Retraining the brain: Longitudinal learning and authentic assessment to develop a culture of design thinking, problem-solving and innovation in future ICT professionals

OVERVIEW: SUMMARY OF CONTIBUTION AND CONTEXT

Design Thinking (DT), creative thinking and advanced problem-solving skills are highly sought by digital and *Information Communication Technology* (ICT) industries, especially among ICT graduates. DT is a systematic process that empowers even the most traditional thinker to develop new, innovative solutions to a problem because it applies a problem-solving framework to the process of short, iterative cycles of problem understanding and ideation with users and stakeholders. The range of people's different perspectives are explored through interviews and empathetic engagement, which are imperative to the DT framework, but require high-order interpersonal and communication skills. Such qualities are often overlooked within the curriculum design in ICT programs where 'hard skills' or technical expertise are the focus for successful transition to the workforce. However, currently there is a job-ready graduate skills gap in these high-order areas according to reports by the Australian federal government and professional ICT bodies.[1-3]

To address this graduate skills gap, the IT@JCU Design Thinking Team have directly embedded a three-subject DT "strand" into the core requirements of a *Bachelor of Information Technology* (BIT) degree. The DT strand deploys longitudinal learning methods to engage students at each year-level to develop essential, deeply scaffolded DT skills across the cohort to create a culture of design thinkers. The DT strand spans the full three years of the degree and is grounded on the industry-based LitheSpeed model[4] where each year the students build on DT basics and incorporate Lean *User Experience* (UX) and Agile programming methods (Fig. 1).

The team developed the IT@JCU Technology *Design Sprint* (DS), which can be likened to a hackathon, as an authentic assessment unique to James Cook University (JCU). Authentic assessment is a major component of the DT strand, which brings students, educators, the ICT industry, and the regional community together to solve grand challenges. In addition to in-class activities, each year all students in the BIT participate in the two-day DS off-campus and in partnership with industry.

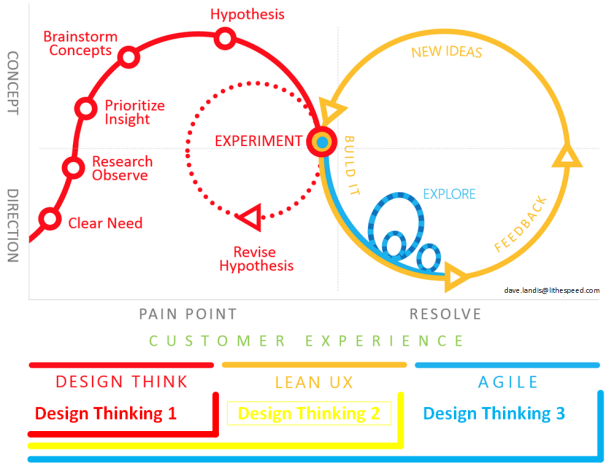

Figure 1: The LitheSpeed model[4] aligned to the three-year design thinking strand.

Local, national, and multi-national industry partners take part in the two-day event and offer *Subject Matter Expertise* (SME) and/or mentorship as students attempt to design solutions to grand challenges around issues of the Tropics such as health, water management, disaster management and sustainability. Outcomes of this sprint have included solutions now being developed further by our students with relevant industry and government partners. Industry representatives report that JCU BIT graduates' skills in overall problem-solving and creativity have increased and that they give preference to our graduates in the graduate programs (Glencore, Townsville Bulletin, 2016). In 2018, based on the success of the DS as embedded curriculum, the event was extended to include undergraduate students in Engineering. The implementation of this DT strand and the industry driven two-day sprint is a clear and innovative exemplar of how to bridge the DT ICT graduate capabilities gap in Australia.

CRITERION 4: INNOVATION, LEADERSHIP OR SCHOLARSHIP THAT HAS INFLENCED AND ENHANCED LEARNING AND TEACHING AND/OR THE STUDENT EXPERIENCE.

Our challenge – how could we develop a culture of design thinking in Information Technology students to improve student experience and employability outcomes?

LONGITUDINAL LEARNING – THE DESIGN THINKING STRAND: In the 2014 refresh of the BIT, the Information Technology (IT) discipline developed the curriculum in degree "strands" (e.g. programming, data management, etc.). That is, subjects were grouped in strands and co-designed by all stakeholders to

avoid the refreshed BIT being developed in "silos," where previously each subject coordinator was the only one responsible for a subject's development. The stakeholders include teaching staff of a strand (i.e. lecturers, tutors, and coordinators), students, and industry representatives as integral curriculum co-developers. This action ensured consistency in the learning experience, distinct scaffolding of curriculum content, embedding work readiness, employability, and development of transferable and high-order skills. Strand committees were created to ensure that authentic assessment, blended learning techniques and active learning activities were embedded consistently across the BIT.

