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Humanoid robots awaken ancient language

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Through the use of humanoid robots, a rural school in South Australia has embedded the 'sleeping' language of the traditional owners of the land (the Narungga people), into the classroom. Maitland Lutheran School, on the Yorke Peninsula in South Australia, demonstrated how pride in Aboriginal culture can be reclaimed using these inclusive and adaptive technologies. This Foundation to Year 9 school of 240 students has a 22% Aboriginal population. Humanoid robots and programming were introduced to students at the school as a way of reconnecting students with their Indigenous culture. Aboriginal and non-Aboriginal students worked with virtual and real humanoid robots to develop in parallel both their programming skills and their understanding of the Narungga language and culture. Simultaneously, students and teachers were learning two languages; the coding language required to program the robot and the Narungga language.

The traditional owners of the Yorke Peninsula are the Narungga people and many of the students at this school have Narungga heritage. Of the 350 Aboriginal and Torres Strait Islander nations in the late 18th century, most, including the Narungga peoples, were forced from their lands as a consequence of government policies. This disruption and dislocation made it difficult for them to engage with their traditional language and culture. Almost two centuries later, Aboriginal children on the Yorke Peninsula know little about the culture of their people and do not speak or know their Aboriginal language. With limited knowledge of their cultural identity and a traumatic post-colonial history, these students do not have a pride in their Aboriginal identity that is befitting of the children of the oldest living culture in the world.

The school acknowledged the injustice that has been done to the Aboriginal peoples and wanted to find a way to work in a partnership with the local Aboriginal community to reconnect these students to their heritage. For six years, dictionaries for the Narungga language laid unused at the school. What brought the dictionaries to life was the integration with digital technologies, through the use of humanoid robots into the authentic learning of the Narungga language.

The Maitland Lutheran School case study is part of a larger three-year study investigating the impact of humanoid robots on students’ learning and engagement. By working in partnership with the local Aboriginal community and the one fluent speaker, the school re-invigorated the language which had been dormant for generations. The learning that happened in the school was a result of a unique partnership between the Association of Independent Schools of South Australia (AISSA), Swinburne University of Technology, Queensland University, Queensland University of Technology, Maitland Lutheran School, and the local Aboriginal community.

Background information about the project
The Association of Independent Schools South Australia (AISSA) purchased two NAO humanoid robots (Pink and Thomas) to use in independent schools in South Australia. For three years, the AISSA regularly invited all of its 96 member schools to submit a proposal outlining how the school intended to incorporate the robot into student learning. Interested principals approached educators and together they forwarded an expression of interest to participate in the study. The AISSA allocated the robots to successful schools for a period of time ranging from three to nine months.

In this project, a humanoid robot (Pink) was deployed into the rural school in South Australia for a period of six months and this case study is from the second year of a wider three-year multiple case study research project that investigates the use of
humanoid robots in different school settings. In this paper, we will be focusing on one school and how they unified difficult, complex, and sensitive issues with technology and programming with the intention of involving everyone and strengthening their community.

**Sources of data**
The participants for this study were three teachers who used the humanoid robot in their classrooms and the school principal. Data collection methods included questionnaires, semi-structured interviews, classroom videos, observations, student work samples and reflective journals. A questionnaire was used to elicit qualitative responses. The questionnaire consisted of 24 questions and was delivered electronically to participants at the conclusion of the six months. The questionnaire was mainly qualitative in nature and involved a series of open-ended response questions. To facilitate reflective practice, scaffolded reflective journals were used to help teachers reflect on the integration of the humanoid robot within their classrooms. The reflective journals used in this study provided participants with the means to move beyond focussing on skill development in digital technologies by providing scope for challenging existing beliefs and about educational practices that promote deep student learning (Koszalka, 2003), about how their class engaged and interacted with the robot, the benefits for students, and any frustrations and concerns that occurred with the technology. To complement the reflective journals and interviews, one of the researchers visited the school on a regular basis to make observations of the ongoing activities. The researcher took videos that were used when analysing the data.

Semi-structured interviewing was used in this study and teachers were encouraged to discuss their experience working with the humanoid robot in the classroom. Questions were developed to act as an initial guide in framing the interview but also to allow for the teachers to discuss their experiences integrating the humanoid robot into the learning design and observing how the students interacted with the robot and other students (Kvale and Brinkmann, 2009).

