Transformation of Educators in Project Based Learning Program Development

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CONTEXT
Fiji National University (FNU) is a dual sector university in the Australasian Region offering a range of engineering programs from certificates and diplomas to Bachelor of Engineering levels. Being the second most populated country in the Pacific, FNU has been the education hub for engineering students from both Fiji and neighbouring islands countries in the Pacific Region. In order to align these programs to international accreditation standards, a massive program design change has been carried out, particularly in the adoption of project based learning methodology in the curriculum. The new learning and teaching methodology and program structure demand fundamental changes to the educators themselves. FNU Engineering will be expanding rapidly in the next few years while introducing the new engineering programs and seeking accreditation from international engineering organisations. The experience in transforming existing engineering educators at this early stage will need to be consolidated and repeated for future staff.

PURPOSE
This paper investigates the implication of changes that are occurring in a faculty wide transformation project for FNU Engineering and attempts identify changes in the role and competency of engineering educators in order to adapt to the new and non-structured learning and teaching processes in project based learning course development.

APPROACH
This research adopts two fundamental approaches. There will be fundamental change in program design and team building due to the implementation of project based learning methodology in the whole curriculum. A team management profile has been developed for each program team to understand the dynamics and potential role conflicts among the educators.

RESULTS
The team profiles have been collected and the progress of program changes is currently being monitored in the next couple of months. The relationship between team profile and the effectiveness of program design will be analysed. Based on the indication in the team profiles, two courses have been chosen to be the pilot study for analysing the changes on the educators, such as amount of courseware, consultative and counselling hours are measured. The results from these pilot courses will form the basis for identifying the implication changes in the system.

CONCLUSIONS
It is still early to conclude but the results in the research in the last three months have indicated that team management profiles are strong indicators of team effectiveness in the development of new programs that are required to adopt a non-traditional learning and teaching approach such as project based learning.

KEYWORDS
Transformation of educators, project based learning program, team management profiling.

Introduction

More than half of Fijians live in urban areas, and with rising water levels this shift to the cities is expected to increase. Whilst there is no notable loss of land mass yet, the quality of drinking water is affected by rising water levels. The Pacific islands are generally challenged by growing populations, modest economic opportunities and challenging weather conditions. Tourism is vital to the economy of Fiji and surrounding South Pacific countries. A viable tourism industry relies on well engineered water supplies, waste treatment, buildings, transport and telecommunications in locations that are vulnerable to earthquakes, tsunamis and cyclones. A good supply of qualified engineers is critical for sustainable economic development. Earlier this year Fiji's Cyclone Winston was the strongest cyclone in recorded history, raising higher expectations of Fiji National University to become an active part of the solution.

Whilst many students study in Australia and New Zealand, this can feed a 'brain drain' and is costly compared to study in Fiji. Fiji's engineering educators provide training and education for Fijians, but the country also serves as an educational hub for the Pacific islands. Fiji National University (FNU) was set up by the Fiji Government by merging six separate colleges and institutes to technology in 2010. FNU's College of Engineering, Science and Technology (CEST) is the primary education unit in FNU responsible for engineering and related educational programs.

In an Industry Forum held at FNU, all participants agreed that engineering independence requires a critical mass of "home-grown" professionals and technicians to work in the Region. Since FNU is a new university, many educational systems and programs are still operating at the Technical, Vocational Education and Training (TVET) and traditional philosophy. To ensure that the new engineering programs are designed and offered compatible to the world's standard including Washington and Dublin Accords, FNU is determined to adopt the latest engineering education practices and processes.

However, the new program design and curriculum requirements demands a transformation of the existing system and educational culture in CEST. The transformation not only includes design of new curriculum but also the people and processes that should be built into this new structure. This paper investigates the implications of changes that are occurring in a faculty wide transformation project for FNU Engineering and attempts to identify changes in the role and competency of engineering educators in order to adapt to the new and non-structured learning and teaching processes in project based learning course development.

Literature Review

One of the fundamental questions asked by the FNU program development team is how to design an engineering curriculum complying with Washington Accord at level 8 and with Dublin Accord at level 6. The approach to find the solution is to explore the nature of human thinking and student learning with respect to the required level of cognition (Houghton, 2013). Shephard (2008) examined aspects of educational theories in different affective domain (values, attitudes and behaviours) and suggested supporting educators' legitimate aspirations for these affective learning outcomes.

