TECHNOLOGY EDUCATION, ENTERPRISE, INTEGRATION AND THE FUZZY FRONT END

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INTRODUCTION

This paper argues that successful integration involving technology education is dependent on teachers having a robust personal construct of what technology entails. This is particularly important when parties are dealing with the fuzzy front end that often occurs with open ended student centred activities. This paper highlights two recent research projects carried out in New Zealand. One of these aimed to identify what takes place when policy directives integrate Technology Education, Enterprise Education and School Community Partnerships. The second was the development of an integrated curriculum course for a pre service primary teacher education programme at Massey University.

The New Zealand Curriculum released in 2007 is a statement of official policy relating to teaching and learning: It describes a vision by setting the direction for student learning.

Included in this vision is a desire to develop young people

- *who will be creative, energetic, and enterprising*
- *who will be confident, connected, actively involved, and lifelong learners*

The confidence will be reflected by them being

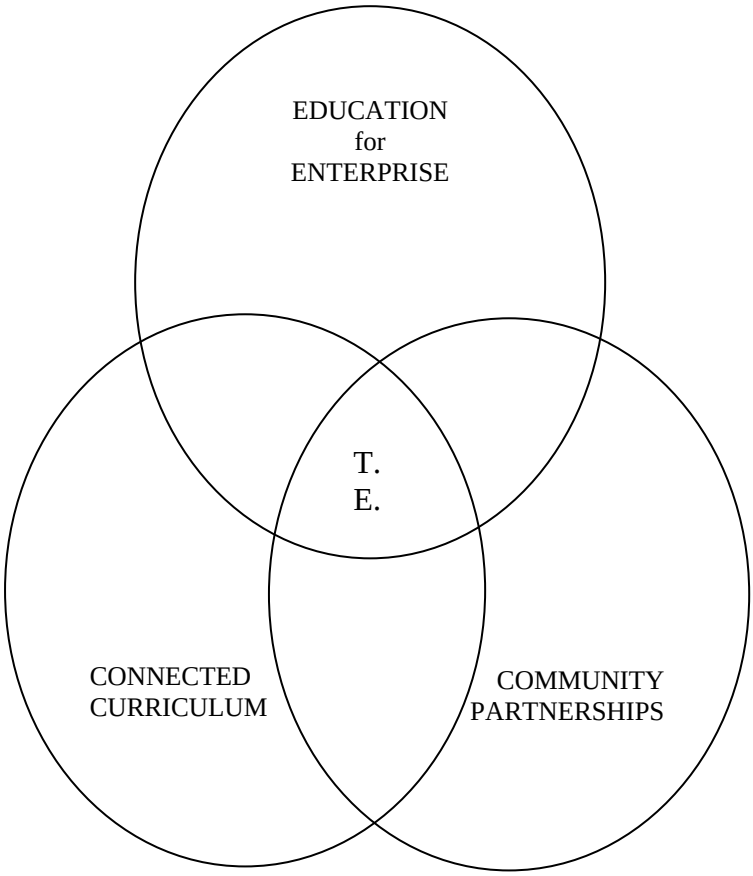
- *Enterprising and entrepreneurial.*

(Ministry of Education, 2007, p. 8)

The enterprising theme is developed further in the curriculum when discussing key competencies which are described as *capabilities for living and lifelong learning*. Under the *Managing Self* competency it is suggested that students who manage themselves are enterprising. When describing the curriculum learning area of technology itself: we are informed that technology will make enterprising use of knowledge and skills. Incorporated in the technological knowledge strand of the technology learning area, students are encouraged to develop knowledge particular to technological enterprises. The enterprise relationship is explicit in the policy directives and was also one focus of this research.

There are questions arising from the Curriculum visions and, in particular, the Learning Area statements:

Do the policy makers see technology education as a key medium for delivering Education for Enterprise E4E whilst involving the community? Is technology the key for developing a connected curriculum? If the answers to these questions are affirmative teachers must have a robust personal construct of what the subject entails to ensure a successful enactment of the intent. One suggestion put forward by O'Sullivan (2009) is a model of integration which utilizes a diagrammatic representation. This model places the learning area of technology education at the centre of a tripartite relationship.



O'Sullivan, (2009).

