

## REFLECTIONS ON TRIALLING TWO TEACHING STRATEGIES FOR SUSTAINABILITY MANAGEMENT EDUCATION IN AN UNDERGRADUATE ENGINEERING MODULE

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**Abstract:** This paper focuses on the effects of trialling two teaching strategies for sustainability management education in an undergraduate engineering module. The first strategy involved delivering a lecture using the TEAM EFFORT formula on the Work Practices & Management module within the School of the Built Environment (SCOBE) at the University of Ulster, Jordanstown (UUJ). This TEAM EFFORT formula is part of a teaching strategy used to deliver and evaluate the required multi-disciplinary approach to sustainability within the built environment. The TEAM EFFORT formula consists of: TE = Team Effort; AM = Appropriate Management; EF = Evaluation Framework; FO = Focused Outlook; and RT = Risk Translation.

The second strategy involved a TEAM EFFORT approach within the same module, in the form of a management simulation assessment referred to as “The Consultancy” which also focused on sustainability. Groups for The Consultancy were multi-disciplinary drawn from programmes within SCOBE. Over a 5-week period, the groups were given tasks to solve by choosing from multiple choice answers. The tasks involved knowledge and understanding of several factors including environmental, economic, social, safety and resource management. The best performing group overall, in terms of selection and justification of its answers, was judged by a chosen industrialist.

The results of formative student assessments for both strategies using this TEAM EFFORT approach showed that the students’ awareness of the linkages across the pillars of sustainability had improved. However, this was not as evident in the summative assessments for this module at the end of the semester. These results highlight the short-term effectiveness of these approaches to teaching and student learning and the need for further pedagogy research to achieve deeper learning and improved sustainability management and employability skills for graduates.

*Keywords: Assessment, Management, Sustainability, Teaching Strategies, Team Effort.*

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## 1. INTRODUCTION

### 1.1 Sustainability Management

The background to this paper relates to the need to apply the principles of sustainability to the management of the infrastructure within the built environment. However, there are many problems associated with basic infrastructure in the UK and Ireland.

In 2006, almost 5,000 homes in England and Wales were still experiencing problems related to flooding despite there being a drought that summer (Goring, 2007). Goring also states that 3,500 million litres of water were lost every day during that period due to leaking watermains. The cost of flood damage from summer flooding in the UK in 2007 has been estimated at a cost of £3 billion with approximately 3,600 Yorkshire businesses and 500,000 homes affected; approximately 145,000 people had no water supply when the Mythe water treatment plant (WTP) in Gloucestershire flooded (Oliver, 2007).

In the past decade, people in UK and Ireland have been exposed to the virus cryptosporidium in their drinking water supplies (Engineers Ireland, 2007). Increased precipitation has also led to flooding episodes on the island of Ireland, the most notable being Cork City in 2009 (Independent, 2009). In Ireland, significant increases in winter precipitation levels have been detected (EPA, 2002).

The myriad of problems which face infrastructure performance require solutions that are based on a collaborative approach. In this context, civil engineering students need to develop problem-solving skills by gaining knowledge through learning. A basic concept of learning is that in order for students to learn at a higher level, they must possess a good understanding of the fundamentals of their subject area. Many programmes in higher education are designed so that students build incrementally on their existing level of knowledge; thereby, students need to ensure they have a good grasp of the prerequisites to help facilitate a smooth transition to the next level. In relation to sustainability, the aspiration at University of Ulster at Jordanstown (UUJ) is to thread sustainability through all modules within SCOBÉ. One particular module, Work Practices & Management provides two explicit sections in terms of sustainability management:

1. The 'TEAM EFFORT Formula' which clearly shows that a collaborative approach is required to achieve sustainable development.
2. 'The Consultancy' which splits the class into multi-disciplinary teams that are given weekly tasks that involve the sustainability management of a construction project.

This approach links to other modules within SCOBÉ as environmental, economic and safety issues are considered.

### 1.2 Teaching Strategies

Learning is... *"about change: the change brought about by developing a new skill, understanding something new, changing an attitude...is a relatively permanent change, usually brought about intentionally and purposefully"* (Reece & Walker, 2003, p.59).

However, not everyone learns in the same way, which is an important consideration for lecturers in education (Fry *et al.*, 2003). Indeed, it is hypothesised that the approach to learning which a student employs is both personal and situational (Ramsden, 1988). It is recommended that lecturers should consider how to bring about change or transformation to the pre-existing knowledge of their learners (Mezirow, 1991).

