Aculturating First Year Engineering Students to Teamwork

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Abstract

In many countries, the traditional academic culture typically described as a 'person culture' is increasingly being questioned by industry, which relies heavily on an organisational model based on a 'team culture' [1, 2]. Engineers working in Australia, just as in other industrialised parts of the world, are more often faced with a dynamic employment environment than in the past, and the sign posts indicate that this fluidity will be the way of the future. In these changing times it is becoming an imperative for engineers to be competent team players and leaders, and education must therefore prepare future engineers to meet these challenges [3]. The strategic plan for the University of Ballarat emphasises the development of student learning environments that are both flexible and encourage lifelong learning. Teamwork, including teaching and learning in teams is a central strategy for achieving cultural change across the University. The University of Ballarat, School of Engineering, is striving to make teamwork an intrinsic part of the cultural landscape of undergraduate engineering study. In order to achieve this goal it is believed necessary to begin with the first year of the engineering course, while reinforcing teamwork as a learning paradigm throughout later years of the course. This paper will briefly discuss the background and context for the work undertaken, outline the initial plan to bring about a teamwork culture, discuss how and why the initial plan evolved, what has been achieved and the way forward.

I. Introduction

In response to changing world view's and the incredible technical and social transformations under way a new integrated Bachelor of Engineering course commenced in 1996 at the University of Ballarat (UB), developed and offered by the School of Engineering. This integrated course aims to present engineering within a holistic societal context and to teach engineering concepts in a way that highlights the connections and relationships between areas of study rather than as delineated, isolated topics. In a 'big picture' sense the course aims to produce engineers who are ready and able to work across traditional engineering disciplines and factor in relevant ethical, political, cultural, environmental and economic issues. The overall structure of the course uses applied engineering design and systems as the means for achieving this integrated approach [4].

The principal characteristics of the new Bachelor of Engineering course at UB are [4]:

Use of applied engineering design as an integrating theme;
Integration of theory and practice through experiential learning;

Adoption of team teaching;
Adoption of an industry focus rather than a discipline focus;

- Alignment with regional and national industry growth areas;
- An emphasis on roles, capabilities, responsibilities and accountability of professional engineers both in the workplace and in society generally;
- An emphasis on generic capabilities such as co-operation, communication, problem-solving, learning to learn and lifelong learning.

In order to be successful in achieving the desired aims, developing a culture of teamwork had been thought of as a vital part of the new engineering course. After implementing the new course for two years, the school was able to identify the importance of various applications of teamwork to the concept and successful outcome of an integrated, holistic engineering curriculum. In these first two years it also became evident that to incorporate effective team teaching and student teamwork would require a specific and concentrated effort. As a result in 1997 the University of Ballarat sought and was successful in obtaining a 12 month National Teaching Development Grant (NTDG) from the Committee for University Teaching and Staff Development (CUTSD). The grant was awarded in order to fund a project in partnership with two other universities in Australia, Swinburne University of Technology (in Melbourne, Victoria), and the University of Tasmania. The project title being, "Co-operative Development of Innovative Teaching Practices for Successful Implementation of Integrated Engineering Programs". It is out of this project that the theme for this paper has arisen.

This paper aims to discuss how teamwork has been woven into the culture of engineering education, beginning with first year, within the University of Ballarat. It will provide an overview of what was initially planned, discuss how and why the initial plan evolved, activities which were successful, those that were not so and the way forward. While the paper will seek to address some of the broad issues raised across the three partner institutions, it will concentrate on activities and reflections from the University of Ballarat, as the primary project partner.

II. Cooperative Learning and Teamwork Skills Development

Before discussing the project under consideration it is necessary to define the meaning of teamwork skills development and to explain it in terms of the similarity and differences between it and cooperative learning. Johnson, Johnson & Smith have published extensively on what is meant by cooperative learning and the processes involved [7, 8]. Cooperative learning is seen as a means of enhancing student learning. While they emphasise the need for students to acquire teamwork skills in order to gain the most out of cooperative learning they do not necessarily see this as an end in itself. The project presented in this paper however had the primary goal of developing student teamwork skills. The driving force for this is the stated objective of the UB undergraduate program of achieving a range of graduate attributes including the ability to work in a team.

