ICT Capstone Projects and Internships: Analysis of Work Environment Characteristics

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ABSTRACT

This paper aims to identify and classify the different cooperative and work-integrated learning education environment characteristics that emerge from different ICT student experiences. These characteristics are also explored with relation to student levels of academic achievement. Previously completed industry projects and internships were analysed with specific focus on the characteristics relating to the students role and relationship with the project or internship sponsor and the work environment. Naturally occurring project or internship 'types' were identified. Each project and internship was categorised and then analysed with relation to academic achievement. Three main categories were identified: student as an expert, student as a subcontractor, and student as an apprentice. Interestingly, the student experience and level of achievement was found to differ notably between these categories. Ultimately, the study found that students functioning as an expert without the support of workplace, domain, or technical expertise tended to achieve at lower levels than students functioning as subcontractor or apprentice. Based on the results of the study the researchers recommend that students undertaking capstone projects who are functioning in an expert role be provided with an on campus collaborative environment to help mitigate the disadvantages associated with working in relative isolation.

Keywords: Capstone Projects, Internships, Work-Integrated Learning

1. INTRODUCTION

Industry based cooperative education capstone projects and internships are often a core component of ICT and computing degrees throughout the New Zealand tertiary sector, usually existing as the focal point of the final year of study (Steele, 2010; Steele, Cleland, & Engelbrecht, 2013). These capstone projects and internships are a popular form of cooperative (co-op) and work-integrated learning (WIL) within the NZ ITP (Institutes of Technology and Polytechnics) sector, however a number of other studies focused on different forms of co-op/WIL within ICT education have been conducted.

Skelton (2010) examined a range of ICT degree paper in reference to industry readiness criteria. Ayling (2010) advocated for the utilisation of Web 2.0 and Social Networking services for enhanced management of co-op/WIL students, although this study was focused on co-op/WIL programmes generally. Miliszewska (2008) reported on the incorporation of community-based learning in a first year computing unit. This study focused on first year computing students working in groups to develop *Settlement Resource Kits* for the Victorian Immigrant and Refugee Women's Coalition (VIRWC). The study concluded that the community-based learning component enhanced the learning experience for students.

A number of studies have advocated the use of online tools (e.g. blogs, social media, and e-portfolios) for enhanced reflective practice within co-op/WIL units (Ayling & Hebblethwaite, 2011; Forbes, 2011; Lay & Paku 2011; Lucas & Fleming, 2011; Lucas & Fleming, 2012; Skelton, 2011). A number of other studies have explored the issues related to the development, management, and assessment of capstone projects (Chard, Lloyd, & Tongariro, 2010; Clark, 2005; Clark, Davies, & Skeers, 2005; Farrell, Ravalli, Farrel, Kindler, & Hall, 2012; Lesko, 2009). Other studies have investigated best practice relating to student preparation for co-op/WIL and real-world industry interviews (Coldwell-Neilson & Craig, 2012; Coll, Lay, & Zegwaard, 2001; Snell-Siddle, Snell, & Steele, 2014). Lloyd and Chard (2013) explored the benefits to industry stakeholders involved in IT capstone projects. The study concluded that the common benefits were: implementation of a new technology, leaning new project processes, and gaining an employee. Skelton (2013) provides a focused exploration of the attributes of high achieving students and interns who are often employment as a result of their internship performance. The study concludes that these students are all academic high achievers (A grades throughout their degree) and have mature personal communications skills. Fleischmann and Ward (2013) discuss an alternative approach for ICT WIL students in a regional area where the local ICT industry is unable to support sufficient student placements. The approach involves multidisciplinary group-based web development WIL projects. The study concludes that the approach is well received by students as an authentic learning environment that contributes effectively to students' development of work-ready skills.

Interestingly very little work has focused on the unique characteristic of ICT capstone projects and internships. Specifically, the differing work environments that make for different student experiences.

Previous work by the authors has examined areas of specialisation for these projects, highlighting the majority are often web and software development focused (see Figure 1).

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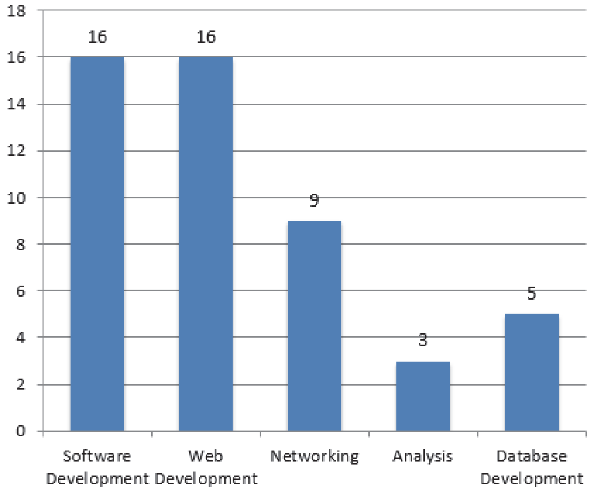

Figure 1. Projects by Specialisation (Steele, et al., 2013)

This work also examined student reflections of these capstone projects and suggested relationships existed between communication, time management, and achievement (Steele, et al., 2013). When positive and negative views (represented by the + and - signs) were combined, the main reflective categories expressed by students were concerns with time management and communications (see Figure 2).

