# CONFERENCE PROCEEDINGS SINO / NZ TVET EDUCATIONAL RESEARCH FORUM – TIANJIN, P.R. CHINA

New Zealand Papers

## Overview

The New Zealand and Chinese Ministries of Education have signed a strategic educational partnership to strengthen the links between the two countries. They have agreed to host an annual symposium, showcasing best practice in the delivery of vocational teaching. This publication provides the papers presented by New Zealand authors to the second Sino / NZ TVET Educational Forum held in Tianjin, P.R. China in November 2014

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# Education for Sustainability in Technological Vocational Education

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Building capabilities for the technological world of tomorrow is the primary aim of vocational education. That includes developing the skills and technical knowledge to problem-solve unseen needs by being able to design for a sustainable future. Education for sustainability is now a widely accepted concept which promotes sustainability skills and awareness throughout a learner's educational pathway. Using the results from three case studies this paper argues the necessity to integrate education for sustainability with traditional VET skills by involving students in practical applications. It contends that the inclusion of the quadruple bottom line (economics, environment, governance and society) into VET allows students to transform their attitudes to their trades and view productivity through the lens of maintaining a 'liveable' world. It concludes with the need to further research synergies between sustainability in the VET sector and aligning curricula to the needs of industry.

Keywords: Sustainable Technology; Integrated curriculum; Vocational education

## Background

Since 1987 the definition of sustainability drawn up by the World Commission on Environment and Development has been *development that considers the needs of the present without compromising the ability of future generations to meet their own needs* (The Brundtland declaration). In order to bring about sustainability in practice a number of researchers have demonstrated that vocational education and training (VET) has to be the starting point for initiating workplace change and up-skilling workers in sustainability concepts, from design and manufacture to use and eventual disposal (Fien & Wilson, 2005; Mazzotti, Murphy & Kent, 2007; Panko, 2012).

This concept has been translated into broader educational goals by the United Nations (2002) as encouraging learning processes that lead to decision making in favour of the long term future of the environment, economy and equity for all global communities. To support the goal of incorporating sustainability into all educational levels and particularly into skills-based education, 2005 to 2015 was declared as the Decade of Education for Sustainable Development (Parliamentary Commissioner for the Environment, 2004). During this decade the UN encouraged countries to embed education for sustainability across a wide range of curricula, in the hope that this would lead towards a more sustainable future and provide corresponding opportunities for the present and future generations.

The Bonn Declaration of 2004 states that "since education is considered the key to effective development strategies, technical and vocational education and training (TVET) must be the master key that can alleviate poverty, promote peace, conserve the environment, improve the quality of life for all and help to achieve sustainable development" (UNESCO/UNEVOC, 2004, p. 2). Even with the Bonn Declaration, the experiences in a number of countries suggest that the embedding of sustainability across the curriculum and particularly into VET areas remains challenging and has been attempted with differing degrees of success.

In Australia the majority of VET programmes now have mandatory requirements to embed environmentally sustainable concepts into the curriculum, and this has been largely due to support provided by the government and VET organisations. A similar situation has happened in Europe where the European Union's Europe 2020 strategy (EC, 2010) contains a commitment to incorporating sustainability in the VET sector.

## Barriers to embedding sustainability into VET

Research carried out by Sharma (2011) in New Zealand indicated that although there was general support for the concept of embedding sustainability into VET, there were also a number of barriers that could inhibit the process. Amongst the academics she interviewed a minority of faculty members raised the following issues they considered might be problematic:

- Sustainable practice was irrelevant for trades and only general trade skills are required by industry,
- Sustainability has economic boundaries and was too expensive to practice,
- Industry is unreceptive to sustainable practice and there is no expectation for academics to teach the concept,
- Educational compliance is not the answer to sustainability and will discourage students and academics,
- There was a general lack of knowledge about the concept amongst VET academics,
- Sustainability education will create extra work for everyone.

In addition, she discovered that in situations where some academics in the VET sector felt confident that they were already addressing sustainability, on further investigation they had only considered a small aspect of the topic, such as recycling. They were not considering the wider Quadruple Bottom Line (QBL) or applying any Life Cycle analysis into their teaching of overall technical processes. Nevertheless, she did discover that students largely had a more positive point of view and basically supported embedding sustainability into their programme of study.