Cognition and Curriculum Design

Anderson and Krathwohl (2001) updated the Cognitive Domain with the aim of making it more relevant for today's students and teachers. Forehand (2010) elaborated on Bloom's one-dimensional taxonomy into a two-dimensional form which depicts the relationships between knowledge areas, learning processes and post-learning actions. The knowledge dimension categorises the types of knowledge learnt while the cognitive process dimension

categorises the processes used for learning. Each dimension contains sub-categories and definitions which can be explored via the hyperlinks.

Crawley (2002) embodied a Statement of Goals in some undergraduate engineering programs by specific CDIO (conceive-design-implement-operate) syllabus. The objectives were to create rational, complete, universal and generalizable goals for undergraduate engineering education. Crawley et al (2011) examined the content and structure of a CDIO syllabus, and then contrasted the syllabus with other important taxonomies of educational outcomes. They found that the CDIO syllabus was consistent and more detailed and comprehensive than any of the individual standards.

The SOLO (Structure of the Observed Learning Outcome) taxonomy is based upon the study of outcomes in a variety of academic content areas (Biggs and Collis 1982). In principle, the outcomes of student learning and understanding display different stages of increasing structural complexity. The SOLO taxonomy provides a systematic way of describing how a learner's understanding grows when mastering many academic tasks.

Constructive Alignment

A key to good teaching is to base the approach on the way students learn. Learning is the result of constructive activities by the student and teaching can only be effective if it supports activities appropriate to achieving course and program objectives and encourages students to adopt a deep approach to learning (Clare, 2007).

Constructive alignment is a term coined by Biggs (1999) to reflect a teaching system which is based upon constructivism in learning and alignment in teaching. Alignment implies that real student learning only occurs if the students take responsibility for managing their own learning (Barrie et al, 2007; Shepard, 2000). The emphasis for constructive alignment has many implications. One critical implication is the change of approaches to designing teaching materials and assessments at Level 8 (Jarman et al, 2014). This has significant impact on staff attitude and morale.

Project Based Learning

Markham (2011) believed that project based learning has two advantages: (1) integration of knowing and doing, (2) planned feedback process enabling students to learn from mistakes. Martinez et al (2011) applied PBL in two courses on power supplies and photovoltaic electricity successfully. The methodology was proven successful, as all the students who have followed it passed the courses due to enhanced skills in project planning, group management, technical writing and presentation in public.

Problem-based learning (PBL) and project-based learning (PjBL) courses have been used in developing engineering programs addressing real-world sustainability problems (Brundiers and Wiek, 2013). However, they also found that PBL and PjBL had weaknesses including paucity of critical learning objectives, solution-oriented research methodology, and follow-up research on implementation. More researches would be required.

Program Design Process

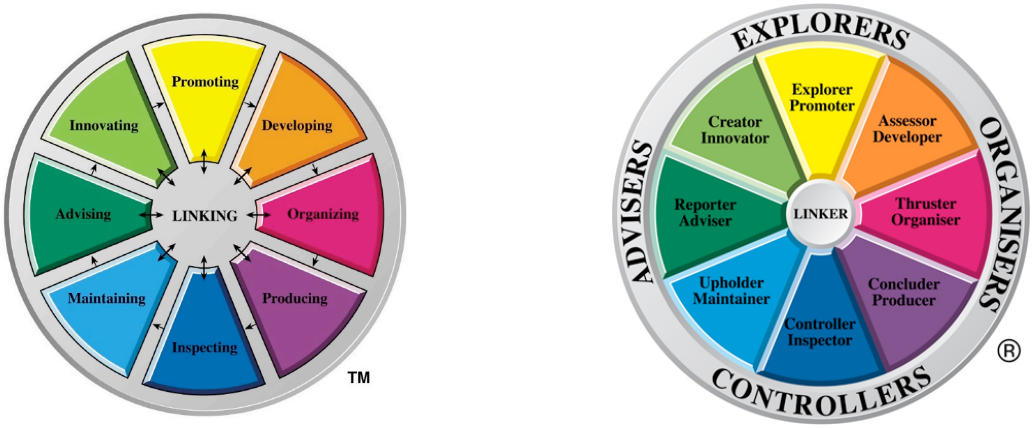
The program development process was initially indifferent from traditional program development process in FNU. However, it was soon found that the outcome was unsatisfactory. RMIT researchers were asked to assist to develop the new programs. Since early 2016 until June, several workshops were held with the academic staff of FNU on the issues as reviewed above. However, progress was slow.