Different approaches to learning exist (Ramsden, 2003) and approaches to and successes in learning are linked to the motivation of the students to learn (Reece & Walker, 2003). This motivation relates to whether the students are determined by outcomes rather than their understanding of the subject (Reece & Walker, 2003). The works of Marton (1974), Entwistle

(1986), Ramsden (1988) and Biggs (1987) have conducted numerous research studies into the area of learning approaches. Their investigations have led to three main approaches – the Surface Approach; the Deep Approach and the Strategic Approach, which can be briefly explained as follows.

The main characteristics of the surface and deep approaches to learning are contained in the work of Ramsden (2003). In simple terms, *surface* learning is about quantity without quality; deep learning is about quantity and quality (Biggs, 1989). From a lecturing perspective, this surface approach to learning would not be conducive to learning as many of the modules on courses require underpinning knowledge of previous modules. Furthermore, this has further implications as graduates progress into employment in industry. A deep learner can become actively involved in the course and will carefully examine the logic behind the entirety of the course content. Meanwhile, the *deep* approach to learning is the ‘*intention to understand*’ (Ramsden, 2003, p.47). A student who employs a deep approach to learning is utilising previous knowledge of the subject and/or any experience relating to the subject area. This is a more desirable approach as students actually develop an interest in their subject which allows them a greater understanding of the topic, and the ability to integrate the material.

Thirdly, the *strategic* approach typifies students who “*adapt their learning style to meet the needs of the task*” (Fry *et al.*, 2003, p.440). A student who engages a strategic approach, also known as the Achieving Approach to learning, is doing so in order to achieve the highest possible marks for their own sake but not necessarily to signify a high level of learning. The strategic approach can use a combination of the surface and deep approaches to learning. A student who primarily uses a deep approach to learning may adopt some form of the techniques of a surface learner in order to obtain a high grade. Thus, the deep approach is not a permanent approach of the student as achievement is mainly associated with the exam or assignment grade, as articulated in the summative assessment

Although a number of learning styles have been described, it is not appropriate to label students into specific categories. Most learners have a primary surface learning style but this can depend on the subject and situation. Lectures must be designed so that everyone on the programme develops and adapts their specific level of learning. However, Felder & Silverman (1988) concluded that the preferred teaching style of most engineering faculties was not meeting the best learning style of engineering students. Different students have their own individual methods of remembering information, showing creativity and demonstrating understanding. These methods can include mind mapping and the use of acronyms.

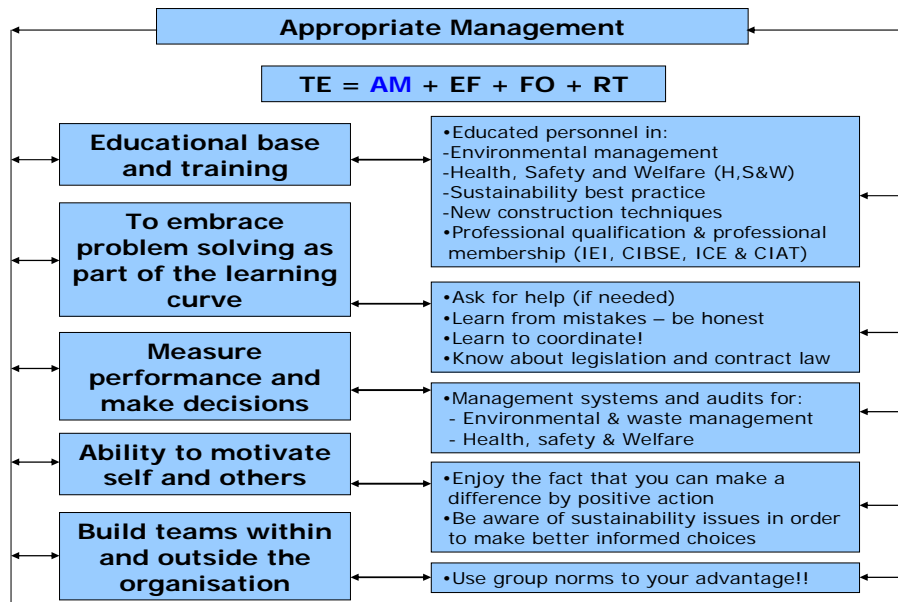
Lecturers continue to aim to facilitate students’ learning, especially in the creation of long-term memory (Herbert & Burt, 2004). Studies have highlighted the advantages of mind mapping as a technique to enhance learning (Mento *et al.*, 1999; Buzan & Buzan, 1995; Buzan, 2002; Buzan, 2005). Stalder (2005) showed that the use of acronyms consistently predicted higher performance in an acronym related exam, and helpful in increasing student motivation to study. However, others have questioned their effectiveness (Carlson *et al.*, 1981; Carney *et al.*, 1994).