BACKGROUND

Since the initial introduction of a national technology curriculum to New Zealand schools in 1999 there has been little critique of the intentions of the curriculum. In late 2005 a Ministry of Education two-year E4E project was instigated to run a professional development programme with a group of sixteen schools. The aim was to examine ways in which teachers' capability to include 'education for enterprise' could be developed. The specific focus was to be on technology education and the fostering of links with education and the wider community. This paper will introduce aspects from the professional development programme with highlights to the ideologies driving the initiatives.

Internationally, there has been a shift in education policy away from liberal-humanist education towards a more vocationally focused curriculum. The change has come about mainly as a response to economic targets and objectives set by national policy makers (Price, 1991). An example of this shift can be seen in the growing emphasis on making education more responsive to the needs of industry and business.

Stakeholder influences, embedded in economic imperatives, have recently manifested themselves in the guise of enterprise education (mentioned above). These economic imperatives have thus had a strong influence on technology educations position within the national curriculum framework. Conversely technology education has also been identified as a subject that can easily form part of an integrated curriculum offering within the school

system. Currently this is evident in changes being made to pre service teacher education programmes where increasingly curriculum integration is seen to be the natural place for technology education to occur. Some concerns have been noted (O'Sullivan, 2008) that without a robust personal construct of what constitutes technology education, poor understandings and enactments of the curriculum intent will follow.

THE E4E PROFESSIONAL DEVELOPMENT CONTRACT

The research component of the E4E project investigated what features promote the development of enterprise attributes in students and what type of school wide practices can be introduced to support these attributes. The research also evaluated the professional development undertaken by teachers working in schools with facilitators focussed specifically on E4E outcomes within technology education. The illumination obtained from the research may in fact lead to an effective model of curriculum delivery, which could be significant in the development of technology education as a discipline and offer a way forward as part of a connected creative curriculum in schools.

An article by Clark (2004) published in the New Zealand Journal of Educational Studies highlighted the differing views about the word "enterprise" when used in association with education. The article also highlights some of the main issues surrounding interpretation particularly those associated with the economic imperative. This article was used as a discussion topic with participants in the E4E research.

The E4E project team was made up of two experienced facilitators and a senior university researcher. The project included a number of scheduled group meetings during the two year contract. These 'workshop' meetings were used to inform and shape the research. The meetings were conducted as a partnership between the 'local' experts (the teachers) and 'non local' experts (the facilitators and researcher). The facilitators were involved heavily with planning sessions as well as being in the classroom whilst projects were being undertaken. The focus was 'mutual aid' to improve teaching and learning with an emphasis on 'Enterprise for Education' through the learning area of technology.

At each of the meetings the groups were introduced to the research stages via an address from the researcher which included power-point presentations and question and answer sessions. These meetings helped to clarify the role of both the researcher and the research, explain the methodology and to highlight the participatory nature of this form of research. It was decided that where appropriate the project would focus on existing planned units of technology education and that the teachers and facilitators would work together to enhance these offerings to develop E4E activity.

A growing international consensus of enterprising attributes was considered:

- Identifying, recruiting and managing resources
- Working with others and in teams
- Communicating and receiving ideas and information
- Negotiating and influencing
- Generating and using creative ideas
- Identifying, solving and preventing problems
- Looking for and creating opportunities
- Planning and organizing

- Being flexible and dealing with change
- Identifying assessing and managing risks
- Using initiative and drive
- Reflecting on what has been done
- Working with the community
- Using their knowledge and skills to go for goals
- Being fair and responsible
- Collecting organising & analyzing information

According to (Kuemmerle, 2005) entrepreneurs can be distinguished from others by their ability to accumulate and manage skills and knowledge as well as mobilize resources to achieve specific goals. They steward resources whilst remaining open minded, learning as they find a way forward to develop responses with some merit or value (Sarasvathy, 2004). Hundreds of transcribed participant interviews were mapped against three focus areas and the 16 enterprising attributes above to ascertain coverage. These were discussed with all parties so the different realties of what was occurring could be identified. An open-ended perspective in constructivism adheres with the notion of data triangulation by allowing participants in a research to assist the researcher in the research question as well as with the data collection. An example of how this was achieved by the project was the '*daily snoop*' where the team facilitated participants to interview each other in a role play situation. This interview was included as an informant of what was actually taking place.