When significant change in any organisation is planned, understanding the organisation's leadership, as well as management and work teams at all levels is absolutely essential. The program development team needs to be well coordinated and their actions synchronised to maximise the efficient delivery of the transformation process.

Team Profiling

TMS was established after extensive research by Margerison and McCann (1995). TMS is now recognized globally as the foremost integrated system of work-based feedback instruments. The method has been used with individuals and teams at all levels in organisations in many industries including academia, banking, construction, energy, government and engineering.

The TMS approach focuses primarily on identifying the key work activities that explain why some individuals, teams, and organizations perform effectively and achieve their objectives, while others fail. The process model, or task cycle, outlining the exemplary work activities is referred to as the Margerison-McCann Types of Work Wheel (Figure 1a).



(a) (b)

Figure 1: Margerison-McCann Types of Work and Team Management Wheel

Further research identified a predictive relationship between individual differences and work preferences (McCann and Mead, 2010). For example, team members who were more practical in how they liked to use information in the workplace tended to prefer Producing and Inspecting types of work. By overlaying individual measures of different approaches to work with their analysis of tasks in the Types of Work Wheel, a model of team roles could be illustrated in Figure 1b. Brief explanations of the key parameters are listed in Table 1.

Table 1: Explanations of TMS types of work

No.	Key	Description
1	Advising	Gathering and reporting information
2	Innovating	Creating and experimenting with ideas
3	Promoting	Exploring and presenting opportunities
4	Developing	Assessing and testing the applicability of new approaches
5	Organizing	Establishing and implementing ways of making things work
6	Producing	Concluding and delivering outputs
7	Inspecting	Controlling and auditing the working of systems
8	Maintaining	Upholding and safeguarding standards and processes
9	Linking	Coordinating and integrating the work of others

To receive personalised feedback from TMS, an individual completes the 60-item self-report work preference measure, the Team Management Profile Questionnaire. The resulting report, the Team Management Profile (TMP) highlights the respondent's major role on the Team Management Wheel (e.g. Creator Innovator or Assessor Developer).

Major role preference distribution - Worldwide profession sample: Academic (n=416)

(a)

Major role preference distribution - Worldwide profession sample: Engineer - Civil (n=547)

(b)

Major role preference distribution - Worldwide profession sample: Engineer - Mechanical (n=360)

(c)

Major role preference distribution - Worldwide profession sample: Engineer - Electrical (n=313)

(d)

Figure 2: TMP major role distribution for academics and engineering disciplines

The next two most likely roles, as well as a comprehensive explanation about the impact their work preferences have on how they approach work and how they collaborate.

Reference Educator Profiles

The FNU team profile data can be compared with other reference groups from the TMS global database of over 300,000 respondents (McCann and Mead, 2010). TMP major role preference distributions for Academics are shown in Figure 2(a) along with data in Figure 2(b), 2(c), 2(d) reporting relevant samples for three major engineering disciplines.

FNU Program Development Team Profiles

Two major changes have been instigated in FNU. First, the program development team has been asked to develop a new suite of Bachelor of Engineering programs conforming to internationally recognised engineering education standards. Second, to reinforce compliance with design and research expectation at honours degree level, the program development team launched two pilot project based learning courses to investigate the changes in team profile, if any, through the transformation project activities.

FNU TMP

To understand what enhancements are required to assist the FNU program development team in this process, key FNU engineering staff have received a Team Management Profile and had their reports debriefed. Collection of these data is already a challenge due to lack of understanding among the staff. In order to focus on the key issues of how to plan for transformation, the survey is restricted to key and relevant staff only.

Unfortunately, due to vacation arrangement, some specific measurement samples are smaller than expected. However, this measurement exercise will continue for a couple of months so further data could be available later.