## 2. METHODOLOGY

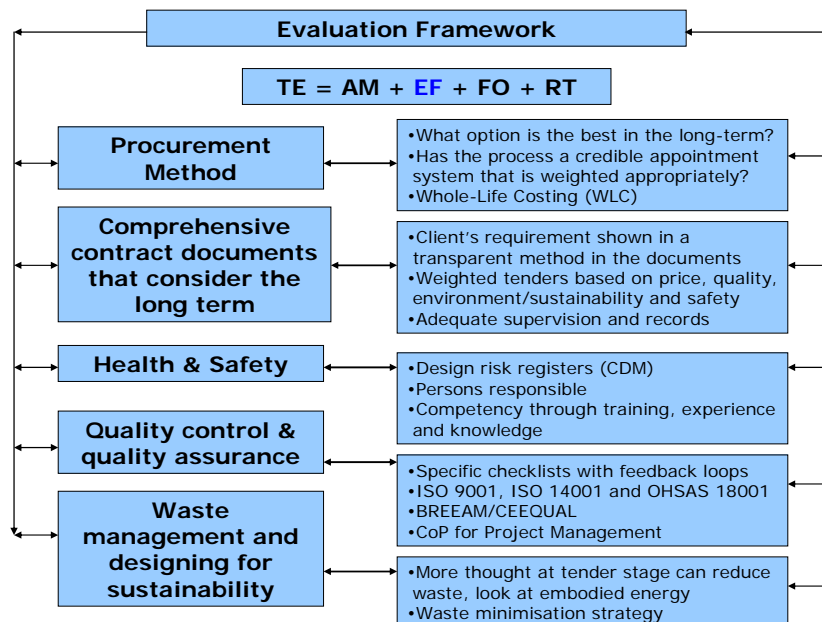
### 2.1 TEAM EFFORT Formula

The TEAM EFFORT formula is a teaching tool using an acronym which is presented to students as follows: TE (team effort) = AM (appropriate management) + EF (evaluation framework) + FO (focused outlook) + RT (risk translation). Part of the lecture PowerPoint presentation entitled “*How can Work Practices & Management influence the direction and focus of sustainability?*” is shown on *Figures 1, 2 and 3*. The formula was devised as a study

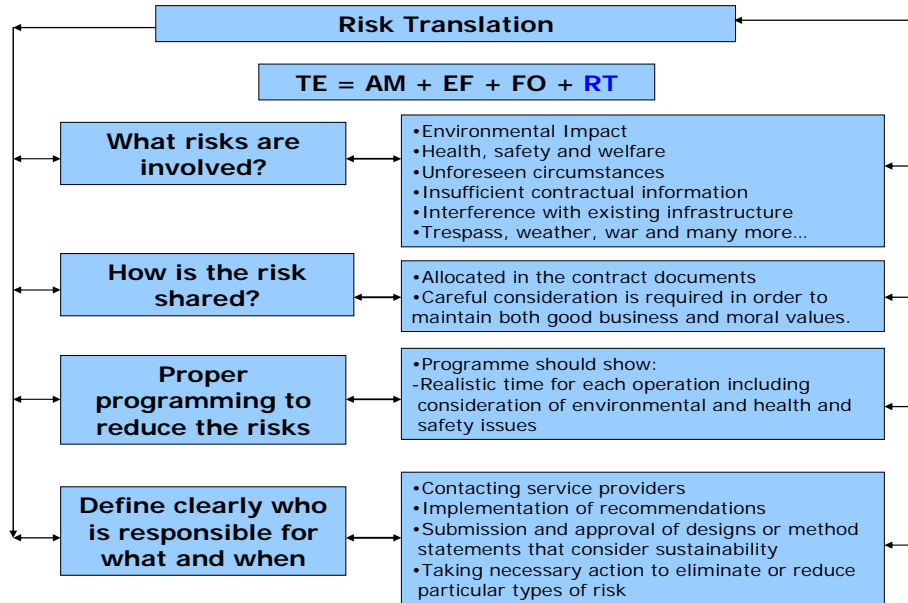
aid to assist students in applying the principles of sustainability by using a team effort approach. Eighty undergraduate students in total attended the lecture. Each of the four criteria, which form the TEAM EFFORT formula, has specific sub-headings which are expanded upon during the lecture. This helps the students understand what *is* required to provide sustainable solutions.