CURRICULUM INTEGRATION

Recently there has been a steady national decline in the number of students attending pre service teacher training courses in New Zealand. A rationalisation of paper offerings available as part of the Bachelor of Education Teaching (BEd.Tchg.) degree programme for primary pre service teachers at Massey University was carried out. The staff leading in the areas of Science and Technology education jointly proposed a new course to recapture some lost ground. This course entitled *'Integrated Curriculum Science and Technology'* was developed in response to the shrinking of curriculum subject offerings as part of the B.Ed. Tchg. degree

A recently published joint international research study called the DEPTH project see O'Sullivan 2008 looked at what makes a good technology teacher. The New Zealand research component of the DEPTH project focussed on the delivery of this newly established integrative course at Massey University.

There are many definitions of curriculum integration Shoemaker defines an integrated curriculum as:

> *...education that is organized in such a way that it cuts across subject-matter lines, bringing together various aspects of the curriculum into meaningful association to focus upon broad areas of study. It views learning and teaching in a holistic way and reflects the real world, which is interactive. (1989, p. 5)*

Others such as Fogarty (1991) Drake & Burns (2004) have moved beyond a single definition and suggested a continuum involving multiple levels. There are many interpretations of curriculum integration expressed. However, they share a general philosophy which proposes a movement away from teaching isolated facts towards a more constructivist holistic view of learning based on the principles of philosophers such as Bruner, Dewey and Piaget. This was an important issue identified by paper planners. To try and cover the breadth of Science and

Technology facts would be impossible in the time available and reduce the paper to an atomistic delivery.

The author had used the DEPTH framework successfully before to facilitate learning in pre service teacher education programmes at Massey see O'Sullivan 2001. This framework had built on previous work carried out by the Center for Research and Development in Teacher Education (CReTE) at the Open University in the United Kingdom. Unlike the earlier research carried out at Massey and reported in 2001 involving students who were 'majoring' in technology and were undertaking their final subject study course. These current students were involved in a compulsory integrated curriculum studies course for all enrolled in the program. Therefore their experience of technology education and technological understanding would be significantly less.

This Integrated Curriculum Science and Technology course was offered at Massey University College of Education to 28 3rd year internal primary students in 2006. The course has at its core a problem based learning (Ward & Lee 2002), instructional strategy. This had been identified by the staff involved as a way to allow the students the opportunity to:

- Become authentic stakeholders in their learning.
- Identify key facets of Science, Technology and Curriculum Integration.
- Participate in a learning environment which modelled a useful classroom approach.

The DEPTH framework was used at the start of the course as a diagnostic tool to help identify the students' current understandings and later as a self reflection tool to help identify concerns. It is the diagnostic aspect that this paper will focus on.

RESEARCH METHOD

The selection of any research design involves a number of interconnected stages (Crotty, 1998; Denzin & Lincoln, 2005). These stages can be summarised into three components:

- Locating the study within a research paradigm.
- The selection of an appropriate methodology.
- Using the selected research paradigm and methodology to identify the methods used to collect and analyse the data.

A paradigm consists of ontological, epistemological and methodological beliefs which help to decipher the complexity of qualitative research. Researchers are guided by particular paradigms, and the associated ontological and epistemological beliefs influence their research questions, their choice of research methodology, and their methods of data collection and analysis (Guba & Lincoln, 1994; Kember, 2000; Lincoln & Guba, 2000). These studies used an interpretivist paradigm (Denzin & Lincoln, 2005) which is supportive of constructivist philosophical approaches. Such approaches share the notion that reality is a social construction, created between the observer and the observed, and that lived experiences need to be understood from the perspective of the observed.

For the purposes of this paper an interpretative constructivist paradigm is employed. Under the interpretative constructivist paradigm interactions between all stakeholders including the researchers are deemed equally important. These interactions, combined with an exploration of values held by all the stakeholders, help shape the information which becomes a major

focus of the studies. The interpretative constructivist paradigm can be characterised by its use of primarily qualitative data gathering techniques in a hermeneutical and dialectical manner. Interpretative constructivist researchers focus on the multiplicity of viewpoints held and illuminate how these interact to shape the study. It is the interpretative constructivist researcher's belief that these mutual interactions between those studied and those doing the studying guides the research outcome. The interpretative constructivist paradigm supports the view that the observed reality exposed as part of a research study is a social construction process with no one truth discoverable (Tashakkori, & Teddlie, 2003).

