Animatronic Puppets: A case study in Interdisciplinary Collaboration

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Abstract:

Authentic contexts are an important element to any effective learning experience. The construction and control of animatronic puppets is a context where students can easily relate to the relevant knowledge required in a wide range of disciplines – ranging from product design through to engineering. This paper reports on the progress of an initiative at Curtin University of Technology where Mechatronic Engineering students are collaborating with Product Design students to produce superior outcomes than would otherwise be possible when working independently. A broader range of more sophisticated design issues are addressed based upon the combined expertise of both groups.

Analysis of the students' final marks showed an improvement when directly compared to the previous cohort to attempt the subject despite the two having similar results in prerequisite units. This is supported by the subjective comparisons of the assessor, and comments from industry experts.

Students' reflections were collected both during and after the collaboration. Their responses indicated that the design students valued the input of their engineering colleagues equally to that of their design colleagues. Further they felt that there was strong benefit from collaboration with peers from another area, and that collaboration with students of a different discipline background was valuable.

Students were also asked their reason for taking the elective unit with the majority indicating the broadening of experience or the acquisition of new skills as their primary goals – goals that align with the advantages of interdisciplinary collaboration.

This paper shows that the students responded favourably to a collaboration with students from a differing disciplinary background. This collaboration has improved the quality of student learning outcomes along with satisfying the objectives of both university and industry alike.

Keywords: Authentic-contexts, interdisciplinary, collaboration, innovative, animatronics

Introduction

Authentic practice is a key element in learning - it is critically important for students to be exposed to realistic situations in which the knowledge they are acquiring can be applied. The presence of an expert mentor is critical in the area of learning by doing[1], for it is the guidance of such a mentor that allows mistakes to be identified, and to be properly learned from.

In this initiative, students from differing backgrounds serve as this expert mentor for each other. Whilst still students themselves, their discipline-specific skill base nonetheless makes them experts when compared to the other cohort of students who have no prior exposure to these skills. In this way the engineering students are able to mentor the design students with regards to electric motors and their control, whilst the design students are able to share their knowledge on topics such as shape, form and design utility.

The benefits of interdependence and cooperation are well documented[2]. One of the consequences of this interaction and cooperation is the exposure to not only the different technical skills of different students, but also to the different learning contexts of other students. These alternative viewpoints can be valuable in assimilating the information to be learned, and also provide a significant opportunity for reflection upon progress not only in the individual context, but also in the context of their progress relative to their colleagues. The best way to learn is to teach, and positioning the students as the expert mentors to each other provides ample opportunity for this to occur – and gives the students the opportunity for a deeper understanding arising from applying their knowledge in a new context.

This interdisciplinary approach emphasises Boyer's four aspects of meaningful learning[3]: "Discovery, integration (making connections with disciplines and across disciplines), application, and teaching (transmission, transformation and extension of knowledge)", in particular the integration and teaching aspects. Victoria University have achieved success in the teaching of Computer Science using a collaborative projects approach called CPR (Collaboration-Participation-Relevance), which was based upon Boyer's framework[4].

This paper details a project in which the collaboration was extended to include non-engineering students. An overview of the project completed by the students is presented. The impact upon the students' assessment performance, and upon their attitudes towards the learning experience are also detailed. Finally a conclusion as to the positive impact of this collaboration is given, along with an indication of how this work is being continued.

The Assignment

The task on which the students collaborated is the design and construction of animatronic puppets. This task forms the core of the assessment in a second or third year design elective subject. The engineering students participated voluntarily in this project as a prelude to their honours thesis project, in which they have taken the completed puppets and added computer-based control through a USB interface.