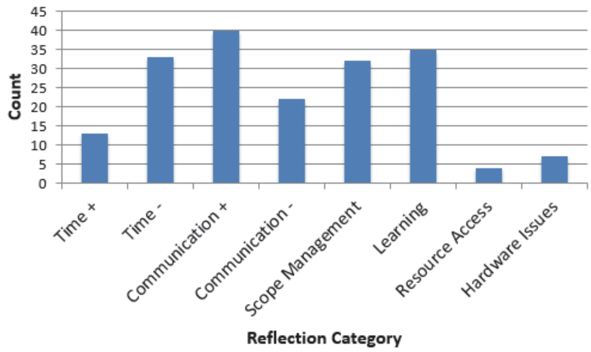

Figure 2. Project Reflection Categories (Steele, et al., 2013)

Specifically, those students who struggled to achieve academically consistently cited weak communication and poor time management in their reflections. Many of these accounts appeared to come from students who were attempting to complete much of their project work in relative isolation (e.g. working from home developing a website for a local business). Interestingly, many of the higher achieving students tended not to have this type of experience, often working in a professional environment for their projects or internships, or making a point of working on campus surrounded by other project students.

Building on this, it is suggested that these cooperative education projects and internships can result in extremely varying experiences for students depending on the ICT focus area and work environment (this could in turn potentially impact communication, time management, and achievement). Of particular interest is the day-to-day working environment that the students were engaged in during their projects or internships and its relationship to the overall outcomes. One extreme sees students functioning as ICT experts working as the ICT lead in some projects, at the other end of the spectrum are the students who undertake internships or work within existing ICT teams in an apprenticeship type role. A recent study focused on graduate perceptions of ICT education found working graduates advocated overwhelmingly for more industry related learning including: industry involvement, workplace learning and business experience, and other real-world activities (Koppi, Edwards, Sheard, Naghdy, & Brookes, 2010). A related report that investigated industry and tertiary education provider's perceptions of work-integrated learning (WIL) determined that a successful WIL experience should provide students with an improved understanding of professional responsibilities within the workplace and should assist with the attainment of generic skills which are strongly valued by industry (Ogunbona, et al., 2013). Other studies have also highlighted the variety of forms that WIL can take within ICT education, ranging from work-experience and internships through to industry-linked projects, however the differences in student experiences were not explored (Pilgrim, 2007). A more closely related study by McLay and Skelton (2007) contrasts ICT projects and internships and highlights the many benefits associated with the internship/ apprenticeship approach (i.e. professionalism, set working hours, communication skills, and master-apprentice mentoring), as well as a number of barriers associated with traditional projects (i.e. limited interaction with project sponsors, lack of professional mentoring, and a lack of structured work environment).

A related field of study, situated learning, also provides support to the notion that the situation or work environment can have a strong influence on learning. The theory of situated learning was first proposed by Lave and Wenger (1991) and can be described as the process whereby novices in a community of practice learn through legitimate peripheral participation and eventually become experts. The process sees novices first participate in simple low-risk tasks that contribute to the community. During this engagement, novices become familiar with the tasks, culture, vocabulary, expectations, and principles of the community through their participation with and observation of experts in the community. In time, the novices move from the peripheral of the community towards the centre as their tasks become more significant to the functioning of the community and eventually become experts. The theory posits that if novices or newcomers are able to observe the activities and actions of experts in the community they can gain the advantage of better understanding of the broader context into which their own tasks fit. In contrast, if novices or newcomers are isolated from community experts they in turn have limited exposure to the tools and processes employed by the experts within the context of the community, an environment which results in limited growth.

2. AIM

This paper aims to identify and classify the different cooperative education environment characteristics that emerge from different ICT student WIL experiences (e.g. ICT expert through to ICT apprentice). These characteristics are also explored with relation to student levels of academic achievement. The intention of investigating this relationship is to provide insight into the types of ICT cooperative education projects and internships that result in more positive outcomes for students. This information will assist educators in developing academic support strategies to improve the overall experience for future students.