**Vision and Leadership**
From the inception, it was the school leader’s vision to use the humanoid robot technology to engage the Aboriginal and non-Aboriginal community in learning about both innovative technologies and Narungga culture:

“...our Narungga students knew very little about the language so we saw it as an opportunity, but it is also a way of trying to engage the rest of the community outside the Narungga community” (David Field, Principal, Maitland Lutheran School).

David engaged a Narungga specialist, the only fluent speaker of Narungga, to work with the teachers and the students. David believed that the humanoid robot was the catalyst for student engagement in the Narungga language and culture. David believed that using technology such as the humanoid robot, significantly improved student engagement. Technology was important to the engagement of the Aboriginal students because they are quite confident with technology. David explained that these students do not have the insecurities that they have with many of the other learning areas, so using the robot as a vehicle for engaging them with their own culture played to both their interest and their strength. Moreover, the humanoid robots had a significant impact on engaging the staff with the new Digital Technologies curriculum.

**The teaching of Digital Technologies**
Rebecca Davey, a teacher with over 10 years’ experience and in a leadership role in the school, worked with six Aboriginal students from Year 1 and 2 for one 45-minute lesson a week over a six-month period. Rebecca explained that the “driving force” behind the project was to use adaptive technologies to promote “pride” and a stronger identity with the Narungga language and culture: “The project fostered innovation by combining the two seemingly disconnected topics of traditional language and digital technologies.” Rebecca believed this project had a significant impact on both the Aboriginal students’ understanding of Narungga language and culture and information technology:

“Deep learning occurred in terms of cultural awareness and language acquisition. Most of the students knew very little, if any Narungga words. (Some did not even know the word Narungga!) In terms of information technologies the students have truly grown from not understanding that Pink was programmable – to programming her to do a variety of things” (Rebecca, Year 1 & 2 Teacher, Maitland Lutheran School).

The Year 1 and Year 2 students learnt to program the humanoid robot through the drag and drop software Choregraphe. The students programmed the robot so that it could speak and sing in Narungga using correct pronunciation and using visual and facial recognition software. One of the recurring themes from this school was the enthusiasm of the students to engage with the robot. Although Rebecca worked with only a small group of Aboriginal students, these students presented and shared their new-found skills in both programming and the Narungga language with the other Year 1 students.

Scott Carson, a Year 4 teacher with many years of teaching experience considered that one of the possible strategies to build pride was to learn the Narungga language, however he had seen “many bad examples” of language learning. Scott believed that embedding adaptive technologies, such as humanoid robots, into learning the Narungga language would increase student engagement and deepen learning. This created an authenticity in the learning because it was linked to a real-world purpose of ‘awakening’ an ancient language and understanding the culture, through the medium of computational thinking and coding.

Students were provided with opportunities to program the robot in Scott’s classes using both the humanoid robot and the virtual robot. After just a few weeks the students started to program both the robots using advanced programming techniques such as timelines in the software supplied with the humanoid robot:

“It is really great having the robot so that students can send part of the coding to the robot and see how their coding works with the robot. It is really paying off having Pink in the classroom” (Scott, Year 4 Teacher, Maitland Lutheran School).

Although the students did most of their timeline programming
using a virtual robot in the first instance, it was the use of the actual hardware that promoted the deeper learning because Scott explains that the students needed to problem solve “how to get the language coded into the robot.”

The students used a trial and error problem solving approach to experiment with how the robot was programmed to reproduce the sound of particular letter combinations. They repeated this until they identified the most accurate reproduction of Narungga sounds. When reflecting on all that his students had achieved, Scott recognised that from the outset of this project he changed his pedagogical approach, encouraging more self-directed and collaborative learning. Scott attributed this change in his pedagogy to using an unfamiliar technology that “made me think outside of the square about what my pedagogy needed to be”.

Peter Gaisford, an early career teacher with a background in STEM, worked with a composite class of Year 3 students for 35 minutes a week for ten weeks. The students formed a relationship and became attached to Pink and treated her like “they would a younger child.” In one task, Peter utilised Pink as a bilingual delivery robot, capable of speaking in both English and Narungga based on the prompts the students programmed. The students were then asked to navigate Pink through a maze using ‘x’ and ‘y’ coordinates and exact measurements by programming its movement so that the robot acted like a tour guide for foreign language students visiting their school.