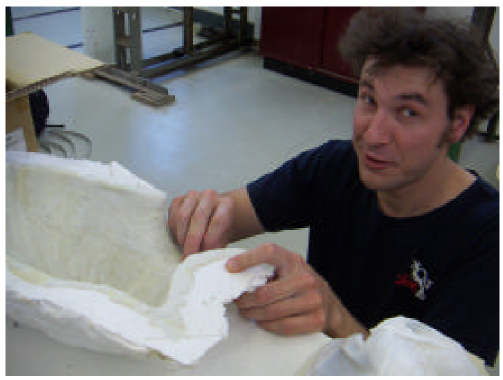
Students are given the following project brief:

> *"You are required to design and make an original mechanical puppet or creature to be used in a Curtin promotional clip. The choice of creature is yours but it should include moving eyes (in 2 axis), moving mouth, and at least one other moving part. The model should be a head and neck only and not too much larger than a human head. You are to consult to Engineering students studying mechatronics to consider the control components required down the track. Your model is to be controlled by simple remote to electric wire to small servos."*

The class of ten students were guided through the development of their puppets by a lecturer, working in a design studio for a three hour session each week of semester. The puppet design progressed through a number of stages:

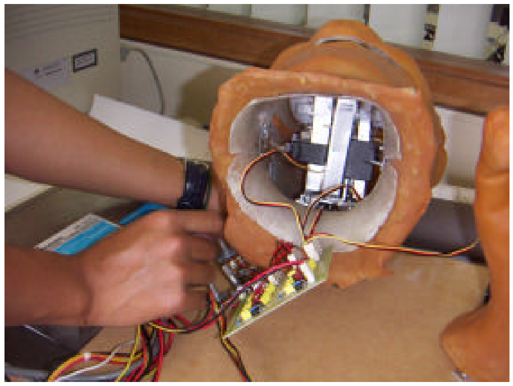
Design students make clay models…

…then plaster…



…then latex…

…then install motors and internal mechanics…



to produce a completed puppet.

Impact of Collaboratio n Upon Marks

One of the most straightforward measures of learning is the final mark awarded to the students for the unit. These marks were compared to the marks achieved by the previous cohort to complete the subject, in 2002 that were not exposed to a collaborative effort.

Figure 1 shows that the 2004 cohort had a greater bias towards higher marks than the 2002 cohort – 50% of the 2004 class achieved a Distinction grade or higher, whereas only 27% of the 2002 class achieved a Distinction or higher.

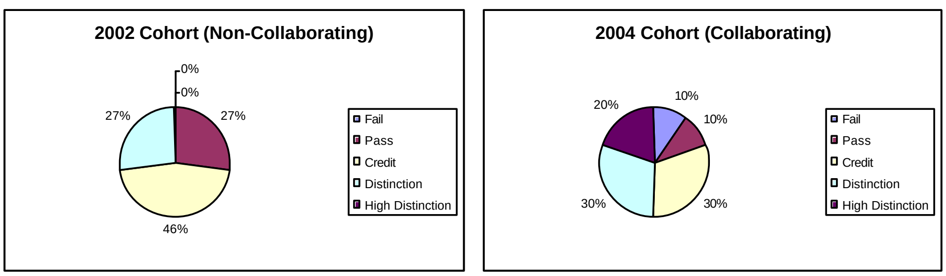


Figure 1: Mark Distribution – Animatronic Design

To control for possible variations in the cohort, the marks achieved by both groups of students in an other elective subject (Furniture Design) were also compared. This comparison (Figure 2) shows that the distribution of grades were similar.

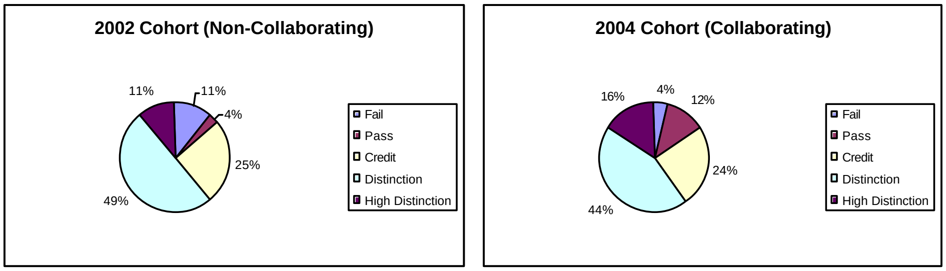


Figure 2: Mark Distribution - Furniture Design

The similarity between the Furniture Design marks of the cohorts suggests that the difference is due to something specific to the Animatronics unit – the collaboration with the engineering students. This collaboration has served to improve not only the quality of the work produced by the students, and thus the marks they have been awarded, but also the students' attitudes towards the work (as demonstrated by their Student Reflections), shown below.

