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# Programmable Toys and Free Play in Early Childhood Classrooms

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*This paper reports on a study that investigated the ways that young children interact with discrete programmable digital toys in a free play setting. One intention was to see whether this interaction would address some of the requirements of the Digital Technologies subject in the Australian Curriculum. The study was implemented in two phases in consecutive years involving teachers and students from two early childhood classes. Researchers worked with the teachers to provide the children with opportunities to use two types of digital toys – the Sphero and the Beebot. The children were observed as they interacted with these toys and their interactions analysed using a checklist of behaviours. It was found that without some explicit scaffolding the children did not tend to demonstrate any actions that could be associated with an understanding of 'algorithms'. However, they did demonstrate motivation, engagement, and increased proficiency and recognition with using the hardware and software of these digital systems.*

**Keywords:** Digital technologies; digital toys; play; early childhood; Australian Curriculum

## Introduction

There is little doubt about the ubiquity of digital technologies in Australian society, including for young children (Edwards, 2014). There is also little doubt that the Australian economy needs workers with enhanced knowledge and skills in the use of these technologies and that the general population needs ICT (Information and Communications Technology) knowledge and skills to successfully negotiate life (The Australian Industry Group, 2015). There is considerable debate over how well prepared children are in terms of technological capability and what experiences they need at various stages of schooling (Ritz & Fan, 2015). There is evidence that most Australian children are not adequately prepared and there is increasing support for the early introduction of technology to the classroom (Deloitte Access Economics, 2015). However, there are also those who oppose the use of digital technologies in early childhood settings, claiming that it encourages children to be passive rather than physically active through play (Edwards, 2014; Hsin, Li, & Tsai, 2014). Despite this, the new Australian curriculum includes an ICT Capability and a Digital Technologies subject that includes the introduction of digital devices and their control in the early years of schooling (Australian Curriculum, 2014).

In response to these broad issues, we conducted exploratory research into the potential for introducing young children to digital toy devices (e.g. robots) and their control. This may provide an active approach to starting to “recognise and explore digital systems” and their control through representations of “a sequence of steps and decisions (algorithms)” as stated in the Australian Curriculum (2014). In particular, this may be implemented through play that would be consistent with the recommendations of many researchers in early childhood education (Edwards, 2014; Sylla, Coutinho, Branco, & Muller, 2015). In general, the questions are whether the use of digital toy devices will meet some of the requirements of the Digital Technologies curriculum for early childhood and whether this can be achieved through playful use as opposed to explicit scaffolding. Therefore this exploratory study sought to address the following three research questions.

1. In what ways do young children interact with familiar programmable digital toys in a free play environment?
2. Is there evidence of young children solving problems during free play using a sequence of steps and decisions?
3. How much support do young children need to interact usefully with programmable digital toys?

**Background to the study**

The study focused on the use of a form of digital technologies, programmable digital toys, in early childhood classes and intended to link to some of the content of the Digital Technologies subject in the Australian Curriculum.

Using digital technologies in early childhood education

Across Australia, young children are typically using digital technologies/media regularly at home and increasingly at school (Edwards, 2014; Yurt & Cevher-Kalburan, 2011). Much of this is using purpose built software and/or devices, particularly since the advent of tablet devices. Usually, the rationale is either that this use helps children to learn better (e.g. reading, numeracy) or that it contributes to a digital literacy necessary for living and working in modern society (Hsin, Li, & Tsai, 2014). Some are critical that such use is passive and just mindless pressing of buttons, and that this discourages physical activity (e.g. play, art) and the development of gross and fine motor skills (Hsin, Li, & Tsai, 2014). However, there is an increasing number of digital toys, or what could be defined as “tangible digital media” (e.g. robots, e-books, control systems) (Sylla, et al., 2015), that could be used by young children in an active manner and allow them to experiencing giving instructions to digital devices. This is what Papert would refer to as a ‘constructionist’ approach to information or learning (Kalaš, 2010), and he defines this approach as,

Constructionism… shares constructivism's connotation of learning as `building knowledge structures' irrespective of the circumstances of the learning. It then adds that this happens especially felicitously in a context where the learner is consciously engaged in constructing a public entity, whether it's a sandcastle or a theory of the universe... (Papert, 1991, p. 1).

In applying appropriate pedagogies for young children, it is suggested that a way to implement a constructionist environment is by allowing the students to engage in experiential learning through play (Bers, Flannery, Kazakoff, & Sullivan, 2014) and being "playful" (Department of Education and Training, 2016). Sylla et al. (2015, p. 47) found that in a play context the "handling of physical devices empowered each child to actively participate in the task while promoting peer collaboration".

