FOSTERING EMPLOYABILITY SKILLS THROUGH THE T-SHAPED STUDENT IN SCIENCE, MATHEMATICS AND MEDICAL SCIENCE

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ABSTRACT

This work reports on a case study on how employability skills can be embedded within science, mathematics and medical science students. The cohort involved two courses within three programs and almost 500 first-year students at a large, research-intensive university. The approach was to redesign the curriculum within these courses to form a T-shaped student experience by focusing 50% of class contact time on employability skills and teamwork activities within an active learning space; while the other 50% of time was spent on discipline knowledge.
The results show positive perceptions from students regarding their learning in these courses through: collaboration; active learning engagement; and professional development. It is suggested that starting the T-shaped student experience within the first year of university has the benefits of enabling depth and breadth of knowledge to naturally develop throughout the university years, as opposed to some capstone courses that endeavour to add some of these skills at the end.

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INTRODUCTION

The purpose of this paper is to present a case study on how employability skills can be fostered within students in science, mathematics and medical science programs.

This paper is structured as follows. Firstly, an outline of the T-shaped student model and its connection to employability skills is presented. This is followed with a brief discussion of the concept of active learning spaces. Next, the case study is introduced involving two courses that aim to foster employability skills. After presentation and discussion of the results regarding the students' perceptions of their experience, we conclude with an indication of the direction we believe the T-shaped learning approach should be going.

This work adds to the special issue of the International Journal of Innovation in Science and Mathematics Education edited by Kuchel et al (2015) regarding possible solutions to the dilemmas experienced in the STEM education-employability transition.

LITERATURE SURVEY

THE T-SHAPED STUDENT

Guthrie (2015) made headlines recently when Graduate Careers Australia announced that employment of 2014 graduates was just 68% nationally – the lowest figure since the survey began in 1982. In the context of lower employment rates, it is important for graduates to demonstrate the skills employers find most important. Edwards (2015), Orrell (2011) and Universities Australia (2015) have advocated the need for achieving the balance between discipline-specific education and education focused on core graduate attributes due to employers placing importance on graduate attributes, including: teamwork and communication skills.

A T-shaped student is one who has not only deep discipline knowledge (the base of the "T") but also a broad skill set needed in the workforce (the top of the "T"), see Figure 1. A greater focus on this

learning model has the potential to close the gap between traditional rote education and the needs of the workplace (Valent, 2015).

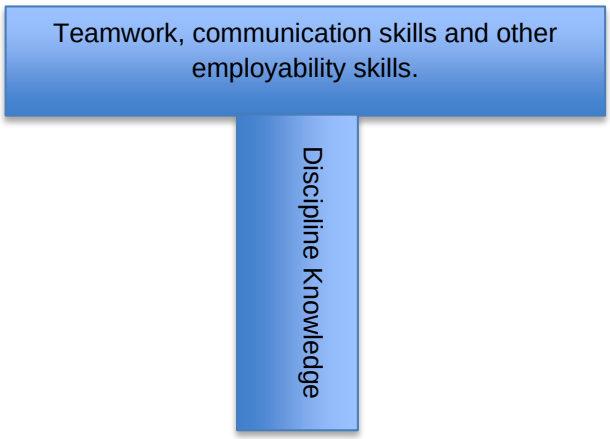


Figure 1: The T-shaped student

ACTIVE LEARNING SPACES

Active learning involves students doing things and thinking about what they are doing. Collaborative learning is one of the active learning pedagogies (CRLT, 2016). Traditional classrooms are transforming to become more flexible, collaborative spaces that foster opportunities for active learning. This includes design principles that enable opportunities for active learning within groups, with physical features such as: wall-to-wall whiteboards; seating that caters for small groups rather than large fixed, linear rows; chairs and tables on wheels; and a flat floor.

The concept of learning space is related to Kurt Lewin's field theory and his concept of life space (Kolb & Kolb, 2005). For Lewin, both person and environment are interdependent variables, a concept Lewin translated into a mathematical formula, B = f(p,e) where behavior is a function of person and environment.