We developed on a single pedagogical strand to strategically place JCU as a leader in DT with a DT strand that is **unique to JCU**. The DT strand has gained national and international interest by other universities and our accrediting body (the Australian Computer Society). The strand comprises three scaffolded subjects and the IT@JCU *Design Sprint*, which is much more than an assessment piece. The sprint is a clear, authentic assessment as we have applied the Kolb methodology[5] that is rooted within the BIT. Every IT student must take part in the yearly sprint simultaneously where we mix the year cohorts.

Students choose to study ICT for various reasons: general interest, some previous study in secondary school or the workplace, a belief in the importance of the field, and for personal professional development.[6] Our commencing students are predominantly secondary school leavers, with approximately 15% being mature age students who are retraining from previous vocations. Most students have had some training in word processing and general applications use and about 25% of the cohort have undertaken previous study in programming or other technical subjects in secondary school.

Although each student varies in their preparation, ability and knowledge, novice computer scientists make similar development errors when creating software solutions. Students prioritise technological solutions over understanding the business or clients' needs; they conflate problem solving, design, and application into one step, which results in a lack of building a deep understanding of the problem before designing and developing a solution. Novice computer scientists jump to the technology solution before considering whether they currently have all the information needed to make an informed decision.

The disparity occurs because technology programs often lack enough time to cover techniques of problem exploration, ideation, usability, and user interaction due to broad nature of technical skills required in an ICT degree. For example, if students proceed with coding before gaining a full understanding of a problem, they fail to consider other solution options and they design in isolation from the people that will be using the end-product. Often, these "soft skills" techniques are segmented into one subject, leading students to believe that they are less important or superfluous to software development. Due to the scaffolding in the three-year DT strand the IT@JCU team developed, students build holistic skills across a range of techniques, focusing on bottom-up, user-centred design.

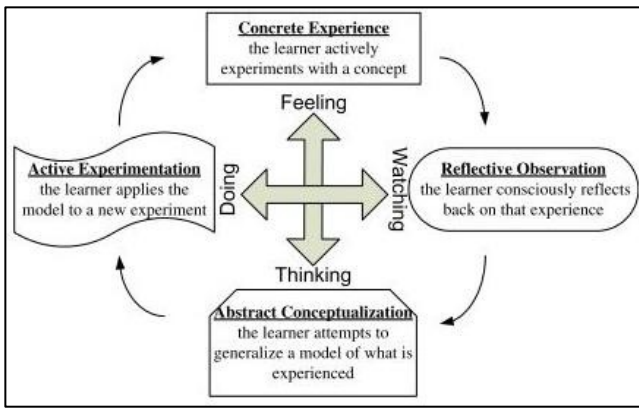

Figure 2: Kolb's experiential learning methodology[5]

The DT strand curriculum was designed as a hybrid using the LitheSpeed model[4] (Fig. 1) and Kolb's experiential learning methodology (Fig. 2)[5]. This methodology applies real experience to the process of learning, or more specifically, *learning through reflection on doing*. The four-stage experiential learning cycle offers a framework to create linkages among education, work, and personal development.

In the first-year subject, DT focuses on the development of four essential design thinking skills following the classic DT framework. These skills include the following:

1. Carefully defining the problem the technology will solve;
2. Building empathy for the end-user of the technology solution, and ideating solutions to the problem;
3. Creating multiple design prototypes, and
4. Testing those prototypes with actual users.

In the second-year subject, the concepts of Lean UX are explored along with the creation of a *Minimal Viable Product* (MVP) with the goal to test the business viability of the prototype. Then, in the final year, the third DT subject focuses on the use of real-world project development techniques to analyse the applications of

DT in the ICT industry, with emphasis on software implementation. This subject is advanced and makes up part of the accreditation capstone for the degree.

EMBEDDED AUTHENTIC ASSESSMENT – THE DESIGN SPRINT: The DS was developed as an authentic assessment to prepare students with high-order graduate attributes. Graduates are required to communicate widely and collaborate with others who may lack their technical skills but have other vital business knowledge. Students take part in three sprints over the course of their degree and each year the cohorts build stronger team-based skills and confidence working with industry partners.

Authentic assessment is paramount in tertiary education for employability, work-ready graduates and student engagement in the learning process. There are three characteristics of traditional ICT tertiary assessment that are different to the experiences that graduates will have when working in the field: 1) small-scale projects; 2) unchanging conditions; and 3) homogeneous skillsets. Student projects are generally limited in breadth for the student to complete the entirety of the project in one semester. Another requirement of tertiary assessment is that the parameters of the work will not change during the subject. Additionally, if the student is working in a group, all the members will be fellow ICT students of the same year who have received the same training. These three conditions are seldom encountered in the ICT industry. Graduates are often placed on teams working on large-scale, staged projects which have been in development for some time. Skills needed include the ability to understand the larger problem, appreciate the business need and brainstorm innovative solutions. Changing business priorities mean that milestones may be shifted and deadlines changed with little notice. Through the development of an annual DS that is required for all DT subjects, the students gain experience navigating these complex social, technical, and business requirements. By partnering with the QLD airports, we have been able to incorporate leading industry partners to act as mentors and SMEs for the students to interview and/or work alongside in ideating solutions. The word has spread of the Sprint event. We now have local, national, and international companies asking to not only sponsor, but also to take part in the two-day event. Each year the industry engagement has doubled, and the recent 2019 sprint had 450 ICT and Engineering JCU students, and over 50 companies fly senior staff into Townsville to take part (~85 local and national industry representatives in 2019). By focussing on grand challenges of the Tropics, the Sprint provides and authentic experience that resonates with the students as the problems are "real-world" and the industry partners are "real" employers who are also looking for future recruits (Fig. 3).