In the case of the research projects mentioned above, defining, and making sense of the impact of a professional development and a pre service education programme need to be co-constructed from the perspectives of all the participants. Interpretivist methodology is thus a participative and collaborative endeavour concerned with constructing new understandings *"that get inside the ways others see the world"* (Neuman & Kreuger, 2003, p. 75). Fourth generation evaluation was used as an effective method to critique the E4E professional development programme for teachers. The tensions and conflicts associated with this methodology were considered including theory and practice issues, the role of active participants and ownership of evaluation studies. The constructivist view as described by Hipps (1993), that reality is changing whether the observer wishes it to or not, is an indication of multiple constructions of reality. Constructivism values the individual multiple realities that stakeholders have in their minds. Therefore, to acquire reliable multiple and diverse realities, multiple methods of searching for or generating data are in order.

SIGNIFICANCE

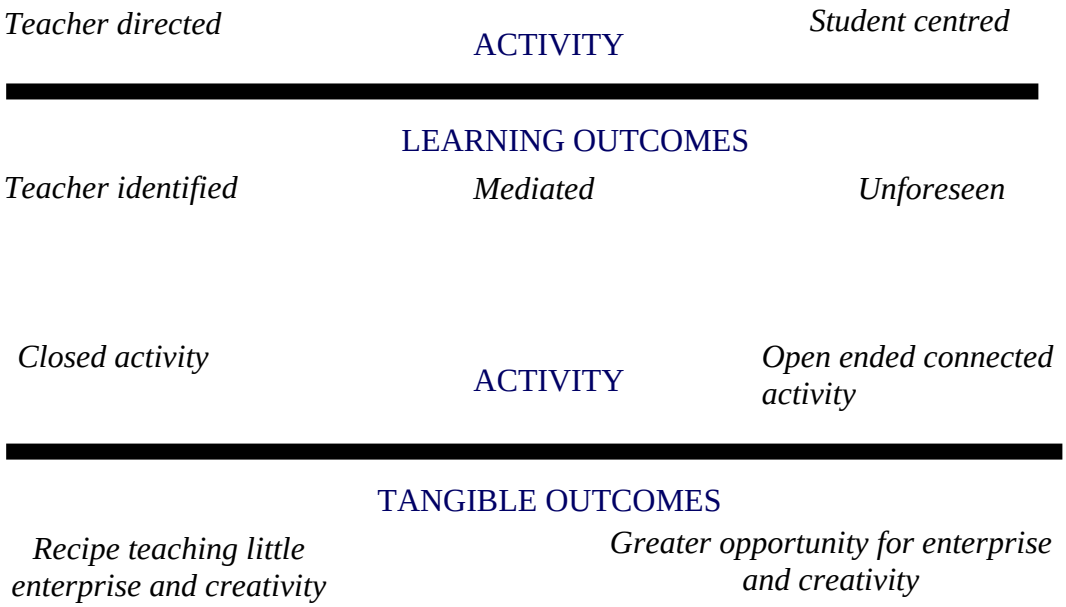
With the new curriculum implementation underway and also the E4E professional development contract concluding, it is timely and important for academic research in to this area to be discussed. Connecting school activity with out of school experience is not a new concept. Indeed it relies heavily on the work of Dewey and reflective thinking as explained by Marshall.

> *This was not to make the schools an adjunct of industry and commerce and to acquiesce in the 'untransformed, unrationalised and unsocialised phases of our defective industrial regime', but of utilising the intellectual problem-solving potential inherent in modern technology; 'to make school life more active, more full of meaning, more connected with out of school experience'. (Marshall, 1997, p 309)*

Young (1998), when talking about flexible specialisation and its relevance to education, introduced a notion of 'connective specialisation'. This contrasts with the insularity of the traditional subjects specialists and ultimately with the divided curriculum which dominates in the secondary sector. Divisive specialists see the curriculum from the point of view of their subjects, whereas connective specialists see their subjects from the point of view of the overall curriculum. Young argues for a shift from teacher centeredness to learner centeredness. According to TKI, the Ministry of Education website:

> *Education for Enterprise provides opportunities for students to link their learning to 'real-life' situations. It combines classroom learning and participation in the broader community, including the world of business, and reinforces the relevance and value of what is learned in the curriculum.*
>
> *(*Ministry of Education (2007).)

