Scientia Education Investment Fund Grants

Final Report

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Interaction Interface for Creative Enquiry into Social Robotics

UNSW Art & Design
Creative Robotics Lab

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1. Executive Summary

Summarise the project, context, priorities addressed, outputs, key findings and recommendations (if relevant)

This project aimed to reduce technical barriers in designing and testing robot behaviour, so as to make this more accessible to students with non-technical backgrounds. Aesthetic and behavioural design are two key factors that determines the success of autonomous robotic systems when operating in conjunction with and around people in both public and private spaces. Hence the creative skills of UNSW Art & Design students are essential in the research and development of Social Robotics, a rapidly growing field of research. However, robots are often highly complex systems, requiring in-depth experience in engineering principles and practices to successfully program, which creates a high barrier to entry for students with non-engineering backgrounds.

To address this problem, we took an evidence-based approach to develop software that enables students to engage in behavioural design for social robotics as part of their classwork, in a way that that leverages existing learning outcomes and encouraged collaboration with academic staff. We first surveyed students at UNSW Art & Design to determine existing levels of use and proficiency with various applicable software and hardware systems. The results of this survey were used to develop design personas that provided an indication of the needs of “typical” students. These personas were then used to develop novel software packages that were well-calibrated for student's abilities, and this design was validated and improved via an iterative testing and feedback process.

The software packages have already been used across multiple UNSW Art & Design programs and courses, and has enabled students to successfully develop, implement, and test their own embodied interaction designs as assessable coursework. In addition, the software packages developed have attracted widespread interest within UNSW Art & Design from both academic and student support staff, as well as outside the University. It has influenced discussion in the faculty around teaching strategies and future development of curriculum in Interactive Media and Interaction Design. In doing so, this project has addressed UNSW 2025 Strategy and SEIF Priorities including improving research quality by connecting students with research labs on campus, has aspired toward educational excellence by establishing a role for creative students at UNSW Art & Design in the future-focused field of Social Robotics, and enhanced student prepardness for post-study life by contextualising skills and knowledge learned through this tool for industry standard approaches to research and commerce.

2. Outcomes and impact

- Describe the major achievements of your project in relation to the outcomes and deliverables.
- Discuss project impact – how and to what extent has the project impacted students, staff, faculty institution, and higher education as relevant to the project.
- Include the strategic priorities addressed.
- Include the number of courses/programs/students likely to benefit from this project.

The primary achievements of this project have been to identify and improve the understanding of the needs of students at UNSW Art & Design with regards to introducing interactive and embodied technologies to creative practices, and to develop software tools that have enabled students at UNSW Art & Design to create their own software as part of their coursework. These tools and approaches have been demonstred to be easily integrated into existing courses, teaching frameworks, and student support services, and have influenced the conceptualisation and design of courses and programs delivered by UNSW Art & Design. Thus, this project has contributed to UNSW's capability to deliver world-class education in the area of Social Robotics by creating pathways for non-technical, creative students to engage with the field. These outcomes have been produced through the project's deliverables, including the results of a student survey and student personas

developed from this data; the software packages and accompanying documentation; and through user testing by teaching staff, professional staff and students.

Understanding of Cohort

NB: See Section 4 for survey results and design personas developed from this process.

As a result of early research leading into the software development stages of this project, surveys of the UNSW Art & Design student cohort and technical support staff were carried out. The results of this survey presented a picture of typical students and staff at UNSW Art & Design that were likely to encounter the technology platforms targeted by this project.

Key to this research was the development of 3 design personas that represented typical groups of students that engage with the Interactive Media and Interaction Design streams in the faculty. These personas provided insight into the student cohort that wasn't present in other field research conducted at this stage of the project and influenced discussion with other faculty stakeholders toward the program and course narrative for using the tools developed in this project as a common software platform across UNSW Art & Design.

