Capstone Project Collaborations Between Inherently Diverse Disciplines: Two Comparative Case Studies

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Abstract: While cross-disciplinary collaborations between students are encouraged in the university setting, there are many issues in achieving this learning outcome. In particular, when the disciplines are inherently diverse (e.g. computing and architecture) and use very different learning and teaching approaches, this type of collaborations can give mixed results. This paper discusses the successes and failures of cross-disciplinary collaborations involving three diverse disciplines via two case studies. In addition to describing the diverse nature of the learning and teaching approaches adopted in each case study, the paper identifies curriculum and assessment design, the commitment of program coordinators, the structure and dynamics of the collaborative student relationships, and differing scholarly cultures as the main factors that decide the success of such collaborations. The paper highlights the need for re-thinking the learning and teaching approaches needed to facilitate the collaboration between inherently different disciplines.

Keywords: Capstone Projects, Cross-Disciplinary Collaboration, Diverse Disciplines, Case Studies

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Introduction

Cross-disciplinary collaboration is a highly valued graduate attribute that students in higher education are expected to have attained upon completion of their degrees. Generally, capstone projects are used to encourage cross-disciplinary collaborations [1-3]. When analysing their nature, Pearce et al. [4] identifies two types of collaborations as: between disciplines that are naturally complementary to each other (e.g., electrical and mechanical engineering), and between disciplines that are inherently diverse areas such as (architecture and software engineering).

Collaboration between inherently different disciplines is imperative in real-life work environments. In most cases, products and services in the commercial setting require diverse disciplines to engage, communicate and have at least a high-level of understanding of each other's disciplines contributing to the workflow. However, in university courses, where the future workforce is trained and developed, achieving cross-disciplinary collaborations between inherently diverse disciplines is challenging.

Cross discipline challenges are due to university courses being siloed into different faculties with different types of learning environments and approaches (e.g. lecture, tutorial, workshops, studios, etc.). Further, the course structures, timelines, and assessment-driven nature of courses do not give sufficient time and resources to establish and nurture the cross-disciplinary collaborations and ensure that they grow and thrive [2, 5-7]. Hence, it is expected that a significant amount of groundwork must be laid by the coordinating academics to facilitate the collaborations. Lack of planning, flexibility in curriculum[1], and commitment of the involved parties are identified as major issues adversely affecting cross-disciplinary collaborations.

This paper concentrates on two case studies that discuss the successes and failures of collaborative efforts involving inherently diverse discipline areas. The first case study discusses the collaboration between communications and art students and computing students of two different schools at Western Sydney University, Australia. The second case study presents a collaboration between architecture and computing students within one school at the same university. The paper presents an extensive discussion on factors that lead to the successes and failures of each of these collaborations.

Contributions of this paper are significant to the capstone design domain as it discusses the issues associated with inherently diverse disciplines as opposed to complementary disciplines that are covered by most of the previous work [1, 5, 7]. This paper opens the discussion of the need for an innovative method of curriculum design needed to improve the cross-collaborations between diverse disciplines.

Case Study 1 (CS1): Communications & Arts and Computing

This case study refers to a collaboration between students from the School of Humanities and Communication Arts (SHCA) and the School of Computing, Engineering and Mathematics (SCEM) at Western Sydney University, in Australia. This collaboration brought together inherently diverse disciplines, computing and arts, through a capstone

program. The set-up was that the postgraduate (PG) students from SHCA had to conceptualise and manage the development of a digital media product as part of the completion of their media research project. A selected set of projects that involved a programming element (e.g. mobile apps) was chosen by the academic coordinator of the postgraduate unit/subject in SHCA, for the collaboration with SCEM. Then, 3-4 undergraduate (UG) students from SCEM were given the task of programming of the software artefact as part of the completion of their final year capstone project in their computing degree. A postgraduate student from the SHCA was the client (sponsor) for the group of students in SCEM. The SCEM students were the IT specialists supporting the SHCA students to get their product developed.

The SHCA students were assessed by their unit/subject coordinator based on their performance in conceptualizing the idea and managing the IT team in getting the product developed. The SCEM students were assessed by their academic supervisor based on their technical skills, project management skills and collaborative efforts, plus the rating they received from their client/sponsor.

