

STEM and Digital Technologies in Play Based Environments: A New Approach

In 2018 and 2019 the Early Years STEM Australia (ELSA) program was trialed in over 100 centres Australia wide. One of the mandated components of the program was the creation of four apps for children that would inspire curiosity and engagement in STEM concepts in preschool children. This symposium will outline our novel approach regarding the use of digital technologies (DT) with young children. It will initially look at research regarding the use of DT. The second paper will discuss STEM Practices and the Experience, Represent and Apply (ERA) heuristic that embed STEM and DT whilst remaining true to the core tenets of the Early Years Learning Framework. The final paper reports on engagement data collected in the trial that supports our novel approach to STEM in the early years.

Chair/Discussant: Doug Clements

Paper 1: Kevin Larkin & Tom Lowrie *The Role and Nature of Digital Technology use in Preschool STEM*

In this paper we critique existing research on the role and nature of digital technology use in Preschools. The majority of the literature points to overwhelmingly positive outcomes for young children when digital technology is thoughtfully used in play based learning contexts. However, despite the wealth of evidence that the use of tablets can be beneficial to preschool students, early childhood teachers often report being uncomfortable in teaching STEM. We suggest that, if accompanied by suitable professional development, tablets are an important addition to early childhood contexts.

Paper 2: Tom Lowrie & Tracy Logan *The Early Learning STEM Australia (ELSA): The Policy and Practice(s) of Engagement in the Early Years*

The Early Learning STEM Australia (ELSA) pilot was a year-long investigation involving 300 educators and 4 500 four-year old children in one hundred learning centres across Australia. This paper reports on a pedagogical and design framework that was constructed to promote children's STEM engagement across digital and non-digital learning environments. This paper describes this process in terms of a heuristic; since the educators in the study became part of the design team as they modified and adapted the activities developed by our team. The heuristic helped the educators modify and adapt the learning experiences to accommodate the diverse cultural and social needs of the students.

Paper 3: Tracy Logan & Kevin Larkin *ELPSA The ERA heuristic in action: Observations from the ELSA pilot.*

The Experience, Represent, Apply (ERA) heuristic is an innovation of the Early Learning STEM Australia (ELSA) project. It provided educators with an approach that embeds digital technologies in play-based learning in such a way that the focus of the learning remains on the child and not on the device. This paper reports on the experiences of early years educators and indicates that the ERA heuristic was instrumental in helping educators to integrate digital technologies in their everyday activities to promote engagement with STEM.

2019. In G. Hine, S. Blackley, & A. Cooke (Eds.). *Mathematics Education Research: Impacting Practice (Proceedings of the 42nd annual conference of the Mathematics Education Research Group of Australasia)* pp. 68-80. Perth: MERGA.

The Role and Nature of Digital Technology use in Preschool STEM

Kevin Larkin
Griffith University
<k.larkin@griffith.edu.au>

Tom Lowrie
Canberra University
<Thomas.Lowrie@canberra.edu.au >

In this paper we critique existing research on the role and nature of digital technology use in Preschools. The majority of the literature points to overwhelmingly positive outcomes for young children when digital technology is thoughtfully used in play based learning contexts. However, despite the wealth of evidence that the use of tablets can be beneficial to preschool students, early childhood teachers often report being uncomfortable in teaching STEM. We suggest that, if accompanied by suitable professional development, tablets are an important addition to early childhood contexts.

The focus of this symposia paper is to provide a brief account of the role and nature of Digital Technologies in Early Years STEM as currently depicted in the literature. Digital Technology is a subset of technology – which can be defined as any tool that assists people to achieve goals (Lindeman & Anderson, 2015) – and in this understanding tablets and smartphones are technologies, but so are unifix cubes, books and pencil sharpeners. However, today’s children are growing up in a digital age characterised by rapid changes in the types of technologies they are exposed to. As with any technology, when used wisely, digital technologies can support young children in their learning and in their relationships with adults and their peers (NAEYC, 2012). Regardless of the type of technology, its use must not “displace or replace imaginative play, outdoor play and nature, creativity, curiosity and wonder, solitary and shared experiences, or using tools for inquiry, problem solving, and exploring the world” (Donohue & Schomburg, 2017, p. 77).

The remainder of this paper will focus on tablet technology more specifically, given that research suggests that preschool-age children can handle the applications for such devices relatively easily, and that these portable devices have been described as particularly suitable for early childhood (Papadakis, Kalogiannakis & Zaranis, 2018, p. 140). It will also discuss the notion of digital play as a way of contextualising digital technology use in the early years and then conclude with a brief account of the importance of early years educators in developing appropriate scenarios for the use of digital technologies in STEM. Although there has been significant research into robotics and computational thinking with young children, in keeping with the overall thrust of this symposium, we put that research to one side and focus on tablet technology and STEM.