The following diagram is used as a discussion starter with pre service trainee teachers attending technology courses at Massey University to broaden their personal constructs of technological activity and to highlight the connected nature of teaching and learning.



A connective curriculum acknowledges that education takes place in a community of practice and that learning is purposive and a social process (Lave & Wengler, 1994 cited in Young, 1998). It exposes the need to relate educational activities to developments in the wider society including but not exclusively linked to industry. So, according to this model connectivity is more than just a curriculum model, it is the purpose of school itself!

FINDINGS

Students in the Integrated Curriculum Science and Technology course expressed some reservations about aspects of Science teaching however these were no where near as strong as there reservations about teaching Technology particularly the fuzzy front end. These findings support the importance of having a robust personal construct of what constitutes technology education. Banks and McCormick (2005) discuss the nature of an 'enacted' curriculum and raise concerns with regard to teachers' professional knowledge and the implications these have for teacher training. The authors also highlight concerns that work needs to be carried out with pre service teachers to ensure there is not a mismatch between any prescriptions developed and the individual's personal construct. Personal constructs which are developed from the experiences, beliefs and values of each student inform their view of education and of teaching. Research has shown that aspects of self-understanding through construct developments play an important role in what pre service student teachers learn (Massengill et. al. 2005, Poulou 2005) and the way in which teachers ultimately teach (see Day et. al 2006, Boote 2006). These views were supported by this research.

Similarly issues arose in the E4E research where many of the teachers struggled with identifying the early stages of their technology projects. The facilitators and researcher re-

acted to this need by providing a workshop on the *'fuzzy front end'* from new product development (NPD) research. This included developmental work around:

1. *Opportunity Identification*
2. *Opportunity Analysis*
3. *Idea Genesis*
4. *Idea Selection*
5. *Concept and Technology Development*

(Koen et al., 2001, pp. 47-51)

These professional development sessions for teachers proved to be both popular and invaluable to the project team as it helped foster a win, win situation for the teaching staff and researcher alike.

Some key success themes have begun to emerge from looking at these research projects collectively these will be reported in more detail at a later stage. However, early analysis looking for success criteria indicates that under each heading some notable key points arise.

E4E

- An emphasis on a real need while designing the unit.
- Making the need transparent to the students so they see what their new found skills and knowledge will be used for.
- Doing more than presentations at the using and doing stage.
- Keeping E4E attributes in mind when designing the whole unit rather than as an add on.
- Curriculum integration, it creates time. Real life is an integration-it's the only way we get things done.
- Making sure the students see the timeframe, deadlines and expectations continually.
- Continued reflection on progress.
- Scaffolding that will help groups organise things-making it simple-initially.
- Building the background knowledge to ask relevant enquiry questions.
- Focus and continuity– not three units happening at once.
- Not too much time spent on the fuzzy front end.
- Student involvement in planning, goal setting, and tangents. Student ideas are actually used.

CURRICULUM INTEGRATION

The framework has confirmed what staff had suspected, the importance of placing and timing of courses within teacher education programmes. Students personal constructs were stronger they noted for Science than Technology partly due to the closer proximity of courses. The technology course had been taken in semester one of year one whereas Science had been undertaken just before the integrated course offering. Additionally students felt they did not have enough understanding of technology to successfully integrate it, their personal constructs were weak. This was not enhanced by the lack of opportunity to see technology education occurring in schools.

THE FUZZY FRONT END

It is worthwhile spending time developing technology teachers' understandings of the fuzzy front end. This notion initially presented itself during the E4E research and subsequently presented to pre service teacher trainees both groups responded favourably. In both cases the efforts made to increase their personal constructs of technology through gaining a deeper understanding of the fuzzy front end proved to be worthwhile. There is certainly early indication that further research in this area would be warranted.

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