There has been very limited research into the use of tangible digital media with young children, but in general it has been found that most children enjoy playing with these technologies and for many minimal help is required, but some scaffolding is necessary (Bers, et al., 2014; Kalaš, 2010; McDonald & Howell, 2012; Sylla, et al., 2015). A variety of devices can be used associated with various contexts from engineering to music and visual arts (de Vries, 2013). There is preliminary evidence that tangible digital media can be used to improve spatial reasoning, sequential reasoning, general cognitive development, and even interpersonal skills (Bers, et al., 2014; Kazakoff, Sullivan, & Bers, 2012; McDonald & Howell, 2012). Further, there is evidence that use can help children think in decentralised terms (e.g. understanding traffic jams) (Resnick, 1998). Some studies have shown that children have been able to 'program' these digital toys/robots (Flannery & Bers, 2013; Kalaš, 2010). Some have been surprised to observe that children can develop their interpersonal and social skills, naturally engage in turn taking, or help others without being told (McDonald & Howell, 2012).

Flannery and Bers (2013) assessed Kindergarten children's programming achievement based on their ability to program a mobile robot to dance the "Robot Hokey-Pokey". They found that the children exhibited a range of behaviours that could be related to their level of reasoning. For example, half of the children exhibiting pre-operational reasoning disregarded the given challenge to focus instead on open-ended explorations of the robot's capabilities, while the rest relied on trial-and-error. However, children determined to be concrete operational tended to stay on task once they started, staying focused until arriving at a complete or nearly complete solution.

Some research has identified common barriers to the use of tangible digital media in early childhood settings (Blackwell, Lauricella, Wartella, Robb, & Schomburg, 2013). Initially, most devices were expensive and despite some research finding that digital toys can be an equaliser among children, particularly for those with certain disabilities (e.g. autism) or across cultural backgrounds (Farr, Yuill, & Raffle, 2010). A common barrier is often the knowledge, skills and attitudes of teachers (Blackwell, Lauricella, & Wartella, 2014). Many do not feel confident at facilitating the use of these technologies, while others, particularly older teachers, are opposed to the use of digital technologies with young children (Edwards, 2014).

Play is an important pedagogical component in early childhood education (Bird & Edwards, 2014); however, the integration of digital technologies within play-based learning has been slow (Edwards, 2014). Edwards suggests that there is a "gap" between "pedagogical understandings of play and young children's experiences with digital technologies" (p. 199). To bridge this gap, she proposes an approach described as "Digital Consumerist Context (DCC)" that focuses on the social setting in which children use technologies and the "cultural meaning-making" they derive from this (p. 201). Bird and Edwards (2014) developed a 'Digital Play Framework' based on the concepts of "mediated tool use" and "epistemic and ludic activity comprising play" (p.

33). This framework was devised to assist teachers with observing, planning and integrating technologies into play-based learning. Additionally, it defines the types of behaviours that children may display when using technologies as tools in an environment where they are engaged in social and experiential learning. As such this framework embodies a close fit with the constructionist approach and was therefore used as the basis for the collection and classification of observational data in the current study. In addition research in Queensland has led to the development of a framework including 11 characteristics of pedagogies appropriate for early childhood education (Department of Education and Training, 2016). These characteristics would all be consistent with a constructionist approach, in particular, those of Active, Agentic, Learner focused, and Playful. The required curriculum is one determinant of pedagogical approach, so we considered the Australian Curriculum.

## The Digital Technologies subject in the Australian Curriculum

The Australian Curriculum includes a Technologies learning area with Digital Technologies as one of two component subjects. One focus of this subject is creating digital solutions through a problem-solving process, referred to as computational thinking (Wing, 2011), that includes formulating problems, abstraction and algorithms. There are other forms of thinking in the curriculum, but we limited the scope to computational thinking. The major controversy in this curriculum is around the concept of programming. It has become popular in the community to insist that children should learn 'coding'. However, programming is not just coding; the latter may be a component of the former (Kafai & Burke, 2013). Coding is the sets of instructions for the processor, whereas programming is a form of problem-solving that designs solutions to create software and use data. Therefore in the Digital Technologies subject, a focus to Year 2 is on "developing foundational skills in computational thinking and an awareness of personal experiences using digital systems". This includes "opportunities to create a range of digital solutions through guided play and integrated learning, such as using robotic toys to navigate a map or recording science data with software applications" (Australian Curriculum, 2014).