Figure 3: 2018 IT@JCU Design Sprint, Townsville: 350 students plus 70 industry partners (50 of whom flew in to take part in the event). Authentic assessment plus student and industry connectivity equal true engagement.

RECOGNITION FROM FELLOW STAFF, THE INSTITUTION AND/OR THE BROADER COMMUNITY: Our curriculum design and the development of the DT strand has been recognised and disseminated within our college, university, and wider academia. The impact of the DT strand has been at both the local, national, and international level. At the local level, the Sprint has attracted great media interest with the team being interviewed by local and national including Channel 7, Channel Nine, WIN, the Townsville Bulletin, and the Herald Sun. At the national level, we have been invited to submit a case-study to the Innovative Research Universities (IRU) National Innovation Case-Study Collection[7], we were invited to present our experiences and curriculum design at the Australian Council of Deans of ICT Teaching and Learning forum (ALTA), the Queensland University Educators Showcase (QUES) and the Australian Computer Society (ACS). We presented a paper on the unique strand at an Australasian Computing Education (ACE) conference, January 2018[8].

THE STUDENT/GRADUATE PERSPECTIVE: Common anecdotal declarations from students at commencement of the Design Thinking (DT) subjects are evenly split between (a) the positive: *"This is so interesting"* or *"I wish more subjects were like this"* and (b) the negative: *"Just tell me what to code," "this is a waste of my time," "there will be design people to handle all this interview stuff,"* and *"this doesn't seem*

relevant to my future career as a software developer." As students advance through the three-subject strand, they scaffold basic DT skills and integrate Lean UX and more software design processes such as Agile and project management. As they progress, the student feedback becomes increasingly more positive and the culture shift towards becoming "design thinkers" is evident. The real change observed is in recent graduates who may have resisted learning DT techniques. The following statements are from unsolicited emails received from recent graduates of the BIT (2018-2019):

- *"Overall the Design Thinking subjects were the most useful to me out of my Bachelor of IT."*
- *"I've learned, admittedly the hard way, that the Design Thinking process is a crucial step to affordably building quality customer-facing software"*
- *"I know that many of my peers feel that the design element of the course was fundamental to securing grad positions; employers have generally been curious about it in interviews."*
- *"My experiences in Design Thinking allowed me to participate in the IBM Garage (a high-impact, week- long design sprint), three weeks into my graduate position."*
- *"The design sprint is a great example to use in job interviews, as it can cover a large variety of questions."*
- *"When interviewing for graduate positions in Melbourne two companies required group problem solving activities, and my training in Design Thinking helped me secure an offer for both positions."*

THE INDUSTRY PARTNER PERSPECTIVE: Response and interest from our industry sponsors and collaborators has been extremely positive. A participant from engineering firm, Aurecon, stated *"It's important that our organisations continue to work together through events such as the JCU Design Sprint to ensure all students are inspired to take on more challenges and are supported to become more capable future STEM leaders"* (Industry created video, 2018). Ed Chung, CEO of TechnologyOne reiterated this point "*We are proud to once again sponsor the amazing JCU Design Sprint event. Innovation is the path to the future, and fostering the next generation of technology leaders is crucial in that journey*" (Video by Ed Chung, 2017). Founder and CEO of iSeek, Jason Gomersall emphasised that *"I truly believe the regions have a strong future with technology, but that can only come about if we support events like this spring and work together as a local community to extract the best outcome"* (video by Jason Gomersall, 2018). Glen Richard, owner and CEO of Green Cross Vets and panel member on The Shark Tank stated that our event is *"the largest Design Thinking sprint event anywhere in Australia".* He continued that *"the skills taught in the sprint of thinking, pivoting and coming up with new ways to think about and solve problems are what make great entrepreneurs"*. The topic of sustainability for the 2018 sprint encouraged both students and industry partners to *"think about global impact for our ideas and how that will make this planet a much better place"* (video by Glen Richard, 2018).

CONCLUSION

The success of the IT@JCU DT strand and the DS since its rollout in 2015 is evident in our feedback from alumni and our industry partners. The opportunity to present the success of our program though scholarly publications, to academic colleagues at JCU, to the wider academic community, to professional ICT bodies and government has enabled us to disseminate the innovative and unique IT@JCU DT strand. The three subject DT strand with the embedded DS for all cohorts shows true leadership with the ICT education field that enhances the student experience through the real-time connection with industry.

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