3. METHOD

The research sample covered a period of five years (2010 - 2014) of all industry project and internship enrolments (n = 128) in the researchers' institution, see Figure 3 for yearly breakdown. These projects and internships are generally sourced by the students the semester prior to commencement and completed individually. However, the institution is often approached with potential projects and internships by sponsors which are then advertised to students. Students typically seek opportunities in their preferred specialist area. Academic supervisors are allocated to each student. Supervisors meet with students regularly to ensure students are making adequate progress.

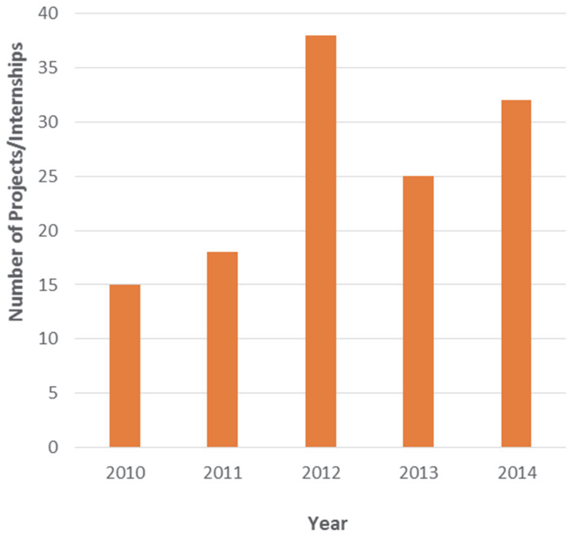

Figure 3. Research Sample by Year

This research sample extended on the previous work by (Steele, et al., 2013) and was again categorised by project specialisation (see Figure 4).

Figure 4. Extended Projects by Specialisation

The sample was then analysed with specific focus on the characteristics relating to the students role and relationship with the project or internship sponsor and the work environment. The analysis consisted of a detailed review of each project which took into consideration a number of factors including: the type of work, the subject area, the students existing skill set, the host organisation and work environment provided, the project sponsors area of expertise and level of involvement, and if there were any project stakeholders supporting the student. As a result of this analysis, naturally occurring project or internship 'types' were identified. Subsequently, each of the projects and internships were categorised according to the identified types. These project types were then explored with relation to academic achievement.

4. RESULTS AND DISCUSSION

The initial analysis led to the identification of three main categories:

- Student as an expert
- Student as a subcontractor
- Student as an apprentice

The student as an expert category typically consisted of projects where the student was the primary source of ICT expertise. Examples of student as an expert project types include: students developing a content management website for a small business, students developing customer management database systems, or students developing web based booking systems.

The student as a subcontractor category typically consisted of projects where the student was supported by other project stakeholders with specific areas of expertise (e.g. ICT, business knowledge, design, etc.). Examples of subcontractor project types include: students developing web or mobile applications alongside a graphic designer, students exploring a new area of technology for an ICT team or business, or students involved in the analysis of systems where they are assisted by a domain expert.

The student as an apprentice category typically consisted of internships and projects where students have an ICT mentor or are integrated into an ICT team. Examples of apprentice project types include: students who upgrade or redevelop existing products where the project sponsor is the original product developer, students who assess wireless coverage of an existing network for the Network Administrator, or students who work as part of a development team on a specific project with senior developers.

The results correspond to previous work which had discussed the clear distinction between ICT projects (student as an expert) and internships (student as an apprentice) (McLay & Skelton, 2007), but extends this work through the addition of middle category (student as a subcontractor). Of the 128 projects 67 were classified as student as an expert, 30 were classified as student as a subcontractor, and the remaining 31 were classified as student as an apprentice (see Table 1). For each of these types, student achievement was also calculated (See Figures 7, 8, and 9)

Figure 5 presents the classification broken down by year. Interestingly the larger years (2012 and 2014) appear to compensate for the increase in student numbers through an increased number of 'student as an expert' projects.

Figure 5. Classification by Year

Each of the three project type categories (student as an expert, student as a subcontractor, and student as an apprentice) were then further analysed in relation to project specialisation (see Figure 6.)

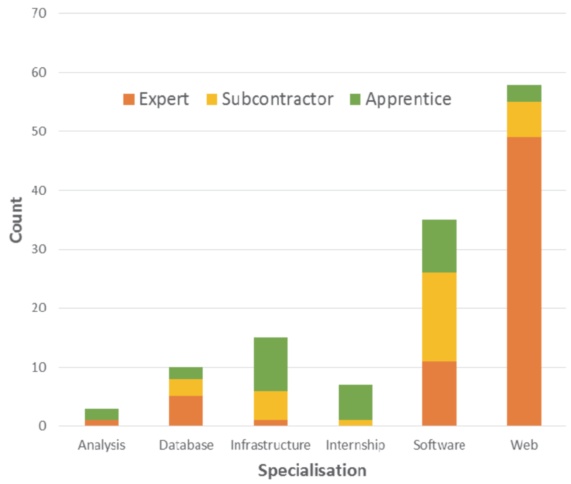

Figure 6. Project Type by Specialisation

It is interesting to note that the majority of the student as an expert projects were web development. This finding reinforces an anecdotal perception that the majority of web projects come from small businesses who lack in-house ICT skills and are attracted to the voluntary nature of student work that is available through industry projects.