We chose to use digital toys that were 'programmable' and were based on a hardware device, such as a robot. An aim was to introduce young children to an experience of using algorithms but through a 'play' pedagogical approach. Grover and Pea (2013) suggest a use-modify-create approach using purpose built tools that are easy to get started with, but still powerful. The aim is to develop transferable knowledge and skills, not syntax and error messages.

## Research design and methodology

The project was implemented in two phases over two years in early childhood classes (4-6-year-old) with about 25 students in each class. The sample consisted of two teachers and their early childhood classes in non-government schools in Phase 1 and then only one of them in Phase 2. The class involved only with Phase 1 was a kindergarten class in a single gender school. The other school involved a co-educational dual stream (i.e. Kindergarten and Pre-primary) class of 25 students with some continuing students into Phase 2. The classes did not contain any students with severe learning difficulties but contained students with a typical range of capabilities likely to be present in any early-years classroom. The teachers worked with the researchers to organize sessions in which children were introduced to the digital toys and then given opportunities to 'play' with them.

Two digital toys were used in the classrooms. The first device was a Beebot which is a programmable "Bee" device that resembles bee with interface buttons that the user pushes to program a set of instructions for the device to execute. The instructions can be cleared and reprogrammed easily. The second device was a Sphero, a programmable Bluetooth ball that is controlled with an Apple mobile device (iPads were used). The user controls the direction, speed and colour of the Sphero with the iPad. Initially, we considered a range of other digital toys: Romo Robots; iRings (music); Pleo; Zoomer; Sifteo cubes; and Play-I. However, some were unavailable or difficult to get in Australia.

The intent in this first phase was to allow the children to engage with the devices through free play in which the students would be able to integrate other classroom manipulatives such as blocks or even paper on the floor on which maps could be drawn. The primary data collection consisted of observations using a checklist (Table 1) of child play by a team of three researchers who visited each class over a period of seven weeks. The researchers visited different schools on different days dependent upon their availability. This approach had the advantage of a reduction in any bias that may have resulted from a single observer. The research team was also able to compare notes and discuss the observations amongst themselves, as well as share results and interpretations with the teacher participants; a form of 'member checking' (Cresswell & Miller, 2000). Before analysing the data, the research team met to further discuss the observations and clarify how to code the behaviours and indicators (Table 1) based on the 'Digital Play Framework' from Bird and Edwards (2014). Additionally, the classroom teacher was interviewed to gain their insights into child play with the programmable toys.

**Table 1**

*Checklist of behaviours (drawing upon* Bird and Edwards (2014)*), and indicators of these behaviours, used in observation of children using the digital toy devices.*

| Behaviours | Indicators |
|---|---|
| **Exploration** | 1. Seemingly random use of device<br>2. Locating operating functions of device<br>3. Exploring operating functions of device<br>4. Following directions of other people<br>5. Seeking assistance for desired outcome with device<br>6. Other exploration behaviours |
| **Problem Solving** | 7. Relating actions to the functions of device<br>8. Trying different actions to solve an issue<br>9. Intentional use of the operating functions of the device<br>10. Other problem-solving behaviours (sequence, decision, repetition) |
| **Skill Acquisition** | 11. Intentional and deliberate use of device functions for a desired outcome<br>12. Sharing learned functions with others<br>13. Intentional and controlled use of device for own purposes |
| **Symbolic** | 14. Deliberate use of device for pretend play |
| **Innovation** | 15. Creating a new pretend play scenario for use of the device |

**School 1 (Single gender)**

This school was a large K-12 independent single gender school. For the first phase of the study, there were five one-hour sessions held during the term using the BeeBots. The teacher introduced these devices to the children using a formal presentation to the whole class group of approximately 25 students. The teacher scaffolded the introduction of the devices including drawing on previous knowledge they had and similarities with previous experiences. She showed them how to control the Beebots and chose a child to help demonstrate to the class. Then the children were divided into prearranged groups of five students and several stations were set up around the class for a variety of activities they could engage in with the Beebots being one of the stations. Each group cycled through the station and was given some support by the Education Assistant to remind them what to do, and get them started. Then they were encouraged to engage with the Beebots through free play, and this included using the devices along with other materials available to them in the classroom.

