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

In 2018 and 2019 the Early Years STEM Australia (ELSA) program was trialled 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.

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The ERA heuristic in action: Observations from the ELSA pilot.

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Despite an increasing body of research on the use of digital technologies in early childhood education (see Alade, Alexis, Beaudoin-Ryan, & Wartella, 2016; Edwards, 2016; Fleer, 2017; Lowrie & Larkin (2019 in review), Marsh, Plowman, Yamada-Rice, Bishop, & Scott, 2016), there is still uncertainty for educators surrounding the best way to implement these technologies in centres and preschools (Nuttall, Edwards, Mantilla, Grieshaber, & Woods, 2015). During the development of the Early Learning STEM Australia (ELSA) Pilot program, there was an identifiable need to assist early years educators as they incorporate digital technologies in a play-based environment to engage children in STEM activities. As such, the Experience, Represent and Apply (ERA) heuristic was developed. With the first-year pilot of the ELSA program complete, it is an ideal time to reflect on how the ERA heuristic was enacted within the project and how early years educators received it.

ERA Engagement with Two STEM Apps

The structure of the ELSA pilot delivered one children's app approximately every eight weeks, starting in mid-March 2018 with the first children's app and the educator app. The first children's app, Patterns and Relationships, included learning activities involving ordering, sorting, patterning and representing patterns in dance. The second children's app, Location and Arrangement, focused on position, location, arrangement and orientation. Along with the children's apps, educators in the pilot were provided with an educator app that included a range of activities, question prompts, and STEM Practices. The educator app was designed according to the ERA heuristic and structured in such a way as to support the STEM concepts developed within the children's apps. The Experience activities introduced children to the relevant STEM concept before they used the tablets. The Representation activities occurred on the device, with support for educators including question prompts to ask as children engaged with the digital learning activities. The Application activities were designed to build on the knowledge gained by the Experience and Represent activities, allowing children to further explore the concepts after they have played the app. At the beginning of the pilot it was unknown how the educators would react to the ERA heuristic, as the project team had not previously used the heuristic with early years educators. The following sections describe some of the student engagement data and educator feedback associated with the Patterns and Relationship app and the Location and Arrangement app. Engagement data was collected and uploaded to our database as the children used the device. Only children whose parents had provided permission for their data to be used were included. Educator feedback was collected through workshops, surveys and the community of practice (CoP) site.

ERA Through Children's Engagement Data

As per the ERA heuristic, the educators were encouraged to engage children in off-app *experience* activities before using the tablets. This engagement could be encouraged via a range of activities provided in the educator app or could come about through their own play-based provocations. Next, children played the digital apps, allowing them to *represent* their understanding of the various concepts introduced earlier. Finally, the educators prompted the children to complete further off-app activities (supplied or generated by the educators) to extend and *apply* the children's understanding. Figure 1 provides a chart of the children's engagement with apps 1 and 2 over a 28-week period. For both apps, the graph indicates a peak in the middle of the respective time periods, suggesting that the educators were not exposing children to the digital learning activities until a range of *experience* activities or provocations had been offered. The downward slope towards the end of each time period indicates that educators were bringing children off the apps to engage in *apply* activities in the centres. The data also indicates that app 1 remained in use even after the introduction of app 2. Figure 1 reinforces that the ERA heuristic was generally being followed by the pilot educators and that they were able to interpret and apply the ERA heuristic successfully.