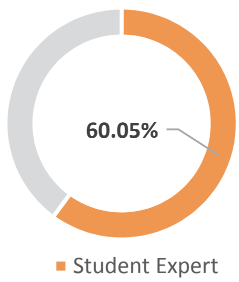

Figure 7. Student Expert Achievement Average

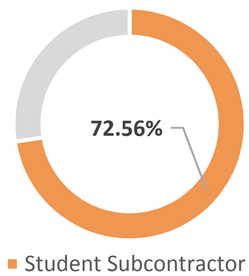

Figure 8. Student Subcontractor Achievement Average

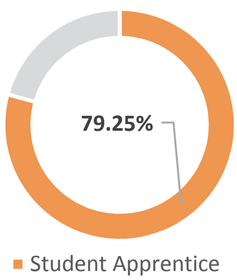

Figure 9. Student Apprentice Achievement Average

Table 1. Project Types and Related Academic Achievement Information

Project Type	Count	Overall Average	Fail Count	Average (completed)
Student Expert	67	60.05%	15	72.34%
Student Subcontractor	30	72.56%	2	77.50%
Student Apprentice	31	79.25%	0	79.25%

When overall academic results were averaged for each of the project types the data suggested that student as an expert projects (60.05%) resulted in lower levels of achievement than student as a subcontractor projects (72.56%) or student as an apprentice projects (79.25%). It is worth noting that the student as an expert category has the highest rate of failure with 15 of 67 resulting in a failing grade (less than 50%). However, of these 15 fails 12 of the students disengaged early in the semester and subsequently did not complete the majority of the assessed components. When early disengagements were excluded from the data the averages for the student expert and subcontractor categories improved, however the overall pattern of achievement remained consistent. The results suggest that students in more supportive cooperative education environments are more likely to have higher levels of academic achievement and are less likely to disengage. In contrast, students who work independently without harnessing stakeholder expertise are more likely to disengage. It is worth noting that causation cannot be established from the data collected in this study, i.e. students as an expert projects may result in lower academic achievement due to the project type, or lower achieving students may have a preference towards student as an expert projects. In order to help determine causation future work could examine these results in conjunction with student grade point averages.

Prior to this study all of the projects and internships undertaken were considered relatively equivalent, each with their own benefits and disadvantages. For example, at one end of the spectrum students who functioned as an expert were thought to have more freedom relating to technology selection and standards but less assistance in completing tasks and ensuring adherence to best practice standards. At the other end of the spectrum, students who functioned as an apprentice were thought to have less freedom as they are conforming to an existing work environment, yet they have the advantage of being able to access much greater assistance and are often provided with expert confirmation when work is completed correctly. Based on the results of this study it has become apparent that there is some discrepancy in the original notion that all projects and internships are equivalent. It is interesting to note that a key difference between the project and internships types is that the subcontractor and apprentice students are usually consistently working within a professional environment, whereas students functioning as an expert often undertake the majority of their work from home.

5. CONCLUSION

This paper sought out to investigate the different cooperative education environment characteristics that emerge from different ICT student WIL experiences. The analysis of these project characteristics resulted in the identification of three project and internship categories: student as an expert, student as a subcontractor, and student as an apprentice. These categories were further explored with relation to student levels of academic achievement. The study found that the student as an expert projects had lower levels of academic achievement and higher disengagement. In contrast, student as an apprentice projects and internships had higher levels of achievement, with student as a subcontractor projects sitting between the two. Although causation could not be established from the collected data the results are still of interest for those involved with the delivery of ICT capstone projects and internships.

Future work will aim to further explore the results of this study with relation to student's grade point averages in order to help determine if a causal relationship exists. In addition, results from this study could be further analysed in conjunction with previous work that investigated student project reflections with academic achievement (Steele, et al., 2013).

Based on the findings of this study the researchers believe providing an in-house work environment for students functioning as an expert could help improve outcomes by increasing student accountability, providing a more structured work environment, and facilitating a professional work environment. The intention would be to mitigate the apparent risks associated with students who work in isolation.

Ultimately, the findings of this study should prove useful for those involved with the delivery and management of industry based projects and internships and could potentially be used to help improve the education experience of ICT students undertaking cooperative work-integrated projects.

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