**School 2 (Co-educational)**

This school was a small low-fee co-educational independent school involved in both phases of the study. For the first phase, there were four one-hour sessions held using the Spheros and four one-hour sessions using the Beebots spread over an eight-week period. The children engaged with the devices in a free play context and were supported when they sought assistance. The teacher introduced the digital toys to the children in a very informal way. She provided a quick demonstration to the class, and then the children could choose to use the new devices or engage in other activities in the class. The students also continued to have access to the usual materials from their play sessions. As new children came to use the devices, the teacher demonstrated the device to them again, and then, for the most part, they engaged with the device through free play.

For the second phase of the study, three one-hour sessions were allocated to 25 children using each device over a total of six weeks. The first session with the devices was a general introduction to the device by the teacher, and then the children could interact with them through free play. They were encouraged to use other things in the play space like blocks and used them in conjunction with the devices. The second session was a structured session whereby the researchers divided the group of children into smaller groups (maximum of 4) and instructed the children to use a trial and error testing method to get the digital toys to negotiate an obstacle course of blocks created by the children at the beginning of the session. The children were able to use skills in estimating, counting, orientation, directions, and recall to get the device to the ‘finish line’. The structure for this session was designed to be a purposeful exercise in thinking how to use the device to achieve a specific outcome, that is, ‘program’ the device. In the third session, the children were able to use the devices again in a free play context. Some children displayed recollection of skills learnt in the previous session but most used the device in a similar way to the first session with the devices. Many of the children lost interest in the devices by half way through the session, and only the more proficient children persisted.

## Results

The results of an analysis of the data are now presented for each phase separately and then discussed in combination.

### Results from Phase 1

A summary of an analysis of the observed behaviours of the children in Phase 1 is presented in Table 2. Items in the two 'indicators' columns were behaviours that were observed for several students and across the researcher-observers. Due to the method of data collection during actual classes in which there was a lot of activity, it was not possible to collect exact tallies of specific observations. It was clear that although there were some children who displayed purpose and a method to their play with the devices the overwhelming majority did not appear to do so. It was observed that some children could not predict what the device would do and seemed surprised when the device made certain actions, or they did not understand the use of the directional buttons for turning the BeeBot. Some children did show more purposeful use of the BeeBot buttons and became more able to use the iPad to control the Sphero. Of the children who engaged with the devices for longer, the main form of play involved competing against each other in 'races' and building 'tracks' and obstacle courses to negotiate. It appeared that the children would have benefited from access to additional materials that they could use for their pretend play and that would encourage their creative thinking skills.

Table 2

*A summary of behaviours observed of children using the digital devices in Phase 1.*

| Behaviours | BeeBot indicators | Sphero indicators | Conclusion |
|---|---|---|---|
| **Exploration** | Mostly random button presses and see what happens<br>Struggled to understand how to turn it right or left<br>No realisation which way it would go first, right, left, forward | Lots of random swinging of iPad<br>Random use | Most demonstrated a random use of the controls and struggled to understand direction (left, right). |
| **Problem Solving** | Pressing 'x' button to clear to start their sequence again<br>Learn which button makes it go to left or right, through repetition.<br>Predict its next moves – understanding of sequences.<br>Count how many times and which buttons they have to press. | Moving around with iPad<br>Using 'bouncing' to get out of a tight spot<br>Tried many ways to help it to escape by shaking or moving the iPad but not touching it. | Some used their knowledge of the directional keys for the devices to create a sequence and some demonstrated prediction and troubleshooting skills. |
| **Skill Acquisition** | Not really paying attention to feedback from BeeBot<br>No use of turning | Mostly individual play – building his 'hive' (child made a hive for the Beebot) | Understanding of the feedback from the device was not evident and this is evident in |

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|---|---|---|---|
| | 'Thinking-planning-operating' process was bit too long as kids sometimes cannot react quickly for the next moves<br><br>Working together to achieve task (first time round) | Only very simple use of programming | their ability to debug the program. The programming was used in a very simple way with some demonstration of individual and group play. |
| **Symbolic** | Racing<br><br>Built a fenced house for Bee bots<br><br>Used as a moving car | Chasing games<br><br>Engaged in 'hide-and-seek' | Children engaged with the devices in similar ways that other general toys are played with. |
| **Innovation** | Drawing roads<br><br>They play Tunnel – form themselves as a shape of tunnel and let the toy pass through it<br><br>Played 'riding' games – they tried to ride on it as if it were a horse<br><br>BeeBots as a loading truck | Play Spinning –as toy spins<br><br>One child programmed the Sphero, and others chased a ball alongside. | Children engaged with the devices in similar ways that other toys are played with. |

