An investigation into the application of research strategies in the final-year undergraduate engineering and surveying projects

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Abstract: *Anecdotal evidence gathered from USQ's capstone Research Project students and their supervisors suggests that many students have difficulty completing the literature review associated with the Project and fail to use the literature review to inform their Project's technical components. This paper provides a preliminary report on a USQ Associate Fellowship project designed to better understand students' experiences and propose further work designed to overcome difficulties discovered by the preliminary research. With reference to responses collated from a pre-test survey, an intervention (in the form of five workshops) was designed and then conducted with participants. On completion of the intervention, a post-test survey was administered. Data from these surveys and observations from the intervention will be analysed along with 'pseudo' assessment data being gathered half way through the Research Project via the Project Appreciation's literature review and again via the actual Dissertation's literature review.*

Introduction

The final year undergraduate "Research Project", as a form of project-based learning, is considered a critical capstone activity in USQ's Engineering and Spatial Science Bachelor programs. It is offered to provide an opportunity for students to draw on the breadth and depth of knowledge and technical skills developed in the first three years of their program, and to help them prepare for professional practice. Anecdotal evidence from both staff and students suggests that students are unable to take full advantage of the learning opportunity offered to them through the Research Project.

This evidence appears to mirror the experiences shared by Montes et al (2007) who reported that 60% of students considered that the most difficult aspects of the project were getting started, defining the methods and content, obtaining data, and preparing and analysing the data. The remaining 40% pointed to the viability (12%) and the construction (28%) of the project as being the most difficult aspects to deal with. At USQ, students, supervisors, markers and moderators have also specifically reported difficulties conducting and writing the literature review, and using the literature review to inform research activities. As the literature review should be a major informer of much of the technical work conducted during the Research Project and is, therefore, likely to impact on other reported Project difficulties, the authors sought funding for a small project that aimed to better understand students' experiences of the literature review process.

This paper provides a progress report on an investigation into students' preparedness to conduct, present and use a literature review in their research and the information literacy issues associated with that preparedness. For practical reasons, the investigation utilises an on-campus cohort but observations, analysis and recommendations will also be considered for relevance to the external cohort.

Methodology

The research team consists of two engineers and a librarian, none of whom had any education research experience. The methodology initially proposed was heavily and inappropriately influenced by engineering research methods and it was not until the team attended an education research workshop (conducted by Dr Lesley Jolly) that it began to envisage the more suitable methodology presented in this paper. Having carefully devised an amended research methodology, the team has since found that further compromises will have to be made to accommodate the unwillingness of some participants to fully engage in some aspects of the study.

Instead the study aims to act as a preliminary investigation. It attempts to give students a voice in a complex learning process, a voice which has been lacking. A better understanding of students' experiences can then be used to inform 'interventions' that allow students to take full advantage of the learning opportunities provided by their capstone Research Project work. These interventions can then be evaluated through an action research process. The study was approved by University's Human Research Ethics Committee.

Biggs' 3-P Model (1989) was used to inform much of the research methodology's development. The 3-P Model seeks to shed light on issues of presage (student and teacher contexts), process (learning opportunities offered by teachers and learning processes undertaken by students) and product (desired learning outcomes). In this case, the emphasis is on the **student** experience of presage, process and product. This is not to deny the importance of the teacher/supervisor/marker/moderator experience. These are simply beyond the scope of this project. It is expected that they will be explored in the later research work.

As participants would be asked to attend several face-to-face sessions, only on-campus students were considered to be part of the study. From each of the four Faculty disciplines (Agricultural, Civil and Environmental Engineering, Mechanical and Mechatronic Engineering, Electrical, Electronic and Computer Engineering, and Spatial Science) four students were randomly selected and asked to participate. Of the four from each discipline, two would possess a grade point average of at least 5.5 (out of 7) and two a grade point average of 4.5 or below. Due to initial low student interest, however, only fifteen participants were found and the Spatial Science Discipline was not represented.

A pre-test survey was conducted to help the team understand the issues of student presage. These results were used to inform the development of the face-to-face sessions and support materials offered to the study participants. At the end of each session, a short "debrief" was conducted. This debrief gave the participants an opportunity to provide feedback and share current research project work experiences. At the end of the series of face-to-face sessions, a post-test survey was conducted. This survey was designed to help the team understand students' perceptions of learning gained through intervention participation.

This subjective data will be analysed with reference to objective data collated through a pseudo assessment process. A pseudo assessment rubric was about to be developed at the time of writing this paper.

Participants will provide their initial literature reviews (submitted as part of an assessable Project Appreciation) for pseudo-assessment against the marking rubric designed as part of this study. Such an analysis should reveal any differences and commonalities in students' perception of their learning and demonstration of actual learning.