**The Quadruple Bottom Line and Life Cycle Analyses**
Although fundamentally similar, the concept of triple and quadruple bottom line may demonstrate slight variations in areas of emphasis. The approach adopted by the authors of this paper focuses on four overlapping aspects of sustainability:

- Environment (Air, water, biodiversity)
- Governance (International, national, local and organisational)
- Economic (short and long term)
- Societal issues (Health, culture and employment)

These four fundamental aspects of sustainability create the complexity that has to be addressed in VET. “TVET for sustainable development is a process of incorporating into TVET considerations that impact on the long-term future of the economy, ecology and society. UNESCO-UNEVOC refers this as TVET for sustainable development” (Fien & Maclean, 2009, p. xxiv). These domains all have roles that need to be considered when examining the life cycle of products or processes from design and manufacture through use and eventual decommissioning. These will include pollution and energy expenditure and need to be addressed within the realms of diverse technical disciplines. When the QBL and life-cycles are examined for any technical product or process, the impact, both advantageous and detrimental can be assessed.

## Educating for Sustainability at Unitec Institute of Technology

Although approximately twenty of the Programmes in Unitec Institute of Technology do contain aspects of sustainability, one programme in particular features it to a significant extent, and this is the Bachelor’s Degree in Applied Technology where students are enrolled in a variety of practical disciplines such as Transport Technology, Electrotechnology and Building. Within this programme students encounter aspects of the Quadruple Bottom Line in conjunction with product and process life cycles - both under relevant topics within their individual pathways of study and collectively as a single semester course entitled Sustainable Technology, which is a compulsory second year subject. Participants are encouraged to explore cases within their own industry and creatively suggest where changes to the process or product could improve aspects of the QBL they had identified as currently highly damaging.

The initial question posed by this paper is: what teaching approaches resonate most with students and have the perceptions of students towards aspects of sustainability changed as a result of their learning? Answering this leads inevitably to ‘where to from here?’ as far as synergies between VET curriculum design and industry needs are situated.

## Research

The students who participated in these case studies were all enrolled in the Bachelor of Applied Technology and were likely to move into practical careers once qualified. A large proportion of these students were international, coming from countries such as Saudi Arabia, Malaysia and China, and the majority expected to return to their home countries to practice in their professions after graduation.

Over a two year period three separate case studies have been employed to investigate the reactions and engagement of students under differing circumstances. For this paper findings from all three cases were compiled to show the perceptions of both local and international participants towards VET issues involving sustainability. The three case studies were:

### Case study 1

Sixty second year students participated in a project designed to focus on reduction of waste materials. They were required to apply the guidelines provided by Jaques (2013) which emphasise the 5 Rs and also provide examples of the way in which these can be achieved:

- Reduce
- Reuse
- Recycle
- Recover and
- Residual disposal

Working as teams of five or six, students examined the construction waste bins around the Unitec campus and created an inventory of all the waste they identified. Then each team had to collaboratively debate online examples of the 5 Rs for all the material they had found. This included identification of the various categories of waste followed by research to explore options available to re-cycle or up-cycle all of this material, at each stage of a product's life cycle, from sensitive design to careful deconstruction. The students were then required to reflect on ways through which waste and pollution could be minimised, particularly within their own industries.

At the conclusion of the waste management project students were asked to complete a questionnaire designed to discover to what extent, if any, their understanding of waste management had been transformed by this process.

### Case study 2

To investigate the responses of International students 22 students participated in an On-line questionnaire at the end of their course. Their ethnicities were diverse (Fig. 1)

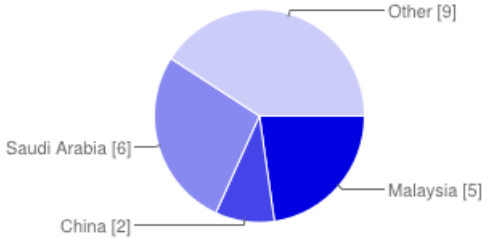



**Figure 1: Origins of the International students**

The international students were asked to respond to questions which explored their knowledge and perceptions of sustainability before and after their course. They were also asked about their views of the potential application of sustainable technologies in their industry in their own country.

### Case study 3

Thirty four members of a different cohort of the class visited a council transfer centre and saw the quantity and nature of waste materials being handled at the centre. They received information about the problems of landfill issues by experts at the site and later, in groups of four or five, discussed online creative design solutions under three main headings: Energy Reduction, Waste Minimization and Water Reduction. These postings were

assessed as part of their course requirements. In addition, they provided oral feedback on the value of the site visit and to what extent it had affected their views about recycling.