Max Packages

The Max packages developed as key outcomes of this project (providing Arduino and ROS support) were designed to support the students identified through design personas and the staff most likely to support these students. The interface and structure of both packages was designed to facilitate several student approaches to programming:

- Visual logic in programming structure to reflect hardware where possible (i.e. Arduino board pins)
- Real-time feedback of changes to hardware and software configurations
- Consistent and accessible approach to naming conventions
- Extendible programming structure for advanced and engaged students

These packages have made it possible for UNSW Art & Design students to more easily engage with physical computing technologies within creative pursuits by reducing the barriers to Arduino and ROS for non-technical practitioners.

Package Deployment

The Max for Arduino package has been successfully deployed across multiple UNSW Art & Design programs and courses (SDES9311, ADAD2402, SOMA2417), as well as being used across institutions (University of Sydney DesignLab). Use of the Max for Arduino package in classes has resulted in students being able to explore sensor technology earlier in courses, allowing time for deeper understanding of embodied and tangible interface praxis, as well as providing the research team with further understanding of use in the student cohort.

Students using the Max for Arduino package have exhibited functioning prototypes to capture real-world user feedback and bring this information into their creative practice in the classroom. myExperience feedback has been positive on the use of the tool in the classroom, suggesting increased confidence of students working with these technologies for the first time and leading to better coursework outcomes.

Impact

The design, development and deployment of these teaching tools has addressed multiple priority areas in relation to the UNSW 2025 Strategy and SEIF Priorities. These include:

1. Improving research quality, by connecting coursework students with the Creative Robotics Lab through introduction to relevant technologies and approaches to research
2. Aspiring toward educational excellence, by establishing a role for creative students at UNSW Art & Design in the future-focused field of Social Robotics
3. Preparing students for post-study life, by contextualising skills and knowledge learned through this tool for industry standard approaches to research and commerce

4. Putting the creative skills of UNSW Art & Design into a new context of solving technical and complex problems in the field of Social Robotics

The success of this tool in improving the student experience of UNSW Art & Design students in Interactive Media and Interaction Design has also influenced discussion in the faculty around teaching strategies and future development of curriculum in this area.

3. Dissemination strategies and outputs

- Describe the dissemination activities and events that have been implemented and/or being planned in the future.
- Describe the outputs achieved until now and that are likely to occur as a result of this project.

This project has developed software packages for both the Arduino and Robot Operating System (ROS) platforms. These packages provide plug-in components for the Max graphical programming environment, and provide the ability for programs written in Max to read data from a variety of sensors and use these and other data inputs for low-level control of effectors such as LEDs, servos, motors and also high-level control of robot behaviour. The package for Arduino was targeted at the standard Arduino Learning Kit provided by the UNSW Art & Design Computer Services Unit on an on-loan basis to students, and supports the primary sensors and effectors included in those kits. The package for ROS has initially targeted the Turtlebot 3, an education-focused robotics platform based on ROS. This supports acquiring data from onboard sensors such as the 360° range-finding lidar and motion-sensing inertial motion unit, and controlling the robot's movement.

These software packages, being the primary deliverables of the project, have been made available and actively distributed in a number of ways. Initially, students enrolled in the SDES9311 course were given access to the software packages via Moodle and instructions in using the software packages as part of their coursework lectures. Staff at Makerspace (a technology-oriented, student centre that supports both coursework and self-directed study at UNSW Art & Design) were given access to the software packages and an overview of how to assist students in developing their own projects using the software packages. As the packages matured, they have been made generally available both as ready-to-run packages for teaching staff at UNSW to download, as well in source code form to enable others in the Max, UNSW and worldwide maker communities to contribute to and further enhance the packages in the future. Discussions with Cycling '74 (the company responsible for the development and marketing of Max) are taking place to include the packages in the official Max Package Manager, which would greatly improve the dissemination of these tools and actively promote UNSW, UNSW Art & Design and the Creative Robotics Lab as a leader in this area, in a global context.