Peter believed that when programming the robot, the students’ “learning grew without bounds”. He felt this deep learning was the result of humanoid robot technology which enabled students to “touch, walk through and adjust the outcome in a variety of ways”. The Year 3 students worked collaboratively in small groups and “they programmed basic phonetics for younger students to engage with language and books”.

Persistence and resilience were two other qualities that Peter noted when the students were interacting with the robot. Peter attributed this to both the human-like behaviour of the robot and the authentic task. The humanoid robot hardware and software were inclusive of learners with different learning preferences and Peter commented that the collaborative learners benefitted from the “camaraderie and overcoming obstacles together” while the “kinaesthetic and dyslexic learners love the robot as they can physically manipulate the robot through a problem, therefore understand the problem and then correct the issue”. Peter explained that the interactive nature of the robot allowed the students to program a real, tangible, three-dimensional object, unlike traditionally programming applications which are restricted to the screen.

**Findings from our research**

This research paper is part of a three-year study investigating the impact that humanoid robots have on student learning and engagement. It was apparent from the four educators’ perspectives, that the students were deeply engaged with learning about the local Aboriginal language and culture through embedding a humanoid robot into the learning. What is intriguing about this case study, is that the complexity, the authenticity and the moral purpose created an environment where the students were learning the language and culture of the Narungga people, who are the traditional owners of the land, while simultaneously learning another new language, the language of programming to communicate instructions to a humanoid robot.

The findings from this study confirmed a number of emerging themes from the larger three-year project; curiosity, challenge, collaboration, communication, critical thinking, creative thinking, computational thinking and coding (Keane et al., 2016). These themes are represented in the 4plus4 Model in Figure 1.

The 4plus4 Model highlights that curiosity arises from the engaging nature of technology. Whilst curiosity inspires students, on its own, it does not foster deep learning. Curiosity is enhanced by the complexity of the task and, combined with the challenge of solving complex open-ended learning tasks, can facilitate deep learning. In the Maitland case study, the challenge was learning the new language of coding to program the robot to speak one of the oldest human languages. The 4Cs supports students with complex challenges by encouraging them to creatively and critically look at problems in new ways, through the communication of ideas, and collaboration to develop solutions to the task. Through the 4Cs, computational thinking is supported as it allows students to collaboratively develop procedural thinking by breaking complex challenges into smaller tasks that can be solved. When computational thinking skills are developed, coding skills are expanded, as students build on their own
and others' ideas. The 4plus4 Model highlights how students can achieve success in computational thinking and coding by incorporating the 4Cs and combining their natural curiosity in solving complex challenges.

Conclusion
The use of humanoid robots in schools has been recent and our findings confirm previous research conclusions that technology engages students in their learning. While this finding is neither new nor unexpected, our study has shown that engagement with humanoid robots promotes curiosity, challenge, critical thinking, creativity, collaboration and communication. Our early findings have identified that curiosity and challenge foster critical thinking, creativity, collaboration and communication and that enables the development of high level skills in computational thinking and coding as described in our 4plus4 model.

Our initial findings suggest that humanoid robots had an impact on the learning of students from Foundation to Year 10. Students embraced the humanoid robot technology with relative ease and initiated challenging, self-directed projects typically without any prior knowledge of robotics and limited knowledge of coding. Teachers in this study reported that the complexity and sophistication of computational thinking and coding surpassed their expectations and made them see their students in new and different ways. This finding challenges not only long held assumptions about students and their learning potential but also teaching strategies and methods.

Both languages, Narungga and the programming language, were not familiar to the students or the educators. It was a steep learning curve to learn and understand two different ways of communicating, one old and one new. To be able to breathe new life into a dormant language using cutting-edge technology was a precarious project that has been considered successful by the principal and the teachers involved. They reported that the

Students embraced the humanoid robot technology with relative ease and initiated challenging, self-directed projects typically without any prior knowledge of robotics and limited knowledge of coding.

Aboriginal and non-Aboriginal students who participated in the project have a new sense of pride in the language of the traditional owners of the land and significantly, the success of this project was dependent upon the partnership with the local Aboriginal community, in particular the Narungga people.


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