## Findings

All three cases showed an overwhelming degree of support for the concept of integrating sustainability into their degree programme, as can be seen from the results in Case Study 1 (Fig 2). This positive view was almost universal and was not affected by the students' country of origin nor by the technical discipline they followed. In addition, 82% of the participants believed that there were major opportunities for further application of sustainable practices in their own industries. Comments from the students' questionnaire indicated that they had undergone a stage of transformative learning in respect to sustainability in general and waste management in particular (Panko, Sharma & Fuemana, 2014) and these are represented by the following examples:

> I will try to plan out what is required initially before I do something that causes me to make mistakes and create cable waste.
> When I am qualified I will set up waste management so I can save more money in my business.
> If I work for a company that doesn't recycle properly I will bring this issue up with my boss to plan ways to recycle.
> [Lack of management is] waste of income, potential profits and the well-being of the human race.

They provided practical examples such as the potential for pollution reduction in China and energy conservation in Saudi Arabia. New Zealand participants considered factors such as the design of alternative energy sources and transportation mechanisms. There was, however, a degree of doubt as to whether changes could be implemented in reality. This feeling of powerlessness was more noticeable amongst participants from the developing world, whereas students from Germany who were previously familiar with the topic and who had observed it embedded in practice in their home country, considered New Zealand industries to be rather backward in sustainable practices.

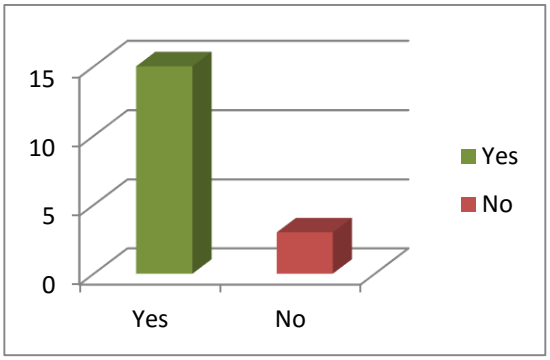



**Fig. 2: Students' evaluation of the relevance of waste management in their industry.**

**Figure 3: Case Study2 – hands-on at the deconstruction waste bins**

In Figure 3, one of the students is examining off-cuts from building construction before classifying the types of

material. When the three case studies were compared, although in all examples student were engaged in constructive learning activities, it was noticeable in their feedback that where they had undertaken hands-on activities such as the physical sorting of waste material, rather than simply observing this procedure, there was an increased degree of the value of the process.

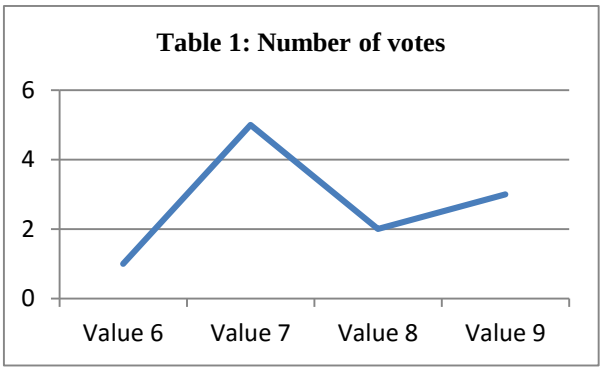
At the end of all three case studies , Figures Three and Four illustrate the difference between the two different learning activities.


**Figure 4: Case Study 3 – viewing recycling at the transfer centre**

Figure 4 shows students intrigued by the vision of a speedboat being prepared for deconstruction, and yet not being involved practically in the recycling process. Nevertheless, seeing steps in recycling actually taking place still proved to be a valuable step in conceptual transformation.

Students designed their own rating scale for the value of their field trip to the Transfer Centre on a Likert scale of 1 – 9, with 1 being of no value and 9 being maximum value. The results achieved by the 11 students who chose to register their evaluation was:

**Table 1: Number of votes**




After this visit one of the participants from Saudi Arabia said that this was the first time he had ever understood the concept of waste recycling. As far as he was aware all waste in his home country was piled up and dumped 'out of sight' and although he had seen recycling notices in New Zealand he had not realised what they related to. He stressed that learning about recycling would not only change his own behaviour but it also made him determined to introduce recycling after his return to his home.

However, not all students grasped the idea so readily. Another Saudi Arabian student said that he could not see any problem arising from continuing to use landfills and in discussion with staff said:

> Why don't you just dig them up when they are full? [*What would be done with the waste if it were dug up*?] You can throw it into the sea to get rid of it. [*But this would damage the environment and kill the fish!*] Fish are not as important as people and therefore this does not matter.

This absolute failure to grasp any of the principles of the QBL or Life cycle interrelationships, while being

unusual, did highlight the difference in sustainability values attained through prior study and experience as well as reinforcing the challenges posed by education for sustainability.