It was observed that the majority of the children tended to get bored with the devices fairly quickly, especially in a class situation where there were other activities that they appeared to value more. For the children who did persevere with the devices, they too grew bored with the device by the end of the session. The children were more interactive and creative when they were put into an uninterrupted learning environment. It appeared that if they were given extra materials to use for their pretend play, it would encourage their creative thinking and they were more likely to remain engaged for longer. It is likely that the children needed more time to digest new knowledge and actually apply the skills in their play. They also needed more time to absorb the concept of algorithms to instruct the devices and applying it through their play.

For some children, there was confusion with the turning and moving forward of the Sphero. Further, they seemed to press buttons on the BeeBot randomly without planning, and therefore it was not clear that learning was taking place. The development of understanding of concepts was generally slow, but they demonstrated learning in later sessions through their improved prediction and planning for the next moves. It seemed that in order for the children to learn something through free play, they still needed to get some ideas or challenges that they could apply to their play, otherwise, they tended to lose their motivation to continue.

### Results from Phase 2

A summary of an analysis of the behaviours observed of the children in Phase 2 is presented in Table 3. Again while there were some children who displayed purpose and a method to their play with the devices, the overwhelming majority did not seem to develop an understanding of what the devices could do, and did not demonstrate purpose in their use of the devices. The devices were used in three 90-minute sessions with the middle session being run by the research staff to teach the children through explicit scaffolding. This session appeared to help the children to refine their skills in using the devices and develop specific inquiry, testing and problem-solving skills. As a result of this session, the children appeared to exhibit greater motivation and engagement and used specific terminology taught by the researcher. In the final session with the devices, some children recalled the skills they had obtained from the previous session and seemed to be using the devices in a more purposeful way when compared to the first session.

The children appeared to be more engaged and show greater motivation in the second session when they were given explicit scaffolding. When the teacher gave them more detailed instructions and support, the children seemed to be very focused on the given tasks. Through lots of repetition of terminology and skills reinforcement, the children understood that they had to measure how many ‘steps the BeeBots needed to make. They started counting numbers of steps and then programmed the BeeBot and executed the program. By contrast, it was interesting to see how children could lose their interest when there were no specific challenges or explicit scaffolding from their teacher.

There was no specific purpose in their play in the first session. However, in the final session the children remembered that they had to plan, measure, count, and program the BeeBots to lead them to their designated point. In contrast, when using the Spheros they did not demonstrate any behaviours that indicated using an algorithm to provide instructions, compared to the measuring and skills that they learned from the BeeBots. Also, there were more restrictions in the classroom environment with using the Spheros in terms of space and technology issues connecting with the iPad app.

Table 3

*A summary of behaviours observed of children using the digital devices in Phase 2.*

| Behaviours | BeeBot indicators | Sphero indicators | Conclusion |
|---|---|---|---|
| **Exploration** | No purpose when they were playing with it<br>Lots of random play<br>Most just pressed random numbers | Struggled to operate it<br>Random use of the device | Children didn’t demonstrate programming skills - play was random and not purposeful. |
| **Problem Solving** | Some counted numbers of button presses but without particular reason.<br>Started thinking and measuring the steps.<br>Pressed the 'go' button, but the counts were not purposeful.<br>After repeating the same task several times, all managed to get it to the finish line without help. | Seemed very frustrated when they could not work out what to do to get it back on the track.<br>Difficult for them to measure the steps as the movement of it is more like rolling than taking steps | When children used problem-solving skills such as counting and testing they achieved better results and increased the desire to engage with the device. |

| | | | |
|---|---|---|---|
| **Skill Acquisition** | Few displayed pre-programming skills<br>Most pressed the random buttons with no specific intentions<br>The older children showed more purpose<br>Those doing better helped those who were struggling. | Not much improvement in the pre-programming with purpose<br>More like remote-controlling rather than programming<br>Helping those who were struggling. | Few programming skills were observed but the more capable children did share their knowledge with less capable children. |
| **Symbolic** | Racing | Chasing and racing games | Used the devices to compete against another, which is typical of children of that age. |
| **Innovation** | Lots of playing racing, dancing, building<br>A loading truck | Lots of playing racing, dancing, building | As above. |

## Addressing the research questions

This exploratory study set out to address three research questions that are now addressed separately.