Widespread Nature and Screen Time

The research literature clearly indicates the widespread nature of digital technology use by preschool children with touch screen devices being by far the most popular with this trend growing rapidly (Kyriakides, Meletiou-Mavrotheris, & Prodromou, 2016). This is perhaps due to intuitive interface of a touch-screen tablet, the ease of installing new apps, and the increased portability and autonomy of the devices. A recent US study of 350 children aged from 6 months to 4 years found that 96.6% of the children used mobile devices and in the UK, Ofcom reported that 65% of 3–4 year olds use a tablet, with one in five of this age group having their own tablet (Marsh et al. 2018). Almost 1 000 new “educational” applications are added every day and there are now more than 100 000 educational apps in Apple’s and Google’s online stores (Papadakis et al., 2018), many of them focusing on early literacy and numeracy skills.

Of course the elephant in the room in relation to the uptake of mobile technologies is the topic of screen time. The proliferation of digital devices with screens means that the precise meaning of “screen time” is elusive and no longer just a matter of how long a young child watches television, or playing on a device, but rather a matter of how this time is spent. In Australia, it is currently recommended that sedentary screen time should be no more than one hour per day for children two to five years of age (Australian Government, Department of Health, 2017). Other health bodies take a different approach. The American Academy of Pediatrics has relaxed their guidelines advising against screen time for young children and now acknowledge that children are growing up “in a world where ‘screen time’ is becoming simply ‘time’” (Alade et al., 2016, p. 434) and instead are encouraging parents to use media jointly with their children. Likewise, the Royal Council of Paediatrics and Child Health in the United Kingdom found that “the contribution of screen time to wellbeing is small when considered together with the contribution of sleep, physical activity, eating and bullying as well as poverty” (RCPCH, 2019, p. 3). In addition, the report concluded that there is no evidence to suggest a definite threshold for screen time overall, suggesting instead that these thresholds become part of a family’s (and we suggest educators) planning (RCPCH, 2019). This finding supports the claim of (Marsh et al., 2016) who indicate that despite children now having access to a wider range of technologies than previous generations; it appears that screen time has not increased.

Tablet Technology – Findings

A wealth of research indicates positive effects from the use of tablets and apps with the broad consensus amongst educators being that tablets can serve as an important tool to improve learning and teaching, allowing preschool children to explore advanced STEM concepts once thought to be beyond that age group (See Papadakis et al. 2018) and to improve young children’s skills, school readiness, or executive-function capabilities (Hirsh-Pasek, et al., 2015). This is important given that school readiness is predictive of later school achievement. In brief, the use of tablet technologies has positive impact on emerging literacy and numeracy skills, problem solving, creativity and overall mathematics achievement. Of importance to our ERA approach to using tablets, research indicates that young children could transfer what they learned on a device to a similar scenario using non-digital objects (Schacter & Jo, 2017). These positive effects may be due to the fact that tablets present very few technical challenges (e.g. the fine motor control required to use a mouse or keyboard) and thus engagement with tablets is higher. Lyons and Tredwell (2015) also note that tablets, with their multi touch capability and their portability, encouraged cooperative and social skills rather than isolated play. In addition, when using the tablets children were collaborative, created artefacts together, and understood the difference between activities on and off the devices. In light of this research, tablets are seen as being particularly suitable for early childhood contexts (Papadakis et al., 2018).

Context For Digital Technology Use – Digital Play

Of significance in the literature, given the play based nature of preschool, is the context of tablet use. Most researchers in this space propose some version of digital play; however, we take a slightly different approach that will be outlined shortly. Marsh et al. (2016) indicate that the nature of play is changing in terms of the resources available for play and the ways in which those resources are deployed in different types of play. This includes the relationship between offline and online spaces. They argue that this leads to communication and play that moves across physical and virtual domains and integrates material and immaterial practices. In suggesting that play moves fluidly across space and time, (Marsh et

al., 2016) provide a counter position against those “who seek to dichotomise digital and non-digital play, suggesting that play with digital technologies is not ‘real play’” (p. 9). A related conceptualisation of play, along the lines proposed by Marsh et al. (2016), is the work of Bird and Edwards (2014) who have coined the notion of digital play as a way of contextualising contemporary play. Digital play is understood as the range of play based activities children undertake with technologies. This concept of digital play can be helpful to early childhood educators in encompassing digital technologies into existing play based learning to support STEM.

Arnott (2016) takes a different approach, looking instead at the issue of play from an ecological standpoint. This standpoint identifies technologies as only one part of a complex ecological system supporting young children’s learning. From this perspective, digital play is not reified as the goal for contemporary play, but rather it describes “how play experiences are being re-imagined in early childhood” (Arnott, 2016, p. 271). Arnott’s argument raises three important points. Firstly, the use of technologies should not be considered omnipotent or deterministic as they are to be used, as children want to use them. Secondly, play with digital technologies is not to be viewed as a unique form of play but rather a component of everyday play. Thirdly, their appropriateness needs always to be considered as part of the broader ecological system.

Finally, our view on the role of digital technology and play is slightly different. We outline this view in full in Lowrie & Larkin (2019). In brief, we avoid the use of the word digital as we think it limits the opportunities for more holistic play when the focus is too heavily placed on the digital and less on the play. We tend to follow the lead of Arnott in our conception of the STEM apps we have designed being available for children to play with when they choose, much like they can choose to play with objects on the craft table or in the construction corner.