Formal cooperative learning as outlined by Johnson, et al in [7] relates most closely to the teamwork based around task focus that was such a large part of this project. However even this structure is only discussed in terms of organised class sessions [7]. At UB instead we have developed a range of activities that can last from a one hour class session up to a ten week

assessment task incorporating the teamwork paradigm.

In an organisational context, teamwork skills development is seen as vital to the process of organisational learning [9] and successful management [10]. Since this is the context in which many of our graduates will work, it was determined that our methods should also draw on the understandings and thinking related to teamwork in organisations as well as cooperative learning in the educational context.

III. Initial Plan

From the beginning of the new integrated engineering course at the University of Ballarat (UB) students have been expected to complete a number of learning and assessment tasks across various units at all year levels as part of a team. The project enabled resources for three universities in partnership to more closely examine and develop strategies for the 'why, when and how' of student teamwork, and provide a specific focus on developing techniques to facilitate effective teamwork practices within engineering courses.

Any culture, including that of engineering education, is distinguishable through a complex system of meanings, assumptions and values. The nature of cultural change is that it can occur at any number of different levels, with varying rates of change and does not necessarily take place instantaneously, or progress in well defined stages according to a timetable [3, 5, 6]. When instigating changes in curriculum design and changing an established pedagogy it is important to start as early as possible in the student experience. Students form expectations regarding their own study and performance and that of their teaching staff from the beginning of a course of study. If students are then expected to consider different expectations, resistance to change can be strong.

Based on this premise the initial plan to incorporate teamwork into the culture of undergraduate engineering studies[1], was to concentrate effort and activities on the first year of the course, before any anti-team expectations are formed, and to enable a higher acceptance level of teamwork amongst students. A further fundamental part of the initial plan was to incorporate teamwork into a single unit of the first year of the engineering courses at each of the University of Ballarat (UB), the Swinburne University of Technology (SUT) and the University of Tasmania (UTas).

Following allocation of the funding from the project grant, several co-ordination activities at and between each of the partner institutions were conducted, in order that the objectives, plan, and involvement of staff and students could be fully examined and understood. As a result of these activities, which included workshops and meetings, some important issues were raised and discussed concerning project delivery and the plan was modified accordingly.

While the emphasis on working towards a teamwork culture remained with the first year of the

[1] At the University of Ballarat, Swinburne University of Technology and the University of Tasmania, as project partners.

engineering courses at UB and SUT, it was also recognised that students in a year of study within any engineering course do not exist within isolation of students from other year levels. Therefore to increase the momentum of cultural change it is wise to simultaneously provide support for teamwork issues at all year levels. Given also that students' own skills, knowledge, perceptions and maturity change as they progress through a course, UTas determined to focus primarily on second year engineering students, providing for a rich diversity of collaborative reflection and comparison between the three institutions.

As a result of the integrated nature of the new engineering course at UB, as discussed previously in this paper, it was decided also that teamwork would be incorporated where appropriate in several units within the first year. By doing so it was thought that the integrated nature of the course would be supported, that students might more readily view teamwork as relevant to engineering and the whole course, and that ultimately a culture of teamwork would result.

IV. Achievements and other Outcomes at the University of Ballarat

Achievements are sometimes difficult to identify depending on the nature of the goal, including when the goal is to alter the cultural fabric of undergraduate engineering studies so that teamwork becomes an intrinsic part. Particularly for engineers who have traditionally felt more comfortable evaluating purely quantitative as opposed to qualitative data. However once the feedback began to stream in and the process of analysis started, some major achievements and non-achievements were distilled.

In professional and industrial settings it is usually accepted that in order to achieve maximum effectiveness teams require appropriate physical spaces that are conducive to both work and meetings. As a result of consultation with and feedback from student teams, three team meeting rooms were created within the School of Engineering. These rooms were set up specifically for team use with a round table style, comfortable seating and a whiteboard. The rooms were available for booking at any time during normal business hours by any student team using a centrally located school maintained diary. Through facilitation of team activities and meetings it was observed that by providing an appropriate physical environment students were more likely to contribute, adopt necessary roles and perform as a team than had been the case before these spaces were made available.

