Outcome
everyday knowledge and concepts		inventive, productive enquiry	
CONTENT	use of resources to complete a task	Identify a need and construct an optimum solution	Technological capability
PROCESS	the need for resources generates purpose and motive to learn		
skills for construction and design		stimulate sense of values, judgement, sensitivity to needs	

provided ideas for modifying the project to suit primary school children.

The students enrolled

The subject was introduced in 1993, and sixty eight preservice teachers and four class teachers have completed the subject. Sixteen were males and fifty two females. The youngest was twenty two years old and the oldest forty six (mean 29.5). As this was an elective subject most enrolled out of interest.

Data gathering

Data were gathered from three sources: a university evaluation survey of the subject, journal entries and interviews.

The university survey was constructed and administered by the centre for staff development (an independent university body). A copy of this instrument is included in Appendix 1. All subjects were interviewed during a three week period after their projects were completed. The female lecturer who conducted these interviews began with the following questions:

1. What did you learn about designing and making as you made your project?

2. What new skills did you learn from the experience?

3. Did you use the electronic journal? If they used the journal they were then asked

    What features did you find useful?

The interviews were open-ended and follow up questions were be asked. Most interviews took 30 minutes to complete.

Results and discussion

The subject was evaluated by the university centre for staff development . The instrument uses a five point Likert scale to rate the various questionnaire items. The highest score is five and the lowest one, and a mean of 3.4 (S.D. 0.5) is regarded as standard for most subjects. The mean for this subject was 4.75 (S.D. 0.4), higher than most subjects. Therefore the subject appears to have been well regarded by the students Table 1 summarise the student responses to relevant question from the survey.

Table 1: Preservice teacher responses to relevant survey questions (N=68)

Item	Response
I have felt enthusiastic about attending lectures in this subject	4.81
I felt enthusiastic about attending lectures in other subjects	3.01
My enthusiasm for this subject has increased greatly	4.72
The subject material has been very interesting	4.67
Lectures have stimulated me to think about the subject	4.81
I am confident that I will be able to teach this subject*	4.81

*additional question added to the survey.

It can be seen that the outcomes of enthusiasm for the subject and confidence in teaching designing and making appear to have been realised. However, the survey data alone is not sufficient to substantiate claims about the outcomes of the subject, as the sample was small and the subjects chose to enroll in the subject. Therefore other sources of data need to be examined. The other sources used for this study were the reflective journal entries and the transcripts from the interviews. Whilst both sources of data support the view that the outcomes of competence, confidence and enthusiasm were achieved, it needs to be acknowledged that the factors that led to the success of this subject may not transfer to a different context.

The following quotes are selected from the reflective journals and represent some reactions of participants to these questions.

Quote 1: Jenny B, a female teacher, aged in her mid forties who enrolled as a full-time student in a fourth year subject. She describes the outcomes of her chosen task which was to design and construct a children's game. The design features incorporated

> *"the properties of magnets and the principles of simple circuits to provide opportunity to develop hand/eye coordination skills and to demonstrate the layout of an electric circuit..."*

"I'm pleased with the finished model. It's gone through a few modifications since my first concept of using a magnet, but I have learnt something about circuits and their assembly. I learnt to solder light wiring too."

Quote 2: Ian M, a male trainee teacher ages in his early twenties. His chosen task was to produce a better surfboard cover.

> *"The final product has turned out satisfactorily. For all its good points there are still some bad ones.....(these are then described)*
>
> *Some of the tasks that I did were: finding a purpose, exploring possibilities, researching, organising, making plans, following plans, collaborating, managing time, and choosing appropriate resources.*
>
> *The most important skill I believe is reflection. If you don't spend some time sitting back and looking what you have done and where you are heading then you are not fully participating in the design and making process. Therefore, for us as teachers it is important that we recognise this and allow time for this in the classroom."*

Quote 3: Fiona N, a female trainee teacher aged in her mid twenties. Her chosen task was to design a removable parcel shelf for hatchback cars.

> *"... It is important to make use of other people to listen to your ideas and discover whether or not what you want to do and what you say you will do are the same thing..*
>
> *...the experience has been extremely rewarding, especially in the sense that I have solved my own problem."*

Two important themes emerged from the interviews transcripts and from the journals. One theme was the importance of collaboration with a wide range of people; many of whom were not "experts" but sympathetic listeners (mentioned by 74% of subjects). These people acted as a non-threatening audience with whom the learner could "sound out" ideas. Often the "sympathetic listeners" who acted as collaborators and confidants were close friends or relations. A study by Tibbitts, Collits and Lucas (1994) supports these findings. They report that it is important for students to share and discuss projects in a non-threatening situation.

The other theme was the satisfaction gained from solving a problem that was different to anything attempted previously (mentioned 81% of subjects). During the process of solving their chosen design problem the trainee teachers had to develop new skills that were required to compete the task. Thus they had to take responsibility for their own learning. The findings of a study by

Boyapati, Inglis and Phillips (1994) support these results as they too found that a great deal of personal satisfaction comes "autonomous learning". For example Jenny B had to learn basic circuit design and soldering. Like many of her peers she felt great satisfaction in learning these skills in an informal setting. Her interview transcript revealed that she would not have considered learning these skills had it not been forced upon her by her choice of project.

The use of the electronic journal

It was not compulsory to use the electronic journal. However it proved to be a popular and 88% of preservice teachers used it. Besides its reference value, it had a motivational value as the preservice teachers were delighted when given the opportunity to present their prototypes in this form. They also appreciated the opportunity to see how others had approached their project. Future research will investigate how learners use the material in the electronic journal to help them in the design and make process and such research will involve tracking learners as they use the electronic journal.

