Role of Effective Team Activities in Engineering Courses that Satisfy Requirements of Industrial workforce in Australia

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Introduction

The focus of an educational institution has always been to deliver quality graduates to support the workforce. Engineering being a very specialised field, the industries rely highly on universities to develop a graduate and prepare the student to perform efficiently in the field. This concept of optimising course design to suit graduate attributes is not new and is in practise today. Tertiary education Quality and Standards Agency (TESQA) provides accreditation to universities and requires that every course curriculum display the graduate attributes defined in Engineers Australia stage 1 competencies (Bui, Nguyen, & Cole, 2019). However, these tend to address outcomes on a wider context encompassing institutional and course outcomes rather than what happens specifically in the classroom. Regardless of the strong quality assurance frameworks in place there is always a way to get around to reach compliance (Lake & Holt, 2019).

The competencies defined in Engineers Australia stage 1 consist of knowledge and skill base, engineering application ability, and professional and personal attributes. The first two are highly technical and form the theoretical basis of understanding for a young engineer. The third competency, i.e., professional and personal attribute, is what the universities lack in meeting the requirements of the modern industry (Oraison, Konjarski, & Howe, 2019). The six sub sections of this competency consist of (i) Ethical conduct and professional accountability, (ii) Effective oral and written communication in professional and lay domains; (iii) Creative, innovative and pro-active demeanour; (iv) Professional use and management of information; (v) Orderly management of self, and professional conduct; and (vi) Effective team membership and team leadership (Australia, 2017). A study conducted in Monash university highlights the importance of developing the team management and communication skills in students (Hill, Overton, Thompson, Kitson, & Coppo, 2019). Investigating case studies of efficient team exercises in engineering to analyse what methods worked and did not work is crucial in making industry ready graduates.

Teamwork in an engineering course is responsible for development of several crucial skills a fresh graduate in the industry should possess. A study conducted in China proves that team exercise can aid in improving students' problem solving ability (Bae, Ok, & Noh, 2019). Team members assigned to the students is mostly not a choice, hence developing interpersonal skills is extremely important to function well in a team. Leadership skills and teamwork go hand in hand. Additionally, team activities aid in developing interpersonal and communication skills which accelerates character development (Brookes, 2019) (Lingard & Barkataki, 2011). Having a stand out leader is proven to improve the throughput of a team (Oh, Lee, & Zo, 2019). Hence, most common questions asked in interviews are to judge leadership qualities as industries are in constant need of potential leaders. It is evident that an improvement in effective team activity in a course curriculum is necessary to improve employability in fresh graduates.

Requirements of Industry

There is a significant gap between the graduate skills required by industry and learned during university degrees (Kolmos & Holgaard, 2019) (Nair, Patil, & Mertova, 2009). It is assumed that we cannot completely simulate an industrial environment in the university, however informing and preparing students' core skills to suit industrial needs is important. Making students self-aware by highlighting these requirements at the start of the course is one way

to do this (Jackson, 2019). Jobs mandating high level of skills are usually considered as secure professions, example being engineering which is not threatened yet by automation. This general ideology prevalent in foreign cultures has seen increasing competition in Australian job market where high skilled overseas students are flooding Australian universities (Baas, 2019; Edge, Fitzgerald, & Willcoxson, 2019; Paulino & Castaño, 2019). Additionally, with evolution of job markets, the skills expected of a graduate engineer have increased in the last decade and will keep on increasing in the coming future (Carnevale & Smith, 2013). Hence, instead of relying completely on industrial training and learning these skills at job, linking university curriculum with industry requirement is crucial in increasing employability (Bennett, 2019). Industrial involvement in training the graduates is required by most universities in Australia, however not all students are able to secure a placement (Male & King, 2019).

Teamwork and leadership skills rank high on expected skills from industry as highlighted in Figure 1 which shows results from a research conducted among Australian employers (Pham & Saito, 2019).