If we combine the idea that learning is social, with activity facilitating learning, and the idea of a learning space, then we obtain the concept of “active learning spaces” for teamwork.

METHODS

CONTEXT

This study was conducted at the University of New South Wales - a large research-intensive Australian university. The two courses involved in the study were: SCIF1121 “Professional Perspective & Practice”; and SCIF1111 “Perspectives in Medical Science”.

SCIF1121 is a large first-year compulsory course taken by students who are studying towards a degree in Advanced Science or Advanced Mathematics. Approximately 280 students were enrolled in SCIF1121 in Semester 1, 2016, with the cohort coming from a diverse range of sub-disciplines/majors, including: biology; chemistry; physics; pure mathematics; applied mathematics; statistics; medical science; and psychology.

Similarly, SCIF1111 is a large first-year compulsory course taken by students who are studying towards a degree in Medical Science. Around 186 students were enrolled in SCIF1111 in Semester 1, 2016.

CURRICULUM REDESIGN

In Semester 1, 2015 problems were identified with both SCIF courses through student feedback. In student satisfaction surveys, many concerns were raised regarding a perceived lack of relevance of course material, describing the course as “tangential” and “unconnected with the real world”.

For example, when asked how these courses could be improved, student comments included: "Less abstract content"; "Having clearer purpose"; "Having more practical activities and groupwork"; "Having more material in the course that is more relevant and useful"; "Making the work done more relevant and more engaging".

In addition, very low course satisfaction scores placed SCIF1121, in particular, within the bottom 5% of the 300 or so courses across the Faculty of Science at UNSW.

Revised Learning Outcomes
In preparation for Semester 1, 2016, we revised the learning outcomes for both SCIF1121 and SCIF1111 to place a greater emphasis on the T-shaped student experience. The learning outcomes included that students should be able to demonstrate the ability to:

- Establish peer-to-peer connections to form a cohesive learning community;
- Communicate effectively;
- Work collaboratively in a multidisciplinary context;
- Increase their levels of work-readiness;
- Appreciate relevant disciplinary knowledge at an introductory level.

T-Shaped Structure
As can be seen from the above learning outcomes, the first four dot points are connected with the top of the T-shaped student experience (50% of the each course); with a close relationship to some of the LTAS project learning outcomes, especially "demonstrate the ability to apply the principles of teamwork and collaboration" (Jones et al, 2011). The fifth dot point relates to the base of the T-shaped student experience (50% of each course). The present work will concentrate on discussion around the top line of the T, that is, the employability skills.

A Cornerstone Course – not a Capstone
In many programs of study, a capstone course can be a final unit. The idea behind the name "capstone" is to emphasize that the course represents a crowning achievement, just as a capstone does in architecture. The completion of a capstone project can be used for an employment portfolio (Cucuzzella, 2014).

The approach to timing of employability skills via the T-shaped student experience in this work flips the idea of this kind of capstone course on its head by suggesting that employability skills should be learnt in parallel with discipline content throughout university studies, rather than at the end. This is why this study timed SCIF1121 and SCIF1111 to be right at the beginning of a student's university life to "sow the seed" early. This idea is referred to as a cornerstone course, based on the ideas from architecture where all other stones will be set in reference to the cornerstone, thus determining the position of the entire structure.

Activities
Each week, two consecutive hours of class time (50% of the total contact hours for each course) were devoted to employability skills through active and collaborative learning within our Active Learning Space. These activities included:

- Networking – Each student creates a LinkedIn profile and connects with others
- STAR statement – each student produces professional STAR (**S**ituation, **T**ask, **A**ction, **R**esult) statements, written to highlight their past experiences and achievements
- Scientific and professional writing – each student writes a biography of a peer
- Group dynamics – each student learns and participates as part of a team
- Public speaking – group presentations / debates
- How to interview a professional – a group video interview with a scientist
- Curriculum Vitae – each student must create a CV
- Cover Letter – each student produces a cover letter for a job of their choice
- Mock Interviews – students prepare for a mock internship interview.