Final literature reviews (submitted as part of the Dissertation) will also be assessed according to the developed marking rubric. This assessment will allow comparison with the Appreciation literature

review and help gauge student development over the remainder of the project. A second level of assessment comparison will also occur. Participants' Dissertation literature reviews will be compared with 2008 Dissertation literature reviews selected according to the same criteria as the 2009 participants.

The team had also planned to obtain literature searching logs as artefacts for methodological triangulation. Search logs would have provided valuable data related to how students searched the literature and evaluated the suitability of information found to their research. Insights from search log artefacts may have combined with survey data to provide rare insights into literature searching and evaluating practices that are poorly understood. Participants, however, declined to submit these logs.

Intervention Process

Five face-to-face sessions were conducted over catered lunches as this was the only time that most participants could regularly attend. The first thirty minutes were devoted to socialising (particularly between students who were keen to hear what others were doing and how they were coping with their Research Projects). The first session (held in the third week of semester) was used to thoroughly explain the reasons for the study, human ethics clearance matters (particularly those related to withdrawing from the study), the elements of the study, the need to not share learning from these sessions with non-participants and completion of the pre-test survey. The pre-test survey results informed the content of subsequent sessions.

Pre-test results clearly demonstrated that students had limited or no understanding of the dissertation or its purpose. Given this result, it was unsurprising that they also reported no or limited understanding of the literature review and its purpose. As a result, the second session (held in the fifth week of semester) was devised to consider these issues and give students an opportunity to undertake a literature review planning activity. Twenty minutes was allocated to the dissertation discussion but the concept was so alien to students and they were so engaged by the discussion, that it lasted one hundred minutes.

The final twenty minutes of the session included an abbreviated segment "What your literature review should do" and how the literature review relates to the course objectives and assessment criteria. Unfortunately, due to time constraints, the planning activity was abandoned however the search log templates were introduced in an effort to encourage planning and obtain research artefacts for future analysis.

Several interesting revelations came out of the session:

- Explanations of the dissertation and its purpose provided by the course material were not understood by those who had read the course material

- Student surprise that the literature review could influence how a researcher chose to conduct experiments

- Prior belief that the literature review should not be conducted until all experiment results had been collected

- Realisation that the literature review may continue throughout the project

- Prior belief literature reviews have a standard/average number of journal articles which should be considered.

Two unsurprising but also important issues arose:

- Having gained an understanding of the dissertation, students considered that they were better prepared to think about the value of the literature review to their Research Project

- The knowledge and skills developed in a compulsory Library session offered in the third year (as part of a project preparation course) were lost by the time students actually came to work on their Research Projects.

Session three (held in the seventh week of semester) was designed to review the previous session and explore any related issues that had arisen for individuals and their projects, consider the concept of critical reading of the literature, and help students with any literature searching problems that they were facing. Criteria for reading critically (such as peer review, statistical reliability and validity, noting particular types of studies being criticised or favoured) were discussed, and most likely sources of reliable information for particular circumstances were reviewed. Critical reading of the literature was introduced with Duthie, Murphy and Sevenson's (2009) report on a negligence claim against an engineer by a major Australian mining company.

The session was planned to allow seventy-five minutes of searching with the academics and librarian available to provide advice and help. Discussions about critical reading, however, extended to almost the entire two hours as students revealed that they had a limited or no understanding of basic critical reading concepts. The Duthy, Murphy and Sevenson paper also created much debate as students were unable to understand why they would be expected to have a professional responsibility to consider the suitability of particular standards to particular jobs and why they should be responsible for keeping up-to-date with professional debates about issues affecting their professional practice. They also revealed a prior and strongly held belief that they could accept as truth what they read in the literature; that there was no need to read with a critical mind. This naivety was particularly surprising as only the higher grade point average students chose to attend this session.

The limited time spent discussing literature searching issues revealed that participants were having difficulty determining most likely sources of information, identifying search terms particularly synonyms, selecting databases and recognising how existing literature might be applied to their particular subject. The problems that they encountered were of a level expected to be encountered by students operating at Willison and O'Reagan's (2006) Levels 2–3 when they should have been able to be operate at Level 4.

The fourth session (held in the eleventh week of semester) was devoted to writing the literature review and writing a dissertation abstract. In the pre-test survey, only one student felt prepared to take on such a task and all students but one reported feeling negative about this part of the process. The student who reported a positive feeling of "excited" also reported feeling "overwhelmed". One student responded "I feel like I am on the verge of much academic pain. I have spoken to previous students during their suffering". After this session, only one student felt ill-prepared to write the literature review while three indicated that other academic writing learning needs were left unmet.