The aggregate, non-personally-identifying results of the student survey and the personas developed from them have been presented internally to Interactive Media and Interaction Design staff for discussion and to elicit feedback on strategies for teaching of embodied interaction and social robotics courses in the faculty. Formal analysis of these results, design personas, and the impact of the project as a whole in planned for submission to the upcoming special issue on Human Computer Interaction in Education in the journal of Multimodal Technologies and Interaction.

4. Evaluation of project outcomes

- Describe the evaluation strategy (formative/summative), tools and actions.
- Include any results of data collection or analysis.
- Provide an evaluation report on the approach and outcomes.

<u>Widespread Use</u>

Rapid uptake of the Max package is evidence for its usefulness not only as a teaching tool, but a novel means of engaging with physical computing for creative practitioners. Feedback from staff and students at UNSW Art & Design suggests that this tool fills a recognised gap in making these technologies accessible and

meaningfully applied to a range of art and design practices across the faculty. Similarly, its adoption by the University of Sydney DesignLab (Masters of Interaction Design program) shows its relevance to teaching and practice beyond the faculty.

Anecdotally, there has been interest in the package from practitioners found in Max forums across the globe. This ‘snowball method’ is a natural way for a package such as this to increase uptake, and an opportunity to continue feedback on the design of the software for future iterations and refinement. There are plans to further engagement with the Max developers, Cycling ’74, to add this tool to the officially distributed Max Package Manager, so that future updates can be automated and the package receives as much public visibility as possible.

Staff Testing

Focus groups were carried out to reflect on the design of the tool and to discuss its usefulness in a teaching and support context. Feedback collected during these focus groups led to further development of accompanying documentation and logic structures to better support approaches to teaching programming to first-time coders in the classroom. The testing groups also provided an opportunity to engage the staff most likely to use the Max package, furthering its uptake across the faculty.

myExperience Feedback

The response to using the Max package in a teaching context has been positive. In the myExperience feedback from SDES9311 (the first course in which the tool was deployed), multiple students identified positive outcomes as a direct result of using the Max package and therefore being able to engage with physical computing technologies in the course. The following comments are taken from the 2018 Semester 1 Course Report: SDES9311 Interaction Design Foundation:

- It's fun to connect the circuit board with computer by Arduino and control it by Max. This experience is like a scientific experiment.
- This course provides opportunities for us to learn how to work with digital elements.
- The second assessment being part of an exhibition was an amazing experience.
- The real project is useful, and the exhibition can make us learn more from other groups.
- Having an exhibition to look at everyones work and discuss it with their groups was amazing– am wishing every course presented their work and thoroughly sought peer feedback.
- I think the best thing about this course is that we have a opportunity to make a physical interactive product.
- Fabulous course, we have access to know some basic interaction knowledge, and do our projects on ourselves.

Survey Data and Design Personas

The results of an open survey to UNSW Art & Design students and staff (attached below) supported the approach to design of the Max packages described in this document. Overall, it suggested that many students are interested in using interactive technologies in their creative practices, but there is a split around feeling knowledgeable enough to carry out this kind of work. This split broadly aligned with the programs that students were enrolled in, leading to 3 distinct design personas (attached below), developed to represent key student cohorts. These personas are:

- Bachelor of Design undergraduate
- Masters of Design by coursework
- Bachelor of Media Arts / Computer Science dual-degree

The development of these personas supported the approach taken to designing the Max package, as well as informing the discussions with other staff involved in teaching and supporting Interactive Media and Interaction Design at UNSW Art & Design.