As the first version of the electronic journal was completed during the first session that the subject was delivered, there was limited opportunity for the first group of students enrolled in the subject to use the entire journal with the trainee teachers. However, all were actively involved in the development phases The discussion that follows relates to interview data gathered from the first group of trainee teachers who experienced the "working" (in-progress) and final product .

Features of the journal that appealed to the preservice teachers were:

*   access to the pictures, printed text and sound. They could browse and select the features that were relevant to their interests. For example some were contented to browse at the pictures of projects, while others wanted to read the related text or listen to relevant interviews.

*   access to the ideas of others. They often used the pictures of students in the previous cohort to find students with whom they could discuss their ideas.

Those that chose to use the journal tended to produce better projects. It cannot be claimed this effect was due to the journal as the sample is small and no control group was organised. It may

just be that the more conscientious students used the journal.

CONCLUSION

The data supports the interpretation that the preservice teachers had developed their competence and confidence in designing and making skills. They also reported that they were enthusiastic about teaching designing and making to young children. While there is a danger that the preservice teachers are telling lecturers "what they want to hear", triangulation from multiple data sources suggests that the findings are reliable for this group of preservice teachers, but no claim is made about transferring the findings to a different context.

The way in which the subject was delivered challenged preservice teachers to become independent learners and to develop their technological literacy, technological awareness, technological capability and to use information technology. It also allowed them to be actively involved in the process of design and make rather than just focusing upon the final product. We felt that the multimedia journal added another dimension to the learning process and presented students with a holistic view of their participation in the design and make process. In particular, the use of excerpts from recorded interviews from students, the inclusion of text from journals and photographs of projects focused student attention and encouraged them to reflect on their role at critical stages in the process. We also feel that the multi-media journal was a popular and effective innovation, but it was not a panacea and should not replace "real life" experience with the design and make process.

Nevertheless some important principles have emerged:

1. when equal emphasis is placed upon the process and the product preservice teachers tend to respond positively to an approach to designing and making that emphasises integrated, interdisciplinary and investigational work. Under such circumstances they are likely to take the opportunity to extend their competency.

2. the product-focused assessment procedures often "imposed" by university administrators can have an adverse effect upon learners enrolled in a subject that

challenges them to develop a whole range of new skills which cannot always be identified in advance. There may need to be a mechanism that allows for assessment processes and procedures to be modified as the subject unfolds.

3. the benefits of "learning by doing" cannot be underestimated. The majority of trainee teachers enrolled in this subject now appreciate the processes that their students will experience as they undertake a design and make project. Furthermore, many have developed personal competence and confidence that should contribute to effective and enthusiastic classroom practice.

4. it also important that preservice teachers reflect upon what they are doing and we feel that the multmedia journal can be an effective tool for reflection.

5. the traditional lecture/tutorial means of subject delivery was not always appropriate in the context of this study. Indeed one-to-one discussion with a trusted mentor proved to very important instructional strategy.

6. a subject that is perceived to favour one gender group over another can generate anxiety in enrolled students. Lecturers need to be aware of this situation and to develop strategies that help to dispel such perceptions. Furthermore there is a need to continuously monitor and, if necessary, modify instructional strategies as the subject is delivered.

7. "show and tell" sessions provide a good forum for swapping ideas and also help to boost the confidence of the more anxious members of the class. The reasons for this need further research, but it appears that the emphasis on process rather than product, and on personal development lowered anxiety levels and focused attention on what each person had achieved. Whilst individuals could still compare their progress to others, the emphasis was upon what each individual had learnt. We favour this approach, but further research is needed in order to ascertain whether a competitive environment that rewards the product and places individuals in competition can also achieve the same results.

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Appendix 1: The University of Wollongong Subject/ Teaching Evaluation Questionnaire.

Responses are recorded in pencil on a form that can be scanned and processed by a computer.

1. The aims of this subject have been communicated:

very clearly (5) clearly (4), uncertain (3), unclearly (2), very unclearly (1).

2. The preliminary information about the content of the subject was:

very clear (5) clear(4) uncertain (3) unclear (2) very unclear (1).

3. The information about assessment requirements has been:

very clear (5) clear (4) uncertain (3) unclear (2) very unclear(1).

4. Various parts of the subject (e.g. lectures, tutorials, etc.) are integrated:

very well (5) well (4) uncertain(3) poorly (2) very poorly (1).

5. The portion of marks allocated to different activities:

very well (5) well (4) uncertain(3) poorly (2) very poorly (1).

6. The total amount of material in the subject, I have understood:

most (5) more than half (4) half (3) less than half (2) very little (1).

7. I have felt enthusiastic about attending lectures in this subject:

always (5) most of the time (4) sometimes (3) rarely (2) never (1)

8. I have felt enthusiastic in attending lectures in other subjects:

always (5) most of the time (4) sometimes (3) rarely (2) never (1)

9. Because of the lecturer, in this subject my enthusiasm:

increased greatly (5) increased (4) stayed the same (3) decreased (2) decreased greatly (1).

10. The subject matter has usually been:

very interesting (5) interesting (4) neutral (3) uninteresting (2) very uninteresting (1).

11. Lecture material has been presented:

very clearly (5) clearly (4) uncertain (3) unclearly (2) very unclearly (1).

12. The sequence of topics within each lecture has been organised:

very logically (5) logically (4) uncertain (3) unclearly (2) all over the place (1).

13. The quantity of materials presented in lectures has been:

far too much (1) too much (2) about right (5) too little (2) far too little (1).

14. The lecturer stimulates me to think about the subject:

always (5) most of the time (4) sometimes (3) rarely (2) never (1)

15. The lecturer has demonstrated understanding of the subject:

very well (5) well (4) sometimes (3) poorly (2) very poorly (1)

16. The lecturer's interest in assisting students to learn is:

very high (5) high (4) uncertain (3) low (2) very low (1).