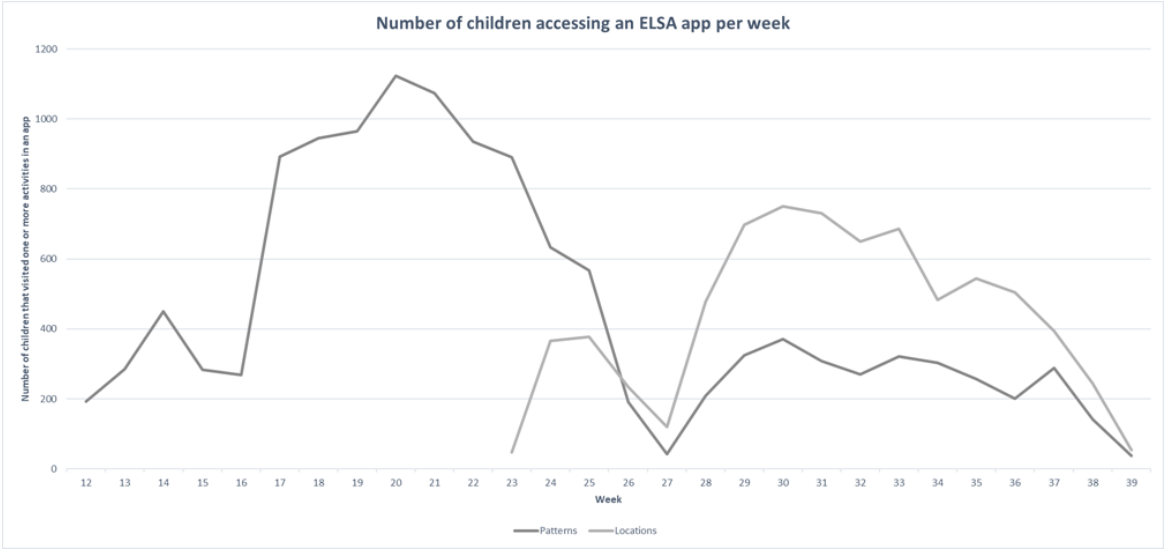

Figure 2. App 1 and app 2 child engagement data.

ERA Educator feedback and activities

Throughout the pilot, the ELSA team were interested in how the educators were implementing the ERA heuristic and the different sorts of activities and provocations they were using in their centres. Table 1 provides some of the themes that emerged from the feedback in relation to the ERA heuristic. An interesting finding for the ELSA team was the change in teaching practices that emerged as a consequence of educators following the ERA heuristic, particularly with regards to language use. Accompanying their feedback, educators often provided photos of activities the children had been engaged with, mostly the *experience* and *apply* activities. Figures 2a, 2b and 2c represent an example of the ERA activities respectively from app 1. It can be seen that children engaged with various patterning activities both off app and on app.

Table 1.
ERA themes from educator feedback and example quotes

Theme	Quotes from Educators
Connection to the ERA heuristic	iPad apps not the main focus Parents expressed concerns around their children spending lots of time on the iPads and apps, had to explain that the apps are only a bridge Love the apps, some more than others and we are working on developing the E and A support experiences as well as around the capacity of what the apps can do Extending from app is easy
Off-app activities	Off app concepts and ideas are supportive of what we are doing in the program I like the off-app suggestions - I work with three year old group so we use the off-app ELSA ideas Good introduction to off-app experiences
Changing in teaching	Gives structure/direction to teaching ELSA pilot has inspired a focus on explicit teaching - use of 'language' related to concepts Improve language (technical) We have been able to have more detailed discussions with the children during non-app experiences Fabulous shift in thinking, not a shift in doing Using the apps makes you think and recognise and focus more on the hands on STEM activities that you are participating in/planning for the children

Figure 2a. An E patterning activity with natural materials showing an AB pattern.

Figure 2b. Children playing the patterning game (R).

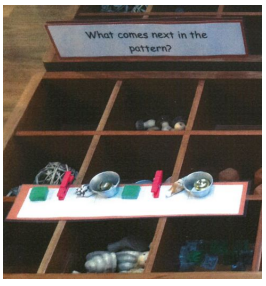

Figure 2c. An A patterning activity with an ABC pattern.

Figures 3a and 3b illustrate an “E” and “A” activity respectively for app 2, where children engaged with different types of maps and considered scale and direction.

Figure 3a. Children read a book and drew a map as part of an E activity.

Figure 3b. A 3D model of the zoo from the app as an A experience.

Conclusions

The ERA heuristic was a critical factor in the implementation of the ELSA project. The ELSA team was cognisant of the possible hesitation of the profession to include digital devices into their STEM play and learning (Palaiologou, 2016) and therefore our program design made explicit the link between digital engagement and more traditional play-based activities. As such, the ELSA apps were not designed to be stand-alone activities, played by individual children with no support. Rather they were part of a package that incorporated the ERA heuristic, where the on app activities built on previous off app experiences and led to further off app activities. The data presented here highlights that the ERA heuristic was well understood and appreciated by the pilot educators, especially as they reflected on their own teaching practice. Further studies could investigate the heuristic with other digital programs.

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