## Discussion

Several issues emerged from our case studies, firstly that the majority of international students had little or no prior knowledge of sustainability before undertaking their programme of study at Unitec. Secondly, that in most cases (although not all) learners placed a high level of value on their new understanding, particularly when they had acquired it through a practical work-integrated approach.

A third point that arose from our work has been the demonstration that students need to be able to see that their actions can make an impact in the world. This finding reinforces the work of Brown and Sack (2012) who recommended that VET programme developers 'should draw on the motivations of future labour market participants, many of whom will also be future employers, for its direction about which 'skills for sustainability' should be included into VET programs' (p.23). Comparable investigations conducted in the UK (Kagawa, 2007) provided similar positive results but additionally indicated a sense of futility amongst the students regarding the future of society in the face of broad-based environmental challenges. However, it was noticeable that many of the international students from countries where sustainability was not practised became ardent supporters of the ideas and were keen to put these experiences into practice after graduating.

## Conclusion

Once students are given an opportunity to discover the potential applications of the QBL and life cycle impacts within their own industry, they generally become impassioned supporters of sustainability design and use. This finding alone does not justify its inclusion into VET programmes but the introduction of more sustainable practices into the labour market should help the global movement towards the Brundtland declaration (WCED, 1987).

In New Zealand Sharma (2011) found that there was little or no collaboration between academics and industry when it came to education for sustainability (EfS) with neither group taking responsibility for embedding the concepts into the VET curriculum. The slow progress of embedding sustainability concepts into the vocational education curriculum is likely to result of this lack of collaboration.

The future of VET in New Zealand and in countries which have not previously integrated education for sustainability into their curricula must be a multi-step approach, built on the foundations of research within different industries and environments. This relationship is illustrated in Figure 5, where industry needs and economic pressures, both long and short term, need to be studied in greater detail so that the findings they reveal can then modify curriculum design.

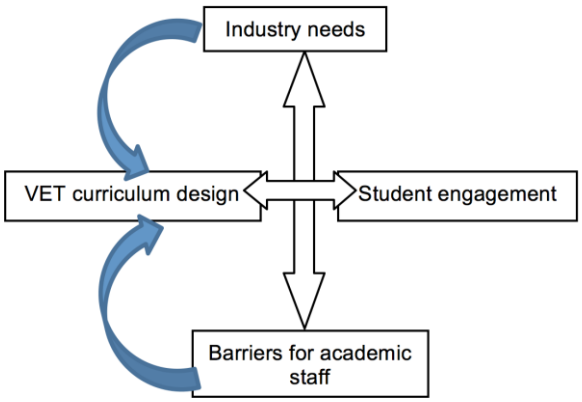



**Figure 5: Potential for collaborative research**

### Future for potential collaborative research

The gaps in knowledge about the requirements in VET curricula are large and depending upon the questions being asked, are all worth posing. However, in order to bring some logic to the topics that could be worth

investigating applying the framework of the QBL could be a valuable starting point when examining the responses of any industry. In other words organisations that employ VET graduates might be investigated to explore what policies or even interest they currently have about:

- Their impact on the Environment (including pollution effects, ranging from extraction used in material acquisition through to decommissioning of products)
- The effect upon their business of existing regulations and/or financial incentives (Governance)
- Economic impacts of sustainability within their organisation (negative and positive; short and long term, including influences of marketing. Including energy consumption.
- Societal pressures (health, employment and values of employees)

This investigative approach should not only produce more in-depth results than a simple inquiry along the lines of "Do you think that a VET curriculum should include Sustainability?" but it may also produce the advantage of triggering an organisation to recognise long term benefits they had not previously considered.

The second area that requires further investigation is the issue of barriers identified by Sharma (2011) from her research with a proportion of academic staff. Although her interviewees responses indicate their beliefs that industry does not want or need graduates with sustainability education, their reactions also appear to stem from a lack of their own knowledge about the concepts of sustainability and how they can be applied to the disciplines they are working within. If this is found to be a general problem, it would indicate that substantial professional development will be needed by VET personnel. Such a potential need for re-education returns once more to the field of curriculum design.

Lastly, when considering the role of curriculum design in technological or industrial sectors, in order to fulfill the widest needs of an industry the curriculum firstly has to work with a graduate profile that fulfills the expectations and requirements of that industry. But that alone is not enough. If the premise of building capabilities for the technological world of tomorrow is truly the primary aim of vocational education, that must include developing the skills and technical knowledge to problem-solve unseen needs by being able to design for a sustainable future. In other words, what industry wants today cannot be sufficient and academic staff have to be prepared to work within that unknown.

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