Role of Early Childhood Educators

Both in the literature, and anecdotally in our work with nearly five hundred preschool educators across Australia, it is clear that there is a need for further professional development in the use of tablets to support STEM. As with any activities involving educators, their attitudes and beliefs towards the use of technology are impacted by factors such as training and education, social economic status, and age. It is likely the case that early childhood educators received little preparation for using technology and thus may find it difficult to apply it appropriately within their pedagogical repertoire. This has flow on effects to the children in their care as “children’s access to technology is ‘contingent upon teachers’ skills in using and integrating technology” (Vaughan & Beers, 2017, p. 322). Yelland and Gilbert (2014) suggest that these limitations can be rectified with professional development opportunities that: allow teachers to work collaboratively in designing pedagogical repertoires for the use of tablets; recognise the multimodal quality of tablets use in their centres; demonstrate the transformative nature of tablet use in modifying or redefining current practices; and promote new ways of thinking about multimodal learning to facilitate a range of STEM skills young people require in today’s (and tomorrow’s) society.

Conclusion

In this paper we have briefly examined existing research on the role and nature of digital technology, primarily tablets, in Preschools to support STEM learning. The majority of the literature points to overwhelmingly positive outcomes for young children when digital technologies, especially tablets and apps, are thoughtfully used in play based and intentional

learning contexts to develop STEM concepts. However, despite this, many of the early childhood teachers in our pilot reported initial concerns regarding STEM, and the place of tablets in supporting children's learning in STEM. Our experience indicates that, once our pilot educators had completed workshops with us, they developed a sophisticated understanding of the role and nature of digital technologies, in play based learning.

References

- Alade, F., Lauricella, A., Beaudoin-Ryan, L., & Wartella, E. (2016). Measuring with Murray: Touchscreen technology and preschoolers' STEM learning. *Computers in Human Behavior*, 62, 433-441.
- Arnott, L. (2016). An ecological exploration of young children's digital play: framing children's social experiences with technologies in early childhood. *Early Years*, 36(3), 271-288.
- Australian Government – Department of Health (2017). Australian 24-Hour Movement Guidelines for the Early Years (Birth to 5 years): An Integration of Physical Activity, Sedentary Behaviour, and Sleep. Retrieved from <http://www.health.gov.au/internet/main/publishing.nsf/content/npra-0-5yrs-brochure>
- Bird, J., & Edwards, S. (2014). Children learning to use technologies through play: A Digital Play Framework. *British Journal of Educational Technology*, 46(6), 1149–1160. doi:10.1111/bjet.12191
- Donohue, C., & Schomburg, R. (2017). Technology and interactive media in early childhood programs. *YC Young Children*, 72(4), 72-78.
- Hirsh-Pasek, K., Zosh, J., Golinkoff, R., Gray, J., Robb, M., & Kaufman, J. (2015). Putting Education in “Educational” Apps: Lessons from the Science of Learning. *Psychological Science in the Public Interest*.
- Kyriakides, A. O., Meleti-Mavrotheris, M., & Prodromou, T. (2016). Mobile technologies in the service of students' learning of mathematics: the example of game application A.L.E.X. in the context of a primary school in Cyprus. *Mathematics Education and Research Journal*, 28(1), 53-78.
- Lindeman, K. W., & Anderson, E. M. (2015). Using blocks to develop 21st century skills. *YC Young Children*, 70(1), 36.
- Lowrie, T. & Larkin, K. (in review). Experience, Represent, Apply (ERA): A Heuristic for Digital Engagement in the Early Years. *British Journal of Educational Technology*.
- Lyons, C., & Tredwell, C. (2015). Steps to Implementing Technology in Inclusive Early Childhood Programs. *Computers in the Schools*, 32, 152-166.
- Marsh, J., Plowman, L., Yamada-Rice, D., Bishop, J., Lahmar, J., & Scott, F. (2018). Play and creativity in young children's use of apps. *British Journal of Educational Psychology*, 49(5).
- Marsh, J., Plowman, L., Yamada-Rice, D., Bishop, J., & Scott, F. (2016). Digital play: a new classification. *Early Years*, 36(3), 242-253. doi:10.1080/09575146.2016.1167675
- Papadakis, S., Kalogiannakis, M., & Zaranis, N. (2018). Educational apps from the Android Google Play for Greek preschoolers: A systematic review. *Computers & Education*, 116, 139-160.
- Royal College of Paediatrics and Child Health (RCPCH) (2019). The health impacts of screen time: a guide for clinicians and parents. Retrieved from https://www.rcpch.ac.uk/sites/default/files/2018-12/rcpch_screen_time_guide_-_final.pdf
- Schacter, J., & Jo, B. (2017). Improving preschoolers' mathematics achievement with tablets: A randomized controlled trial. *MERJ*, 29(3), 313-327. doi:10.1007/s13394-017-0203-9
- Vaughan, M., & Beers, C. (2017). Using an exploratory professional development initiative to introduce iPads in the early childhood education classroom. *Early Childhood Educational Journal*, 45, 321-331.
- Yelland, N., & Gilbert, C. (2014). *SmartStart: Creating new contexts for learning in the 21st century*.