In each class, students were placed in teams of 6-8 people. Each team was given tasks or questions related to a weekly topic, ideas were then generated via team discussion and recorded on the

whiteboard by each group. These were then reported back to the class as a primer for the course tasks described earlier.

Figure 2: Typical collaborative learning in a SCIF1121 class within an active learning space

ACTIVE LEARNING SPACES

As can be seen from the Figure 2, the active learning space involved wall-to-wall whiteboards; seating that catered for groups of 6-8 students; chairs and tables on wheels; and a flat floor.
Monitor screens on each table gave the opportunity for students to connect their own devices and share ideas, or for the teacher to share different things with different tables.

METHODOLOGY

The mixed methods approach herein analyses the quantitative data regarding students' judgement of the usefulness of the courses, and the qualitative data from the open-ended comments all collected in the survey of students, to answer the following research questions:

- What was the perceived level of active learning in our courses?
- What was the perceived level of collaborative learning?
- What was the perceived level of professional development?

The open-ended comments were analysed to identify themes for the whole cohort.

RESULTS AND DISCUSSION

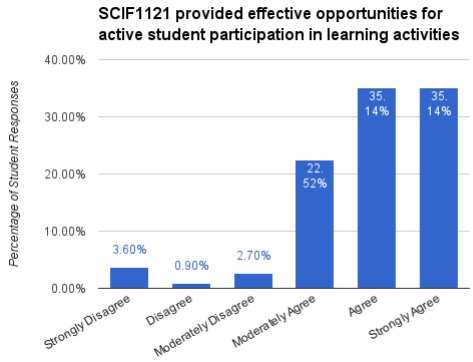
DEMOGRAPHIC AND PARTICIPATION OVERVIEW

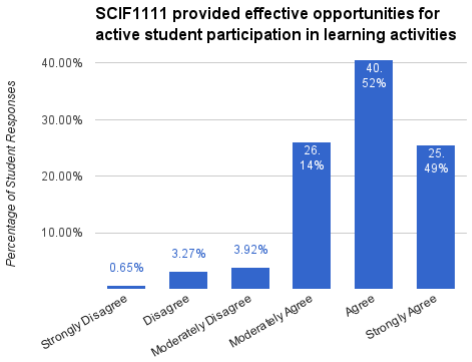
A total of 225 students completed the survey, out of a total number of 280 in SCIF1121. This gives an 80% survey response rate for SCIF1121.

A total of 157 students completed the survey, out of a total number of 186 in SCIF1121. This gives an 84% survey response rate for SCIF1111.

DID THESE COURSES PROVIDE OPPORTUNITIES FOR ACTIVE LEARNING?

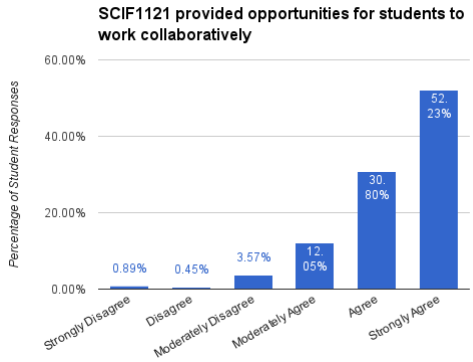
The answer to this question is yes for both SCIF1121 and SCIF1111. As can be seen from Figures 3a and 3b below: 93% of SCIF1121 students either: Strongly Agreed (35.14%); Agreed (35.14%) or Mildly Agreed (22.52%) with the statement "This course provide opportunities for active learning". In addition, 92% of SCIF1111 students broadly agreed (25.49% Strongly Agreed, 40.52% Agreed, 26.14% Mildly Agreed). On a 6-point Likert scale (with 6 = Strongly Agree moving down to 1 = Strongly Disagree), SCIF1121 had an average level of agreement of 4.9 with a standard deviation of 1.16. For SCIF1111, the average level of agreement was 4.8 with a standard deviation of 1.02.