**Figure 1 Appropriate Management**



**Figure 2 Evaluation Framework**



**Figure 3 Risk Translation**

### 2.2 The Consultancy

The Consultancy requires the class to be split up into approximately ten groups of eight students each. The students in these multi-disciplinary groups are from programmes within SCOBE. The Consultancy takes into account sustainability in construction as opposed to a complete focus on tendering/cash flow. Each group is assigned a specific role; for example, SCOBE consultant, building services consultant, architectural consultant. Over a 5-week period, the groups are given tasks to solve in terms of choosing the most appropriate answer to a given question from a choice of three answers.

The project, which was assigned to the class in the 2009-2010 academic year, involved the construction of an access bridge over an existing river. Part of the site was on a flood plain and the site was adjacent to a wildlife sanctuary.

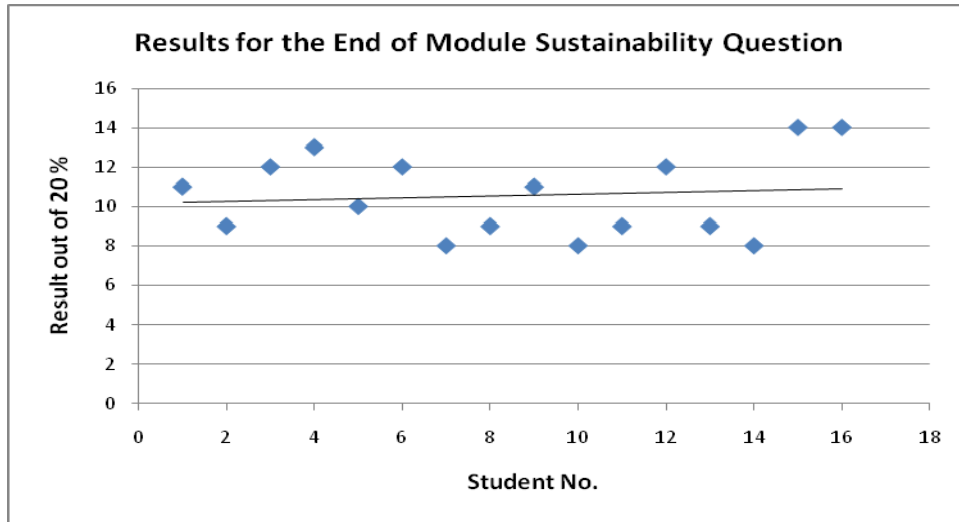
Each group had to submit its answer by a specified deadline on each consecutive week. The best performing group overall, in terms of selection and justification of their answer, was judged by a chosen independent industrialist. Each student in the class used their role within the simulation to submit an individual report which conveyed their experiences from the simulation. The individual report accounts for half of the coursework mark in the module.

## 3. RESULTS

### 3.1 TEAM EFFORT Formula

The 2009-2010 Work Practices & Management examination had a specific question that related to the TEAM EFFORT formula. The average results for this question were lower than similar qualitative questions within the exam paper. It appears that this was due to the students providing a large amount of theoretical information on teams/groups as opposed to concentration on the formulated approach to sustainability management delivered in the specific lecture. *Figure 4* illustrates that the majority of students only managed to achieve approximately half the marks for this question, with a median score of 55%. Although they effectively recalled the theory on team work, their answers did not necessarily link the TEAM EFFORT formula to sustainability. Thus, the results do not concur with all the theoretical information on the use of acronyms in teaching, and indicated that there was only

surface learning achieved, despite the attempt to develop deep learning. It is also worth noting that this sustainability question was the second lowest performing question out of a total of seven questions in the exam paper.