In addition to the numerical measures of the quality of the students' work, there are also the subjective reflections of the unit coordinator involved. The unit coordinator for both cohorts observed significant improvement in the learning environment and as demonstrated in their assessment outcomes.

The puppets produced by this class were exhibited by invitation at an Animation Exhibition curated by a Industry Expert who was involved in the teaching and review process for the Unit.

Student Reflections – Mid Semester

The students were asked to reflect upon their learning experience during the subject – once halfway through the semester, and again at the completion of the subject. These reflections were gathered through a multi-question survey filled in by the students and returned to the lecturer. The mid-point survey received a full response rate from the class whereas the end of unit survey only returned 75%.

There was good support for the items in which the direct impact of the presence of engineering students were measured. The survey statement *"I feel that I can engage with the task more because I benefit from the collaboration with peers from another area"* had 80% of respondents either agree or strongly agree (Figure 3), and the statement *"I find it valuable working with students from another discipline background"* had 50% either agree or strongly agree (Figure 4). Neither statement had any responses in which the student disagreed.

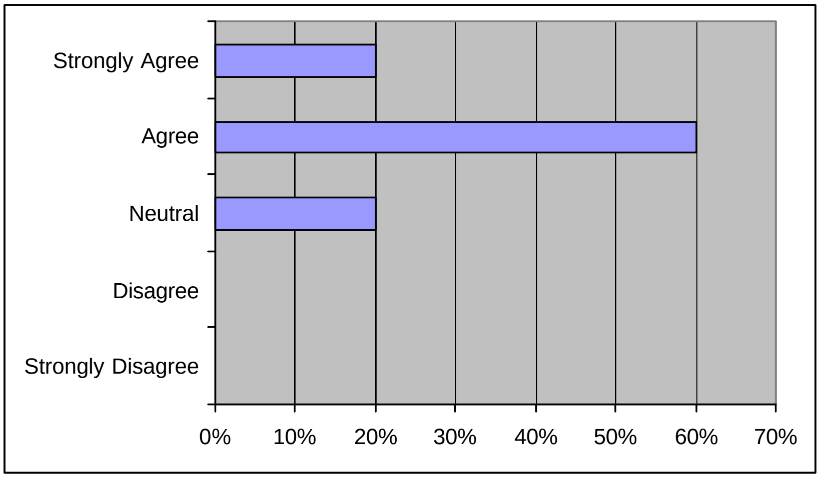


Figure 3: "I feel that I can engage with the task more because I benefit from the collaboration with peers from another area" – Mid-Semester

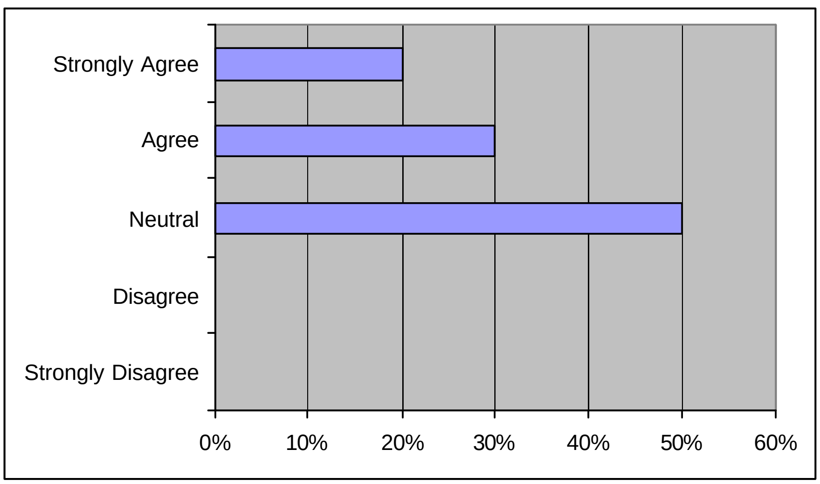


Figure 4: "I find it valuable working with students from another discipline background" – Mid-Semester