The fourth session, like the third, was designed to be a very practical session with students bringing along their literature review drafts for specific advice and assistance. Although not all students remembered to bring their drafts, those that did received great benefit from asking simple questions like "Is this sentence too long?" and "Can I outline chapters in my introduction?". With basic skill deficiencies such as these revealed, it was no surprise that participants had, in the pre-test survey, reported feeling apprehensive about more complex literature review writing skills such as balancing description and analysis, synthesis and writing for their audience.

The fifth and final session was devoted to a "debrief" and completion of the post-test survey. Attending students commented that intervention participation was beneficial to their Research Project work and that they were glad to have been invited to join the study. They also commented that students not selected to participate in the study asked them about the sessions and expressed a wish that they had experienced similar information literacy interventions during this period of their Project work.

Preliminary Observations and Questions

Although data is not fully collected or analysed, some interesting observations and questions can be made at this point. A previous adaptation of The Research Skill Development Framework (Willison and O'Reagan, 2006) was used to articulate the processes (Biggs, 1989) and standards associated with the undertaking of a fourth year dissertation literature review. Having generated their own research

topic with the assistance of a supervisor or chosen a topic from a list provided by the Faculty, the Framework indicated that students should be expected to be able to:

- Identify their information needs including the possession relevant pre-existing knowledge and knowledge gaps to be filled

- Identify, without guidance, the most likely sources of the required information

- Determine, without guidance, search strategy/ies for each likely source

- Conduct searches

- Evaluate found information against a quality and relevance criteria developed by the student

- Collect and organise suitable information according to structures and guidelines provided by the course materials

- Synthesise and analyse literature demonstrating rigour, deep understanding, independent thinking and identification of knowledge gaps in the subject area

- Demonstrate an independent and scholarly approach to the literature review while working within the prescribed format

- Use discipline language

- Address all relevant elements/perspectives embedded in the topic/question

- Present the literature review in a way that it could be understood by the intended audience

- Cite and reference accurately and completely according to USQ's Harvard AGPS referencing guide.

As described earlier in the paper, most participants struggled with most or all of these. Reference to the 3-P Model (Biggs, 1989) may provide some insights into this struggle. Considerations of presage – prior knowledge, abilities, and conception of learning (Biggs, 1989) all have possible relevance.

In the first three years of their program, students have only limited exposure to professional literature yet they are expected to explore and make sense of it at a high level during their Research Project. Furthermore, sciences-based approaches to learning such as favouring the concept of ultimate agreement through "the correct way of scientifically describing and analysing any particular phenomenon" (Hand, 1999) may inhibit the development of critical thought embedded in expectations of rigour and deep and independent thinking which are fundamental to the production and use of a literature review. Not only are students lacking opportunities to develop essential knowledge and skills, they receive minimal opportunities to see them role modelled through the professional literature.

What then for "process" (Biggs, 1989) during the Research Project courses? Students might reasonably expect that, as the previous three years have not equipped them to undertake processes essential to the Research Project, the capstone Research Project course should. So far the study seems to suggest that it does not. As students' experience of the research and academic writing world is so limited, they could not attach any real meaning to the words they read in the course materials. Unable to conceptualise the dissertation and literature review "products" (Biggs, 1989) that they are expected to create during their learning processes, it is unlikely that they would be able to foresee the complex processes necessary to create those products.

Without any formal attention to essential learning opportunities, students might expect that their supervisors support this learning. But, is it possible for supervisors to support the development of such knowledge and skills in such a short period of time? And, is this need recognised by workload allocations etc? Perhaps this situation leaves both student and supervisor focusing, as anecdote suggests) on building the gadget or doing the experiments rather than fully engaging in the **whole** learning opportunity being offered to them.

Conclusion

The investigation so far has provided an insight into the learning hurdles faced in the capstone Research Project. The investigation has not, so far, discovered anything new in the pedagogical sense, nor is it statistical valid or reliable. But, it has given students a voice and this voice has informed an experimental "intervention" to support this particular journey in student learning. Although the interventions such as these may be a solution in the interim, they cannot be considered a realistic intervention for the longer term. As participants demonstrated, even this intervention left several fundamental learning needs unmet.

It is more likely that fundamental academic and research skills require systematic embedding and appropriate scaffolding through programs and across disciplines so that knowledge and skills may be developed from Level 1 to Level 4 of The Research Skills Development Framework (Willison and O'Regan, 2006). A clear articulation of required knowledge and skills may also support the creation of a professional development program for the supervisors who are vital participants in the Research Project process. Further stages of the study will explore these issues. Happily the Faculty has embarked on a general path of exploring constructivist, authentic learning and other pedagogies which are likely to support learning-centred changes.

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