Students were provided with a high level of support to operate as a team. These support mechanisms included advisory sessions, individual student guides (manuals), a teamwork training session in a professional setting, and a teamwork co-ordinator. Advisory sessions were held for one hour each week of semester one, for small teams of students to discuss issues, such as different learning styles and working with others, with a member of the teaching staff. Student guides were issued to all students at the beginning of the academic year and were produced as a ring binder to allow students to enter other useful information as it was collected. The guide contained information including, course details, unit descriptions and teamwork notes on meetings, project plans and peer assessment. The teamwork training session was held outside the university in a professional setting as an experiential workshop, covering topics such as, team life cycles, conflict and conflict resolution, shared participation, decision making

and action planning. The teamwork co-ordinator was involved with various parts of the course delivery and acted as a point of reference for teamwork issues, a facilitator and coach to actively encourage effective teamwork.

All of these support components were valued by students and are therefore valuable concepts to the continuing evolution of a teamwork culture. Through these various activities it also became evident that effective teamwork and meeting skills are not inherent, particularly with young school leavers; the students benefit from facilitation (rather than instruction alone) on what effective teamwork and effective team meeting practices are. Support is vital.

Another reflection from the project is that students have developed a far greater sense of self awareness than has been observed in the past. This self awareness could be related to their increased experiences of learning and working with others in a team environment, discovering different learning and team-player styles, and from having the opportunity to reflect on their own and fellow team members commitment levels.

Much can be learnt from the aspects of this project that did not succeed in the manner hoped for. From the point of view of student experience one of the most disappointing aspects of the project was that the value of teamwork was not communicated to students as effectively as might have been hoped. This became apparent in the second semester of the project implementation when within one unit of the course students were offered the opportunity to choose whether they would complete a particular assessment task in teams or individually. None of the students chose the team option. This was despite the fact that many students were voicing their belief that teamwork skills development was a vital component to their course of study.

It was also apparent that staff had failed to communicate to students that teamwork skills development was an objective in its own right for a number of assessment tasks. This was evidenced by students who would seek to complete team projects by themselves to avoid having to deal with the issues of non-contributing team members or team conflicts in order to produce the "best" solution to the set problem. An attempt was made to avoid this by offering continued support and facilitation by the project co-ordinator throughout a second semester assessment task.

The two issues mentioned both relate to the broader issue of assessment. It has been noted that assessment systems encourage students to use particular strategies to engage in learning [11]. In particular students may be influenced both positively and negatively by the choice of assessment system, in terms of what they see as of value. It was very quickly recognised in this project that assessment of teamwork is a complex issue. In particular the method of assessing the teamwork process versus the teamwork product is a central problem. While a number of different assessment methods have been tried ranging from one team grade to individual grades, it is still felt that innovative assessment techniques need to be explored in order to provide the right balance. Staff need to make clear to students the objective of teamwork skills development as well as other content oriented objectives for particular assessment tasks.

The failure of staff to engender in students a valuing of teamwork may well be related to their

perception of its value. Despite a forward looking curriculum development there is still some sense amongst staff that we need to ensure first and foremost that "content" is covered before we can deal with issues such as teamwork skills. Some staff also continue to equate team teaching with time consuming meetings for units in which they could readily teach alone. It is perhaps not surprising that this view of teamwork may hence be communicated to students.

As mentioned previously to change a culture takes considerable effort and often much time. What we believe has been achieved in the last 12 months is a large step forward towards the ultimate goal of a culture of teamwork. It is not the end of the process, however we have journeyed far from the beginning and have a strong foundation laid on which to continue building.

No project of this kind can hope to achieve a cultural change in only one year so there are a number of ongoing plans that seek to support this process of change. These include:

- the provision of a teaching and learning environment that fosters teamwork. This will consist of a room in which there are breakout cells containing a table, computer and other support material. These will surround an area where traditional lecture style presentations can be made. In this way teamwork can be incorporated more readily in the normal student timetable.
- ongoing staff support through the provision of opportunities for discussion and workshops with similar minded academics throughout Australia.
- a team camp for first year students at the start of classes in order to foster the development of a valuing of teamwork from the outset of the undergraduate experience.
- the support of staff to present our results and reflections from this project both within Australia and internationally.

V. Conclusion

This paper contains the reflections from a 12 month project aiming to incorporate teamwork as a teaching and learning paradigm within engineering education. A number of activities have taken place across three partner institutions over the 12 month period. Some have had positive impacts and others have shown us new ways of looking forward to aculturating our students with the value of teamwork skills development.

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