Beyond these direct measures, however, there were also further indicators as to how the interactions between the two groups of students were perceived. The students were asked who they had discussed their ideas with, and of those who responded yes, whether they had implemented any ideas from those they had discussed with. The responses to these items are shown in Figure 5:

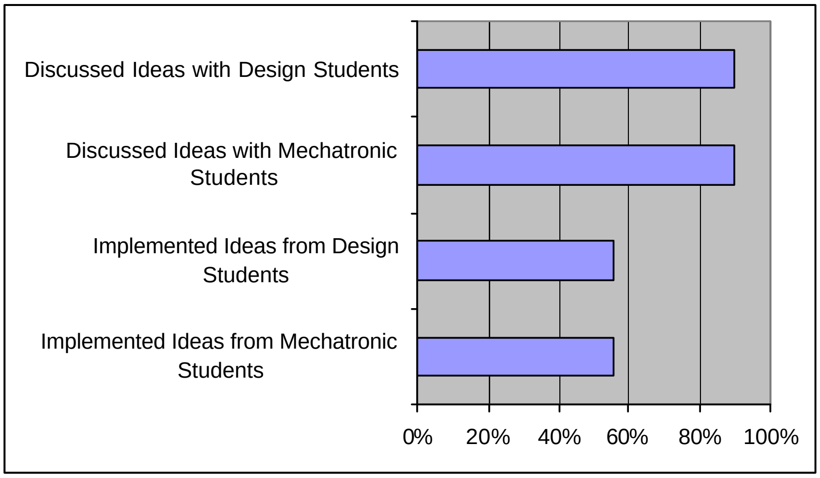


Figure 5: Indications of Collaborations – Mid-Semester

Figure 5 shows that the design students were comfortable discussing their ideas with the engineering students, with 90% of the class doing so, and 55% of those implementing these ideas. More significantly, however, it suggests that the students did not make a distinction between the engineering students and their design student colleagues when discussing their ideas, reporting identical proportions of students who had discussed and implemented ideas with their design colleagues.

Animatronic Design 292 is an elective unit, and thus the students who enrol do so on a voluntary basis. In order to gauge their motivations in choosing this subject, the item *"What do you see as your own personal objectives in doing this unit?"* was included in the survey. 40% of the students responded with "Broadening of experiences" and 30% responded "Learning new skills" – two key objectives that are well met through the mechanism of interdisciplinary collaboration.

Student Reflections – End of Semester

At the end of the semester the student survey was reapplied, seeking to determine how the students' attitudes towards the experience had evolved through the completion of their project. The response rate was poor, with only four of the class responding.

The end of unit surveys were less positive towards the collaboration than the mid semester results. Where initially 80% of the class agreed or strongly agreed with the statement *"I feel that I can engage with the task more because I benefit from the collaboration with peers from another area"* the second round of results was only 50% either agreeing or strongly agreeing, and with 50% actually disagreeing (Figure 6).