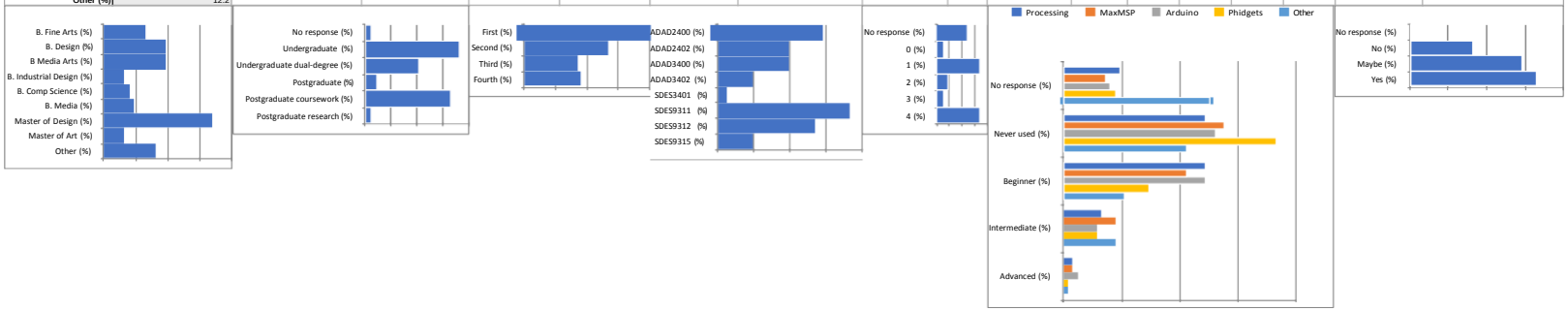
Student context

Which degree are you currently enrolled in?		Undergraduate/Dual/ Postgraduate/ Coursework/Research		What year of your degree are you currently enrolled in?		Which interaction design or coding-related courses have you completed?		Total relevant courses
B. Fine Arts (%)	9.8	No response (%)	2.4	First (%)	37.8	ADAD2400 (%)	13.4	No response (%)	30.5
B. Design (%)	14.6	Undergraduate (%)	36.6	Second (%)	26.8	ADAD2402 (%)	9.8	0 (%)	7.3
B Media Arts (%)	14.6	Undergraduate dual-degree (%)	20.7	Third (%)	17.1	ADAD3400 (%)	9.8	1 (%)	42.7
B. Industrial Design (%)	4.9	Postgraduate (%)	4.9	Fourth (%)	18.3	ADAD3402 (%)	4.9	2 (%)	11.0
B. Comp Science (%)	6.1	Postgraduate coursework (%)	32.9			SDES3401 (%)	1.2	3 (%)	7.3
B. Media (%)	7.3	Postgraduate research (%)	2.4			SDES9311 (%)	18.3	4 (%)	42.7
Master of Design (%)	25.6					SDES9312 (%)	13.4		
Master of Art (%)	4.9					SDES9315 (%)	4.9		
Other (%)	12.2								

Which software/hardware platforms have you used and what would you consider your skill level in each?

		Processing	MaxMSP	Arduino	Phidgets	Other
No response (%)	No response (%)	14.6	11.0	12.2	13.4	37.8
Never used (%)	0 (%)	36.6	41.5	39.0	54.9	31.7
Beginner (%)	1 (%)	36.6	31.7	36.6	22.0	15.9
Intermediate (%)	2 (%)	9.8	13.4	8.5	8.5	13.4
Advanced (%)	3 (%)	2.4	2.4	3.7	1.2	1.2
	4 (%)					

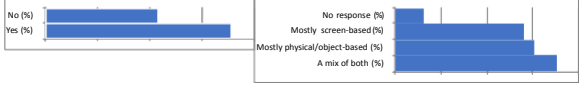
Do you currently plan on enrolling in any further interaction design or creative coding courses at UNSW Art & Design?	
No response (%)	1.2
No (%)	20.7
Maybe (%)	36.6
Yes (%)	41.5



Use of interactive technologies

Have you been able to apply the technical skills you have learnt in interaction design or creative coding courses to other work at UNSW Art & Design?	
No (%)	37.8
Yes (%)	62.2

Have you used the interactive technologies taught in UNSW Art & Design courses primarily for screen-based work, or physical/object-based projects?	
No response (%)	6.1
Mostly screen-based (%)	28.0
Mostly physical/object-based (%)	30.5
A mix of both (%)	35.4