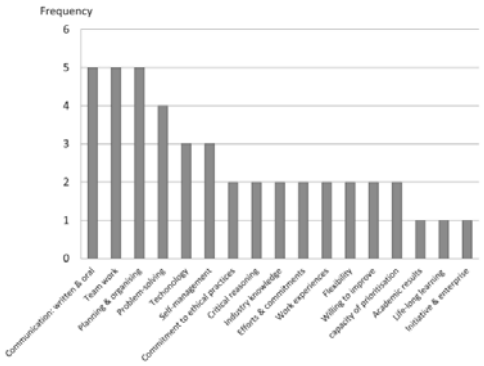

Figure 1: Graduate skills expected by Australian employers (Pham & Saito, 2019)

X axis and Y axis on Figure 1 indicate categories of item and frequency of references on those categories. Teamwork is the second preferred skill next to communication skills. Addressing this by efficient team activities in course curriculum will help develop highly skilled graduates.

The aim of this work is to identify the skill gap between university graduates and industry expectation. Interviews were conducted with employees from Northrop and students of the University of New South Wales (UNSW), Sydney. The interview questions focussed on ratings and discussions on existing frameworks and review of graduate roles within the company to identify the important skills expected from a graduate and to what level the universities are focussing to develop these.

Context of Teamwork

Teamwork in University

General aspects of team activities and group work in university consist of motivation, accountability, communication, leadership, organization, and choice of group members. There are various innovating teaching methods which impact team-based activities like blended learning, flipped mode teaching, and project-based learning (Savage, Chen, & Vanasupa, 2008). Research conducted in a business school suggests that team-based learning improves learning outcomes (Lohmann et al., 2019).

Teams in universities often have an option to choose their preferred group members. This can restrict development of interpersonal and communication skills required for the industry. Roles for every team member are not clearly defined. Determining tasks for every team member is where leadership skills are required. It is often observed that teams with efficient

leaders perform better (Norris, 2019). Individual accountability is another aspect which ties with motivation to perform in the team. Motivation drives accountability, hence involving marks for individual performance is crucial to maintain the drive (Naeem, Islam, & Siddiqui, 2019). Group marks when meshed with individuals marks further increases motivation and accountability.

Students' Experience

Open ended questions on teamwork skill set understanding were asked to students in UNSW. This was important to understand student's perspective to judge what improvements need to be made. These interviews highlighted a number of loopholes that students often exploit in team activities:

- Only a few team members complete the work while the other members only show up at crucial assessment periods;
- Communication and meetings are only held during assessment periods;
- A united group can get around peer marking by discussing what marks to give for their peers; and
- If students are allowed to choose their own teams, they often select close friends hence reducing need to communicate with other peers.

Challenges with International Students

With exponential increase in the number of international students in Australian universities, it has become extremely difficult maintaining balance in the cultural diversity to increase exposure (Bista, 2019). While forming teams, often 90% are from same ethnicity which causes groupism in larger groups, and an individual with a different first language gets left out from the rest of the group. Study conducted by (Shcheglova, 2019) found that Chinese students show low level of engagement due to passive group activities.

Large portion of the international students wish to migrate and contribute to the workforce making it very competitive to get through. Often students with local industrial experience are preferred by employers. Hence developing interpersonal and communication skills is much harder coming from a different culture which are unfortunately the most sought-after skills from an industrial standpoint. Unaware of these expectations from the industry, talented international students struggle in finding jobs in the Australian market due to variety of reasons.

This increases the role of university courses and team activities to push students out of their comfort zone and develop these abilities. Hence, the need for team exercises that develop students interpersonal, oral and written communication skills along with core technical base is extremely beneficial for these students (Craig & Bielenberg, 2019).

Teamwork in Industry

Teamwork in an industry has a very different outlook from that of universities. Factors such as motivation, accountability, communication, and choice of group members are of paramount importance. Industrial setting often does not allow for choice of group members. A team of professionals formed to deliver a project are held accountable for their disciplines. Since reputation, money and career of the company and the employee are at stake, there is no issue of motivation and hence accountability (Sabri, Mutalib, & Hasan, 2019). Group members in an industry are specialist in their roles and have a clear shared goal to achieve. Successful teams have good communication, coordination, cooperation and cognition (Salas & Bisbey, 2019).