This collaboration saw the successful completion of 36 projects between 2013 and 2018 until the degree at SHCA was re-designed. While there have been some mixed results in individual projects, the majority of the projects have had positive outcomes. The sustained success of six (6) years is a testament to the success of the overall collaboration between the communication and art students (n=36) and computing students (n=108).

Case Study 2 (CS2): Computing and Architecture

This case study refers to a collaboration between students enrolled in a second-year architecture unit (n=20) and students undertaking the same capstone unit referred to in the first case study (n=14). The collaboration was experimental in the sense that the students were brought together across different disciplines and scholarly cultures to develop creative artefacts using a computational design system; it was unknown how this collaboration would evolve. The role of the architecture students was to work with their computing peers in the refinement of computational design briefs within the conceptual framework of an urban renewal project known as Inhabitable Bridges. With assistance from a facilitator, they would act as 'clients' for the computing students, providing them with practical information about the desired end-product, an interactive visualisation such as a pedestrian flow simulation, parameterised bridge structure, or renewable energy optimisation model.

The intention was that the students would be divided into five groups, and, following an induction workshop outlining operational elements of the collaboration and basic use of the adopted computational design system, forge briefs consistent with the Inhabitable Bridges design ideas and principles. Equipped with well-refined briefs, the computing students would then part company with their architecture peers and complete the technical work required to produce the artefacts. While this collaboration and the ensuing supervised programming, project management and client communication effort would constitute all of the computing students' assessment, only a small percentage of the architecture students' assessment (5%) would be allocated to their participation in the initiative.

This sequence did not unfold as planned. Due to a range of reasons that will be outlined in the discussion, the architecture students' involvement in the collaboration ended prematurely, leaving the computing students in the care of an individual client (the lecturer who was facilitating the project) and supervisor (computing lecturer or tutor). The client took responsibility for development of the five briefs and explanation of how they should be implemented. Regular communications between the computing student groups and the client over the course of the teaching session ensured that the computational design artefacts were completed, the majority to a high standard. Immediately prior to their formal end-of-session presentations, the computing students re-joined their erstwhile architecture collaborators to present their visualisations and receive feedback.

Discussion

The focus of this paper is to provide a critical comparison of the above case studies (hereafter CS1 and CS2), not only to inform future implementations of collaborative capstone projects, but also to provide testament and guidance in cases where the collaboration involves inherently different disciplines. There is relatively little research addressing student collaboration between creative and technical disciplines in a university setting. The documented examples that do exist point to the potential for productive synergies and co-discovery of new skills and concepts, but also inhibiting or disabling factors such as learning culture incompatibility, clashing objectives or fractured communication.

Prescriptive nature of the task

Both the programs highlighted in CS1 had well-established curriculums that have been operating independently of each other successfully. Both programs had clearly defined the deliverable structures that were assessed. The communication and art students had the responsibility of overseeing the digital artefact development process and they were assessed based on how well they performed

this project management role. Computing students were assessed based on the quality of the artefact that was developed. As mentioned in CS2, the collaboration was experimental in nature from the beginning, with less clarity between all involved parties including the academic teams. Firstly, the architecture degree itself was still at its infancy, while the computing capstone program was well established. Architecture students had less clarity on what was expected of them and the design task that they were required to complete was not an assessable item within their curriculum.

The sequencing of the curriculum activities also would have contributed to the different outcomes between the two case studies. for example, in CS1, students had already developed the conceptual designs in a prior subject, before starting the collaboration with the computing students. So, the communications and art students were well aware of what they wanted to result from the collaboration. In comparison to this, in CS2 the creative and engineering processes were expected to take place at the same time. Having to commit to designs without allowing the full creative process to take place made the architecture students uncomfortable, while the fluid nature of the system specifications frustrated the computing students. Therefore, sequencing the creative and engineering process appropriately [5], with the possibility of interactive feedback should be considered in such diverse collaborations.