### In what ways do young children interact with familiar programmable digital toys in a free play environment?

All children were able to interact with the toys to some extent but most only did so in a limited fashion, choosing to go to a different activity. In this study as children played they interacted with one another and constructed their play environments. For example, one student made a jump for the Sphero while another made a pretend 'hive' for the Beebots. All of the children were developing simple theories about how the digital toys worked. However, generally the children tended to use the devices only for short periods and limited activities such as 'races', building 'tracks' and obstacle courses. However, some children demonstrated a more sustained engagement with the devices and an increased proficiency in using their programming features. Some worked with less able children to teach them what they had learnt. As they played with the devices with more proficiency they had a better opportunity to "discover, create, improvise and imagine" what the device could do and "enhance their desire to know and learn" (Australian Government Department of Education, 2009, p. 15).

A finding of importance was that students did not necessarily lose any time in developing gross motor and other skills through the introduction of the digital toys. The students continued to draw, build, socialise, and move around while interacting with the devices. This demonstrates that digital toys may be used to address some of the early stages of the Digital Technologies curriculum without significant impact on other critical areas of child development.

**Is there evidence of young children solving problems during free play using a sequence of steps and decisions?**

There was little evidence of computational thinking problem solving with the devices during free play although it is recognised that this is difficult to identify. One clear example was a boy who wanted to get the Sphero to roll up a ramp and 'fall' over the edge. He spent over 15 minutes trying different strategies to achieve this result and eventually succeeded. Many children during free play appeared to lack purpose (e.g. random pushing of buttons on BeeBots) in their use of the digital toys, became 'bored' and opted to do other activities that were available. This was less the case in the second phase of the study where the teacher included more explicit scaffolding with most children demonstrating some purpose to their use of the devices, particularly the Beebots, providing more evidence of problem-solving activity.

**How much support do young children need to interact usefully with programmable digital toys?**

It was observed that without some explicit scaffolding where the children learnt about the device and the control instructions necessary to engage with the device, for the most part, they did not show the use of algorithms in their free play with the devices. Some children could not predict what the device would do and seemed surprised when the device made certain actions. Further, some became frustrated when they thought it was going to do something; but did not. This demonstrated a lack in their understanding of the connection of their actions to the future actions of the device. Implementing explicit scaffolding for the skill set that the children needed appeared to promote the child's understanding and fostered a higher-level of thinking (Australian Government Department of Education, 2009, p. 15). This helped the children to refine their skills in using the devices through repetition and developed specific inquiry, testing and problem-solving skills. As a result, some children tended to show greater engagement that was likely to improve their digital literacy; a complex area as outlined by Neumann, Finger and Neumann (2016). This was demonstrated in their use of newly assimilated language being applied during free play with the device. However, in general, there is a need in this new subject area for teachers to align the expectations of the curriculum with appropriate pedagogies (Department of Education and Training, 2016).

## Conclusion

This paper has reported on a small exploratory study into the use of two programmable digital toys by young children in a classroom setting. Therefore any conclusions are difficult to generalize without more extensive research into the area. However, we found it interesting that while most children did not need much support to be able to use the toys, they were unlikely to demonstrate meaningful uses, in terms of curriculum outcomes, without explicit scaffolding. There is clearly a balance between allowing free enquiry/play in the use of these technologies and tightly scripting activities. With the former children are unlikely to achieve the desired learning outcomes in terms of conceptual development (e.g. computational thinking), and with the latter, the risk is that their natural interest will be diminished. To assist teachers in getting this balance right considerably more research is required using a greater range of types of digital toys and in a variety of settings. The age appropriate pedagogies developed in Queensland (Department of Education and Training, 2016) provide a good start at getting this balance. In particular, in our study we initially sought to focus on the Active, Agentic, Learner focused, and Playful characteristics of pedagogies, but found the need to balance these with the Explicit and Scaffolded characteristics.

Clearly young children can develop early understandings of concepts related to using digital technologies through interacting with these types of toys, and the range of options is expanding almost weekly. Furthermore, these understandings do not necessarily come at the cost of any loss of time in developing traditionally critical areas as they are gained while still interacting with the environment, moving around, and socialising. Considering the requirements of the Digital Technologies curriculum in Australia, although the digital toys we included provided the potential for achieving some of the outcomes, for most of the children in our study, there was little evidence that this occurred to any significant extent. However, it is likely that further research considering a wider range of toys and a considered balance of free play and explicit scaffolding will find that these outcomes can be met for most children.

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