Table 2: FNU Team Management Profiles

Key	1	2	3	4	5	6	7	8
Academics (including exec and HOS)	0%	5%	8%	20%	25%	26%	13%	3%
Civil	0%	0%	17%	33%	33%	17%	0%	0%
Electrical	0%	8%	0%	25%	25%	33%	8%	0%
Mechanical	0%	8%	8%	17%	33%	25%	8%	0%

The engineering educators in FNU are predominantly iTaukei or Indian, mirroring Fiji's cultural composition. The TMP data (n=33) revealed that the iTaukei and India-trained academics shared similar team profiles (Figure 3). Further, like the Malaysian sample, the vast majority of team role preferences (23 out of 33) were in the Practical 'Thruster-Organiser' and 'Concluder-Producer' roles. Work preferences of the vocational and higher education teams were similar as were those of the Mechanical, Civil and Electrical teams.

In Team Management Profile terms, this would be considered an imbalanced team, with gaps in the 'Reporter-Advisor', 'Creator-Innovator' and 'Upholder-Maintainer' role preferences in particular. Additionally, the few participants in the 'Explorer-Promoter' role preference were not in a management position.

Figure 3: Number of Major Role Preferences for Engineering Educators team at Fiji National University

Yet when Fiji's engineering educators need to align themselves to IPENZ's expectations, its overarching standards includes an appropriate customisation of the programme design to meet the expectations of likely employers and industry, and the achievement of the intended

graduate outcomes in practice. Translation of this into educational practice typically involves much greater emphasis on deliberate interaction with likely employers and industry. This direction mirrors the AAEE conference experience, where engineering educators practice the more creative aspects of engineering education, in Types of Work Wheel terms Advising, Innovating, and Promoting.

How does this change the role of the engineering educator? A key challenge of this project is that the greater interaction with employers and industry requires the practising of the more creative, extraverted aspects of engineering education, such as the development of contacts and projects. As engineering educators are expected to facilitate more interaction with practising engineers, their role will shift from transmission-type teaching to co-construction.

The work preference feedback from 32 participants shows that the three engineering discipline teams have remarkably similar preferences to one another. The vocational educators showed similar work preferences to their colleagues in higher education. In addition, Fiji's engineering educators show great similarity in work preferences to engineers worldwide.

Whilst this conclusion is preliminary, this does have implications for implementing a transformation project such as this. Hypothetically, these engineering educators are comfortable working in the preferred aspects of developing, organising and producing. In workshops this preference revealed itself in the requests for project plans and charts. An individual's work preference develops in a cyclical manner. This is a cycle in which the engineering educators tend to practice and become more proficient at what we prefer.

Reviewing the work preference data, these teams are considered 'imbalanced', as there are important tasks with no team members in the "non-preferred" realms of reporting and advising. In addition, there are relatively few staff with a related preference in creating or innovating, exploring and promoting. This suggests that the majority of engineering educators will tend to focus on implementation aspects of work.

Actions to fill Missing Team Roles

In this project, FNU's engineering educators will be challenged to form research clusters, working in partnership with both students and engineers in the South Pacific on challenges relevant to the region. The engineering educators will be challenged to grow the PjBL strands in the renewed programs. Alignment of education practice typically involves a shift to an interaction with likely employers and industry.

The TMP data provides a useful focus to improve individual and team performance. From observations and discussions with team, several actions are taken to minimise the effect of missing key roles in the program development teams. These are summarised:

1. Team added with several members from central administration as promoters to promote incorporation of university development, quality and standards.
2. External assistance is secured from RMIT University as advisors to assist in the design of the new engineering system
3. Restructuring laboratory and resources planning, under a central manager, resources and planning, as maintainer.
4. Added new executives specialising in teaching and learning, research and development, as inspectors.

Conclusion

New team profiles will be collected and the progress of program changes is currently being monitored. The relationship between team profile and the effectiveness of program design have been identified. Several actions have been taken to fill the "gap" indicated by the team

profiles compared to the generic team profiles of similar nature. Two courses have been chosen to be the pilot study for analysing the implication of these changes on the educators. These results will be used to plan further actions to transform the FNU engineering faculty into one that can deliver compatible engineering education programs.

It is still early to conclude but the results in the research in the last three months have indicated that team management profiles are strong indicators of team effectiveness in the development of new programs that are required to adopt a non-traditional learning and teaching approach such as project based learning.

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