Teams in industry deliver successful projects within deadlines only if all the members contribute. If one member delays or fails to come up with a satisfactory solution the whole project stalls which could cost millions to all stake holders. Such blunders can destroy individuals careers, hence training students in the universities to similar circumstances is

important (Subekti). The practicality of the work being undertaken can have an impact on thousands of people. Exposing students to work on an industrial project or problem during university studies can help them understand the difference between designing or producing something, i.e., theoretical work to obtain marks or pass grade in exams versus designing something that is practical for real world implementation (Raoufi, Wisthoff, DuPont, & Haapala, 2019).

Professional Experience

Working in a consulting engineering firm as a professional engineer, the first author has industrial insight on his journey. Participating in the industry nights representing the company gave him a clear insight into what industry looks for and the urge to share this information has motivated him to identify these gaps and help university and industry to closely ally their goals and requirements to benefit from each other.

Skill Gap

There is a clear gap in teamwork skills obtained at university level versus industrial setting. When a question was raised to employees on whether the university education has helped them transition into industrial role, a very common and unanimous answer was no. Industrial training which is a mandatory part of every engineering degree in Australia is not always enough to develop the teamwork and leadership skills in students. Graduate employability has been critically assessed in recent times and teamwork skills is a big part of it (Bridgstock & Jackson, 2019).

Methods to Bridge the Gap

Study performed by Giselle indicates that innovative skills are lacking from students even after industry placements (Rampersad & Zivotic-Kukuloj, 2019). Clearly relying on industry placements in not enough and new methods need to be trialed, few of such methods are discussed below.

Project Based Learning (PBL) is a popular concept gaining traction in the field of engineering education. It has significant impact on teamwork capabilities and when blended with industrial projects is considered a form of work integrated learning (Clanchy, Sabapathy, Reddan, Reeves, & Bialocerkowski, 2019). Work integrated learning (WIL) is a new method to encourage innovative thinking in students by industry involvement in the projects performed at the university. WIL when implemented over a period will evolve and become more effective. A study on industry integrated projects when embedded in all the courses found that over time the assessment methods evolved and nature of the problems from industry became much more wider (Mitchell, Nyamapfene, Roach, & Tilley, 2019).

Linking and sourcing these projects from industry collaborations can benefit both students and companies. Victoria university did this successfully by introducing students to valuable skills including project management, client negotiation and report writing(Simcock, Shi, & Thorn, 2008). Challenging students by integrating a real-world problem as a final year project in an electrical engineering course was implemented in Portugal. Findings indicated that students displayed higher motivation, increased team work and analytical skills (Valdez, Ferreira, & Barbosa, 2019).

Another example of similar initiative is found at maker games present in various universities worldwide, where undergraduate students take part in a competition to provide solutions to real world problems provided by industry.

A collaborative learning method such as team-based learning (TBL) incorporating industrial case studies can make students think outside the box. Such exercises supplemented with industry guest lectures help students gauge what to expect and possible career paths they

could choose. A paper in Kazakhstan (Syzdykov & Ozkan, 2019) found that industry guest involvement improved students' awareness about the industry expectations. An active and agile learning method such as TBL is practiced in many engineering courses throughout Australia (Parsons & MacCallum, 2019).

These techniques force a student to work in a group solving industrial problems, increasing students' ability to work with team mates' strengths and weaknesses to achieve a common goal.

Result and Discussion

Industrial interviews and existing research suggest that teamwork skills is the most required attribute from a graduate in an industrial environment. Hence efficient team activities which bypass the traditional loopholes exploited by students and are more aligned with simulating a team environment in the industry is crucial. While industry training helps in gaining an insight into the workplace, it should be supplemented by industry involvement in course design and providing projects for students to work on. An exact simulation of team setting of an industry may not be possible at university level but exposing students to industrial challenges can help them get accustomed to the commitment required to deliver an industrial goal.

Some of the suggestions from this work, are to run the group activities where roles are pre-assigned to every team member which would better simulate an industrial project setting. Graduates with good teamwork skills have a higher success rate in the company. Interviews with employers suggested that they believe training for the industry can start earlier during university education.

Conclusion

The importance of linking industrial requirements to the academic course curriculum is extremely important. Teamwork is rated as a crucial skill required by majority of employers. To develop these skills universities must implement new teaching and learning strategies like work integrated learning and project-based learning.

Satisfying industrial requirements like teamwork skills starts in the universities which can develop a young graduate not just technically but also in building a strong character to develop into future leaders.

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