ROBOTS ALIVE
Exploring technological thinking in preschool

THE WHY

We live in an increasingly complex world that requires us to be responsive to rapid change. The types of thinking developed by STEM disciplines (science, technology, engineering and maths) are valuable tools for generating creative solutions to everyday problems in our technological age.

Robots Alive was a collaborative research project between four Department preschools, the Learning Improvement Directorate and Flinders University. It set out to investigate whether it was possible for young children to develop the knowledge, skills, dispositions and understandings necessary for learning with, and about, digital technology. The project was designed to surface children's ideas, questions and insights as they made meaning with robotics and coding.

THE WHAT

Playing with ideas and engaging in inquiry involves different ways of thinking. Robots Alive focussed on the types of thinking that both the educator and the child needed to understand the language of technology and to apply it in play. Throughout this project educators were required to develop their own knowledge and skills so that they could identify and support the technological thinking of children.

This project was particularly relevant to educators given design and digital technologies are present in both the Early Years Learning Framework (EYLF) (DEEWR, 2009) and the Australian Curriculum. The Australian Curriculum Technologies (ACARA, n.d.) learning area describes three types of technological thinking – systems, design and computational – that are referenced throughout this research.

For the purposes of this project the following descriptions were used:

Systems thinking involves considering how individual components influence, connect and interact within the context of a working system.

Design thinking is an iterative process that involves planning, applying and testing solutions to meaningful problems.

Computational thinking involves breaking problems down into smaller parts and coherently organising data to develop instructions (*algorithms*).

THE HOW

The role of the educator, as co-researcher, was to surface the thinking and ideas of the children as they played and ensure this learning process was documented and reflected on, in order to plan the 'next steps' with the children. Robots were employed as the project's entry point, taking advantage of children's natural curiosity about robots.

Educators were expected to recognise the children's existing design, systems and computational thinking in their play and encourage the development of these ways of thinking through a variety of learning situations.

Educators planned learning that provided opportunities for children to make their technological thinking visible as they engaged with plugged and unplugged technology to solve problems. Based on these observations, it was predicted that the children would acquire the knowledge, skills and dispositions to become literate, numerate, competent and confident in applying technological thinking in a diverse range of contexts.

Government of South Australia
Department for Education

PROJECT DETAIL

For the purposes of this research, a Cubetto[1] was offered for the children to explore and discover. Cubetto is a small screenless wooden cube, powered by the language of coding, that can be programmed to move forward, left and right. Coloured directional blocks are placed into Cubetto's board to represent the algorithm (sequence of steps) that Cubetto follows. More complex algorithms can be created using the function bar, which is performed by Cubetto every time a blue function block is situated on the board. Its versatility provided opportunities across multiple areas of learning, including creative thinking, social and emotional development and STEM.

Cubetto was viewed as a way to develop children's computational thinking without a computer screen. The blocks and board used to program Cubetto allow the user to represent code physically, off-screen. Children can see the components of the algorithm and how they work as part of a functioning system.

In purposefully writing an algorithm for programming, children were beginning to develop a foundational understanding of computational thinking. Debugging code encourages children to problem solve, to be flexible in their approach to learning and to persevere.

Robotics is an area that incorporates all aspects of STEM learning: science (physics, movement), technology (coding), engineering (design, mechanical and electrical), and maths (geometry, data, algorithms). Coding in the early years prepares children for higher-level computer science studies in later life (Gadzikowski, 2017). When embedded in play, coding becomes another of the hundred languages (Malaguzzi, n.d.) children can use to communicate in the early childhood environment.

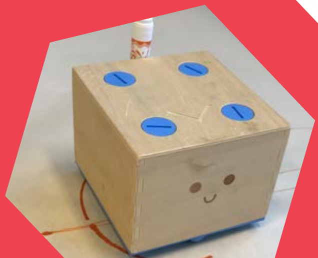
[1] https://www.primotoys.com/

WHAT HAPPENED?

At the beginning of the project, educators were asked to document and discuss what 'technology' looked like in their setting. Initial drawings revealed the resources that were available to children; both plugged and unplugged. However, the language of design and digital technology was lacking, along with the three types of technological thinking.