Commitment of the curriculum designers and facilitators

A significant factor in the success of CS1 was the buy-in of the academics responsible for its design and delivery. Integration of the cross-disciplinary project in the communications and art curriculum was managed by the coordinator of this unit, and similarly for the SCEM unit. This investment meant that sufficient intellectual and practical value was placed on the content, and time devoted to its transferal, for students to feel reassured that what they were learning was interesting, relevant and worthy of dedicated scholarly effort. The direct commitment of coordinating staff vested the collaborative work with a purpose that centred it around the units' curriculum and learning designs, ensuring its proper articulation with broader degree programs.

Such integration was not evident in the case of CS2, where only a short period of time was available to retro-fit the initiative to an already well-organised architecture curriculum. The idea was to focus the initiative around the Inhabitable Bridges concept in such a way that the design-programming collaboration at its heart dove-tailed with existing learning goals and sequences in the architecture unit. This did not come to pass for two key reasons: 1. the integration plan needed more time to mature and be woven into the architectural concepts, themes and problems underlying the Inhabitable Bridges project; and 2. while the 'owner' of the initiative on the computing side was the coordinating SCEM academic, this was not the case on the architecture side, where ownership, if it existed at all, belonged to a third-party facilitator responsible for developing the initiative.

Structure of the collaboration

The student cohorts in CS1 involved postgraduate (PG) communication and art students, and undergraduate (UG) computing students. The mature approach in solving problems deployed by PG students was one reason that it was possible to have a sustainable success over a long period in CS1. In contrast to this, in CS2 both student groups were from UG cohorts. Given that the CS2 projects did not benefit from a full semester of collaborative group work, it was not possible to gauge the approaches that students would have used in real problem-solving. Examples of successful collaborations spanning inherently different disciplines often involve at least one post-graduate collaborating party (see Eloy et al. [8] for example). In the case of CS1, it was identified that the PG students played the role of the client (sponsor) and UG students were the solution providers. However, in the case of CS2, this demarcation was not that clear as both parties were expected to work together to complete the creative and engineering processes. This lack of direction of roles of various student parties involved is not desirable in the collaborations of student groups comprising diverse discipline areas.

Learning Culture of the student groups

A phenomenon affecting the collaborative dynamics in CS1 and CS2 that was not obvious at first, was the difference in learning cultures across the disciplines. While in CS1, the collaboration was characterised by pre-defined, tightly prescribed roles among each of the communication and art and SCEM student cohorts, the structural and organisational relationships underlying the CS2 collaboration were intended to be more open and conducive to creative emergence. This meant that the CS1 students, though coming together across a divide in terms of what and how they learned (e.g., creative/discursive versus technical/regimented), were not thrown off course by the collaboration. The CS2 students, however, found themselves the unwitting victims of a 'culture clash', where flexible, artistic, studio-based learning behaviours (architecture) met with systematized, scientifically rigorous, lecture-tutorial-based behaviours (computing). This caused some initial discomfit and disorientation among the students, and until the facilitation of the collaboration acted to harmonise (and productively

exploit) these differences, the effect was learning inhibition.

Illuminating examples of learning culture differences involving design and engineering students are documented in Rushel et al. [9] and Burry and Maher [10], which describe the inhibitory effects of regressive learning patterns and frustrated efforts to assert familiar learning styles.

Conclusion

Given the importance industry places on collaboration as a 'soft skill' required for success in the 21C workforce [11], and of the growing demand for this collaboration to encompass many disciplines, this paper offers a critical perspective on what aids or inhibits such modes of learning among university students. Especially noteworthy is the fact that, in the two case studies considered, the disciplines are inherently different (studies examining such collaborations in a capstone context are rare). Key factors identified as influencing the success or failure of these collaborations were: 1. the extent to which the learning tasks set for the students were determined in advance, and the form that these prescriptions took; 2. the level of intellectual and organisational investment of the teachers coordinating the disciplines; 3. the nature and relationship of the student cohorts involved in the collaboration, their relative levels of maturity and preparedness, and the manner in which they are guided by facilitators through the learning experience; and 4. the prior scholarly inductions and expectations students bring to the collaborative experience, and how these might manifest (at least initially) as incompatible scholarly cultures. These findings suggest the need for those coordinating capstone units of study to reconsider how they manage cross-disciplinary collaborative learning, particularly in cases where the disciplines are inherently different.

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