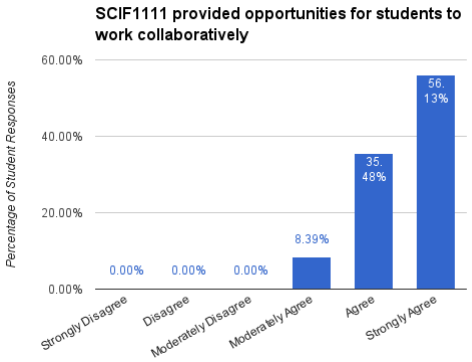




Figures 3a and 3b: Opportunities for Active Learning

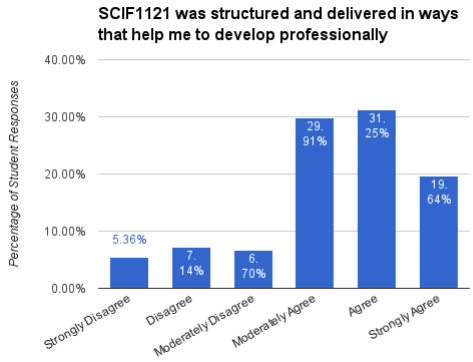
DID THESE COURSES PROVIDE OPPORTUNITIES FOR COLLABORATIVE LEARNING?
The answer to this question is yes for both SCIF1121 and SCIF1111. As can be seen from Figures 4a and 4b below: 95% of SCIF1121 students either: Strongly Agreed (52.23%); Agreed (30.8%) or Mildly Agreed (12.05%) with the statement "This course provide opportunities for students to work collaboaritvely". In addition, 100% of SCIF1111 students broadly agreed (56.13% Strongly Agreed, 35.48% Agreed, 8.39% Mildly Agreed). On a 6-point Likert scale (with 6 = Strongly Agree moving down to 1 = Strongly Disagree), SCIF1121 had an average level of agreement of 5.28 with a standard deviation of 0.95. For SCIF1111, the average level of agreement was 5.48 with a standard deviation of 0.65.

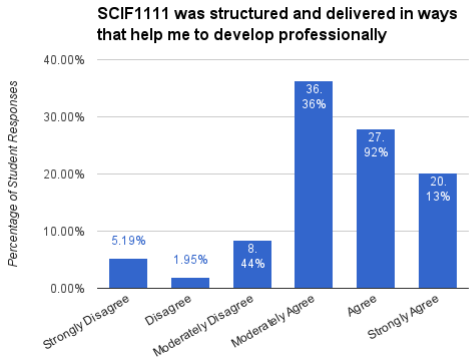




Figures 4a and 4b: Opportunities for Collaborative Learning

WERE THESE COURSES STRUCTURED AND DELIVERED IN WAYS TO HELP STUDENTS DEVELOP PROFESSIONALLY?
The answer to this question is yes for both SCIF1121 and SCIF1111. As can be seen from Figures 5a and 5b below: 81% of SCIF1121 students either: Strongly Agreed (19.64%); Agreed (31.25%) or Mildly Agreed (21.94%) with the statement "This course was structured and delivered in ways that helped me to develop professionally". In addition, 84% of SCIF1111 students broadly agreed (20.13% Strongly Agreed, 27.92% Agreed, 36.36% Mildly Agreed). On a 6-point Likert scale (with 6 = Strongly Agree moving down to 1 = Strongly Disagree), SCIF1121 had an average level of agreement of 4.3 with a standard deviation of 1.35. For SCIF1111, the average level of agreement was 4.4 with a standard deviation of 1.25.