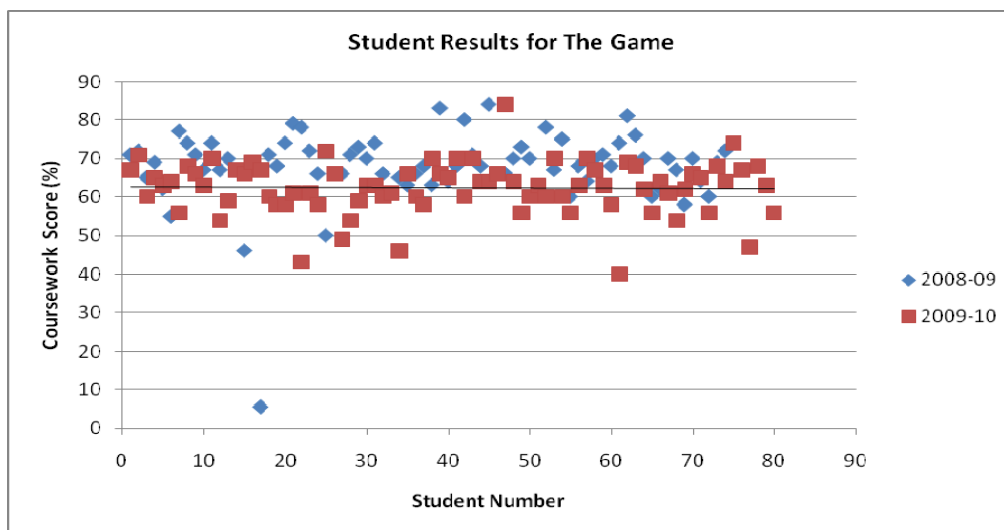


**Figure 4 Results for the End of Module Sustainability Question**

Considering these results, it is proposed that the TEAM EFFORT formula lecture material will be delivered as a six-hour workshop in the 2010-11 academic year, to embrace both surface and deep learning. This is not merely an attempt to improve formative or summative assessment but to improve sustainability management for life. Further development of the sustainability aspect of the module may include a specific discussion board for the TEAM EFFORT formula and the inclusion of an online quiz. These would be particularly useful forms of assessing student performance and engagement.

### 3.2 The Consultancy

Since the introduction of implicit consideration of matters relating to sustainability within the management simulation consultancy in 2009, the average individual assignment results for “The Consultancy” dropped from 67.7% ( $\pm 9.91$ ) in 2008-09 to 62.38% ( $\pm 6.80$ ) in 2009-10, (see Figure 5).



**Figure 5 Student Results for The Consultancy**

There was no distinction shown across the three built environment disciplines, in this reduced summative performance. This also suggested that the attempt to integrate the more complex aspects of sustainability was not fully achieved.

#### 4. CONCLUSION

The collaborative approach given in the teaching of sustainability management in the Work Practices & Management module at UJJ is in line with what is being called for by leading institutions. Mr. John Power (Director General, Engineers Ireland) has proposed that the relevant bodies collaborate with Engineers Ireland to facilitate greater coordination for flood management (Engineers Ireland, 2010); similarly, sustainable development is a core requirement of the Engineering Council in higher education programmes which provide under-pinning knowledge for potential chartered engineers (EC UK, 2007). Whilst Power's comments are set in the context of coping with floods, this broad and deep approach is required for all aspects of our infrastructure, and to satisfy the broader sustainability requirement.

The results of the summative assessment relating to the introduction of explicit sustainable development management themes into the Work Practices & Management module showed that a number of students found it difficult to apply the theory to cross disciplinary understanding and analysis needed within sustainability management; however, a good knowledge of team/group theory was demonstrated. Graduates must be equipped with the transferable and essential skills relating to decision-making, problem-solving, managing people, working as a team and communicating outputs whilst instilling in them the sustainability ethos. The research undertaken within the universities will help governments and consulting engineers to make the right decisions. This is highlighted by the Irish Academy of Engineers and Engineers Ireland in the 2010 report on *Infrastructure for an Island Population of 8 million*.

*“The complementary nature of the major research capabilities should be supported by all-island grant and incentive mechanisms, particularly those facilitating the trend towards increased enterprise-academia collaboration”.*

Irish Academy of Engineers and Engineers Ireland, 2010, p.57.

It is evident that SCUBE graduates from UJJ who progress to industry rather than postgraduate study still possess the foundations and skills in being able to undertake research that relates to sustainable development and sustainable management. However it is also evident that there needs to be ongoing pedagogical research and experimentation to achieve deep learning for graduates in order that they naturally embrace the holistic and integrating thinking of sustainable development and sustainability management. Therefore, module delivery is of vital significance for the future, so that the Work Practices & Management module fully assimilates the dynamics of the challenges of employment and multi-disciplinary and professional thinking, and that graduates become sustainability managers irrespective of their discipline. In summary, this study highlights the short-term effectiveness of two approaches to teaching and learning and the need for further pedagogy research to achieve deeper learning and improved sustainability management and employability skills for graduates.

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