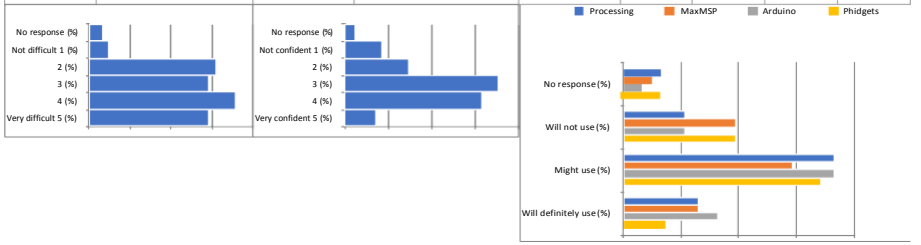


Barriers and future use

How difficult did you *initially* find it to get started with any of these technologies/platforms? Not at all (1 / 2 / 3 / 4 / 5) Very difficult		How confident do you *now* feel in using the technologies taught during courses you have completed? Not at all (1 / 2 / 3 / 4 / 5) Very confident	
No response (%)	2.4	No response (%)	2.4
Not difficult 1 (%)	3.7	Not confident 1 (%)	8.5
2 (%)	23.2	2 (%)	14.6
3 (%)	22.0	3 (%)	35.4
4 (%)	26.8	4 (%)	31.7
Very difficult 5 (%)	22.0	Very confident 5 (%)	7.3

Do you plan on using any of these technologies in a self-directed project, or in work outside the courses offered at Art & Design?

	Processing	MaxMSP	Arduino	Phidgets
No response (%)	9.8	7.3	4.9	8.5
Will not use (%)	15.9	29.3	15.9	29.3
Might use (%)	54.9	43.9	54.9	51.2
Will definitely use (%)	19.5	19.5	24.4	11.0



ELLA PEARSON

ARCHETYPE Design undergrad

AGE 19
DEGREE B. Design
SKILL Beginner
INTEREST Applying to creative arts

interested
uncertain
broadly creative

BIO

Ella is interested in exploring ways that interactive technologies might be able to be used in her own design ideas. She is comfortable with many software packages, but feels that there is a high bar set for entry into programming, and is not confident of her ability. Ella can see the potential of responsive objects, but doesn't know where to begin.

CODING SKILL

APPLICATION

ENGAGEMENT

VICKI YING

ARCHETYPE Masters by coursework

AGE 25
DEGREE Master of Design
SKILL Beginner
INTEREST Commercial applications

career focused
rote learner
surface interest

BIO

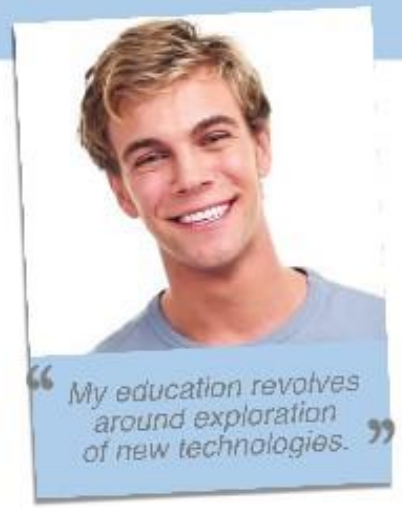
Vicki is an international student, who previously studied Marketing in China. She is nervous about her English speaking ability and is generally passive in class. While she would very much like to find future work in fields of Interaction / Experience Design, her approach to learning is limiting her understanding of concepts and technologies.

CODING SKILL

APPLICATION

ENGAGEMENT

JOSEPH MASON



ARCHETYPE CompSci dual-degree

AGE 20
DEGREE B. Media Arts / CompSci
SKILL Advanced
INTEREST Career in programming field

career focused
motivated
highly skilled

BIO

Joseph is in the third year of his Media Arts / Computer Science dual-degree, split between Art & Design and Computer Science & Engineering. He is highly engaged with creative coding subjects and is familiar with a range of programming languages. He is self-motivated and interested in many applications of Interaction Design.

CODING SKILL

APPLICATION

ENGAGEMENT