In particular, the language of computational thinking wasn't present; terms such as 'code', 'blocks' and 'debugging' were not used. The ways in which technology was already being used restricted the possibilities for children's learning. Educators' existing philosophies and assumptions around technology were limiting the value of this area of the curriculum. These initial drawings became a provocation for educators to go back to their site and develop children's STEM play.

An important aspect of the work was consistently introducing and making use of the new and authentic language associated with computational thinking as the child experienced Cubetto and the associated learning. Challenges that surfaced included trying to solve the problem of how to hold the child in the complex and unfamiliar thinking required by the learning experience beyond the initial engagement and novelty of the robot.



Educator documentation and discussion about what technology looked like was repeated at the end of the project to surface a shift in pedagogy. It was clear that a change in attitudes and dispositions had occurred in this short space of time. Educators could now see the role of technology in children's play, the importance of precise vocabulary to facilitate language development and how numeracy skills could be encouraged during problem solving. After considering the definition of design, systems and computational thinking, educators began to see these emerging in children's play and were confident to plan the next steps in the children's learning.

PROJECT FINDINGS

Formative assessment was undertaken and the data analysed. A summary of the educators' collective findings is listed below.

To grow an understanding of how a robot such as Cubetto can be programmed to move, the children:

- engaged in a process of inquiry to explore, pose, share and test their thinking and evaluate their findings
- explored the language of position and direction through intentionally designed play experiences
- were introduced to the language of technologies in the context of their explorations
- drew on their prior knowledge (such as puzzle construction) to develop an understanding of coding and computational thinking.

Educators provided opportunities for children, educators and families to identify computational, systems and design thinking in diverse contexts. In doing so, they were able to:

- make clear the connections to both the EYLF and the F–2 band of the Australian Curriculum Technologies learning area and the Indicators of Preschool Numeracy and Literacy (DECD, 2015)

- encourage children and educators to work together as co-researchers, teaching and learning with and from each other
- enable children to think about their own learning and that of their peers by encouraging collaborative reflective thinking, planning and evaluation
- identify and describe when children were thinking technologically, in both digital and non-digital contexts (plugged and unplugged).

Consequently, the children demonstrated:

- increased levels of curiosity and creativity in designing solutions to problems
- high levels of persistence as they worked collaboratively to design and evaluate solutions
- increased levels of listening in group discussions and debates
- increased use of directional language (go forward, turn left, go around etc)
- an increased understanding, application and use of discipline-specific vocabulary (debug, code, algorithm)
- increased capacity to recognise, interpret and predict patterns
- high-level design thinking as they offered solutions by designing, testing and evaluating their ideas and prototypes
- increased capacity to discover and predict problems through trial and error
- a raised awareness and understanding of code as a set of instructions
- improved confidence and the ability to use design and computational thinking and coding (children designed their own code)
- an ability to apply their knowledge and understanding of coding to new contexts
- the capacity to program, successfully creating and debugging a code.

CONCLUSION

In a world that is increasingly moderated by the influence of technology and its use, it is essential children develop a strong foundation of computational, systems and design thinking from the very earliest stages of learning.

When children use critical and creative thinking to question and explore ideas in their play, to make connections, to test their hypotheses and to design and create solutions to meaningful problems they are thinking technologically.

When educators identify children thinking technologically in their play, it positively impacts their pedagogical strategies and ability to design effective STEM learning.

References

Australian Curriculum, Assessment and Reporting Authority (ACARA) Australian Curriculum: Technologies, available at https://www.australiancurriculum.edu.au/f-10-curriculum/technologies/

Department for Education and Child Development (DECD) (2015) *Implementation Guidelines for Indicators of Preschool Numeracy and Literacy in government preschools*, Government of South Australia

Department of Education, Employment and Workplace Relations (DEEWR) (2009) *Belonging, Being and Becoming: The Early Years Learning Framework for Australia*, Commonwealth of Australia, Barton, ACT

Gadzikowski A (2017) *Robotics for Young Children: STEM Activities and Simple Coding*, Redleaf Press

Malaguzzi L (n.d.) 'The Hundred Languages of Children' [poem], Reggio Emilia