Figures 5a and 5b: Opportunities for Professional Development

While the quantitative data for this question is not quite as strong as in the previous sections, the real story lies in an analysis of the qualitative data. We asked the students to list the best features of their course. There were 185 students who made a comment in SCIF1121, while there were 138 students who made a comment in SCIF1111. We found at least 74 instances of where a student had indicated that the best feature of the course was related to: job / employment skills; relevance to real life or future career; or LinkedIn / resume skills. Specific comments included: "Teaching about real work skills / how to write a resume / interview skills / talking to a professional was very helpful"; "Group collaboration"; "The classes were informative and taught me many things which are useful in day to day life such as how to find a job"; "very active, much learning".

We summarise the situation in Table 1 below.

Table 1: Themes extracted from student responses regarding the best features of these courses.

The best features of this course were:	Course	Number of comments
Job / employment skills	SCIF1121 SCIF1111	22 21
Relevance to real life	SCIF1121 SCIF1111	5 5
Relevance to future career	SCIF1121 SCIF1111	3 5
LinkedIn / resume skills	SCIF1121 SCIF1111	3 10

OVERALL, WERE STUDENTS SATISFIED WITH THE QUALITY OF THESE COURSES?
The answer to this question is yes for both SCIF1121 and SCIF1111. For example, as can be seen from Figure 6 below: 76% of SCIF1121 students either: Strongly Agreed (13.9%); Agreed (31.84%) or Mildly Agreed (8.52%) with the statement "Overall, I was satisfied with the quality of this course" in 2016. Compare this with the results from 2015 where just 54% of SCIF1121 students either: Strongly Agreed (6.72%); Agreed (18.49%) or Mildly Agreed (28.57%) with the statement.

On a 6-point Likert scale, in 2016 SCIF1121 had an average level of agreement of 4.13 with a standard deviation of 1.39. Compare this with the 2015 mean score of 3.34 and standard deviation of 1.15.

As be seen from Figure 6, there was a significant increase in student satisfaction in SCIF1121 between 2015 and 2016.

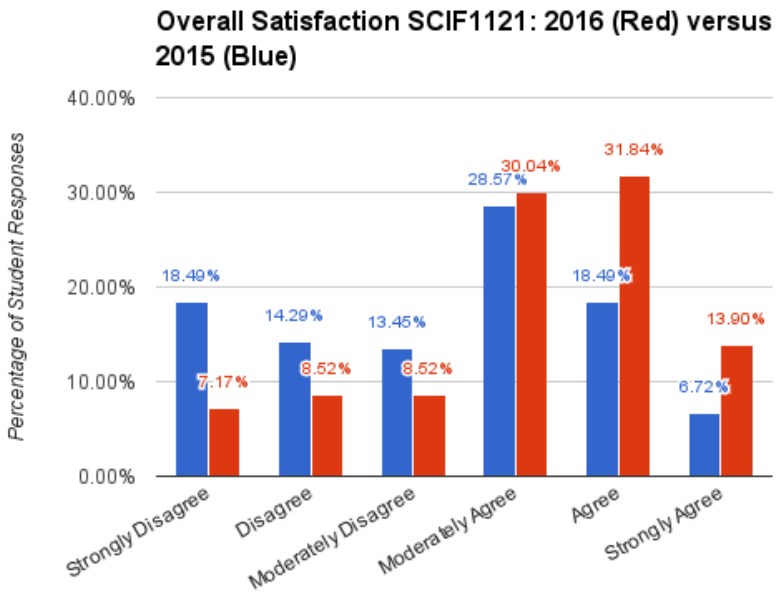


Figure 6: Overall student satisfaction for SCIF1121

CONCLUSION

It is clear that these students believe these kinds of courses are beneficial for their learning. When we combined a revised curriculum with an active learning space, we have seen a strong student perception of opportunities for active learning, collaborative learning and professional development.

It is suggested that the T-shaped student experience model could be adopted throughout university studies, rather than at the end of the student's university life. This would enable a natural growth of T-shaped skills throughout the student experience at university, as opposed to being added via a capstone approach at the end. There are plans to follow these students throughout the rest of their studies and beyond withtheir LinkedIn profiles providing a natural mechanism for doing so.

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