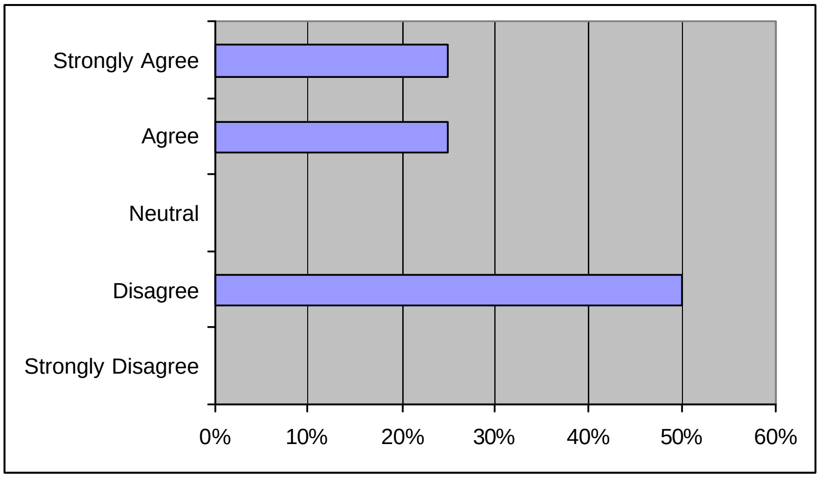


Figure 6: "I feel that I can engage with the task more because I benefit from the collaboration with peers from another area" – End of Semester

The physical involvement of the Mechatronic Engineering students was concentrated in the design phase of the project, with less frequent interactions as the building of the puppet progressed. This reduced sense of presence could potentially be a cause for this perception of a weakened collaboration at the end of the semester.

This perceived weakening of collaboration was also evidenced by a change in the proportions who responded Yes to the statement *"Have you discussed your ideas with Mechatronic Engineering Students?"*. Whilst initially 90% of students indicated that they had, only 75% of the respondents in the second survey indicated yes (Figure 7). Whilst there was less discussion of ideas, however, the relative uptake of ideas increased, with 66% of the respondents who had discussed their ideas indicating that they had implemented these ideas.

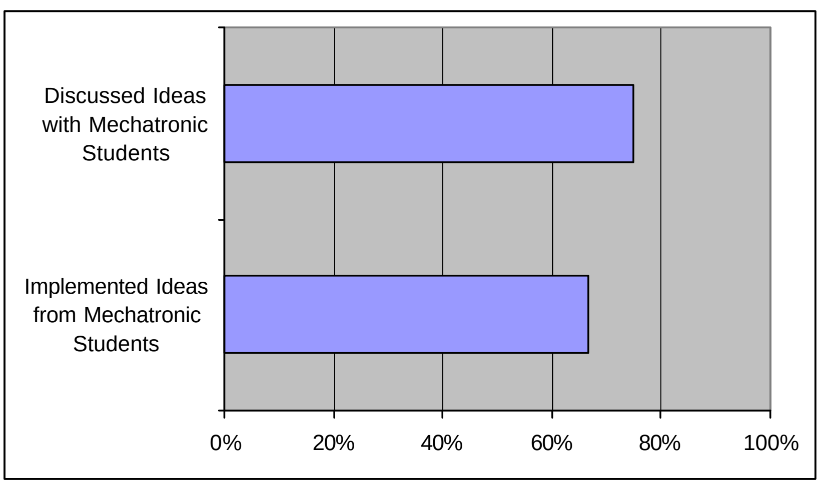


Figure 7: Indications of Collaborations – End of Semester

One additional question was asked on the second survey that was not asked on the first – the statement *"I feel that I have achieved in my final model what I set out to achieve"*. This statement had unanimous agreement from the students, with all of the respondents indicating that they felt they were happy with the overall results of their work.

Conclusion

This paper has documented the attitudes of students in product design towards a collaboration with engineering students in their animatronic puppetry elective. The collaboration has been particularly successful, with the quality of the overall work being enhanced from previous cohorts to attempt this subject. This improvement has been measured through the marks that have been awarded, and also verified through the input of industry both directly and through the marking process.

The students showed that they were receptive to the idea of cooperating with students from another discipline, consulting with them as often and to as much effect as they consulted with their colleagues from their own discipline. This indicates that the prejudices against outsiders can indeed be overcome, and that higher quality learning outcomes can be achieved as a result.

Further Work

The Mechatronic Engineering students who were involved in this collaboration have continued this work as their final year project, and have successfully implement a computer-based control system for these puppets using a USB interface. Students from the Design cohort have also remained involved in the project to improve and maintain the puppets throughout their continued use. The authors also intend to explore the opportunities for extending this collaboration to an international level in light of the second author's relocation to Singapore.

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Biography

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