# Developing Computational Thinking through Pattern Recognition in Early Years Education


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**With recent UK initiatives on computing education alongside the development of wider digital competencies, we propose that computational thinking skills can be taught to early year students and highlight a method for carers to teach a specific aspect, namely pattern recognition. Although our example might appear specific to the example, we identify how this could readily be extended to a broader class of educational settings, proposing an underlying pedagogical framework. Finally, a proof-of-concept prototype, corresponding to the implementation of the method, is highlighted.**



*Computational thinking, early years education, signature pedagogies, computer science education*


## 1. **INTRODUCTION**

Computational thinking is increasingly recognised for its importance in school education (see, for example, Papert, 1996; Guzdial, 2008; Wing, 2008), both for underpinning computer science foundations, as well as for developing wider problem solving skills across all curriculum subjects. We have seen significant educational reforms in the UK (Crick & Sentence 2011; Brown et al. 2013; Brown et al. 2014) prioritising the development of computational and digital skills, in many cases driven by economic levers, but also recognising the wider societal imperatives of a digitally confident and capable citizenry – being able to access public services and be safe online, enabling to being innovation and creativity in a digital domain, through to digital democracy (UK Digital Skills Taskforce, 2014; House of Lords, 2015). The new Computing subject in the English National Curriculum that was implemented in September 2014 addresses computational thinking skills at each of the Key Stages (2013), with similar curriculum reforms proposed in Wales (Arthur et al, 2013). Wing (2008) argues, however, that in order to achieve a common basis of understanding and applying computational thinking, then those skills would be best introduced in the early years of childhood. Taking the view of Shulman (2005) and Miller *et al* (2012) of early years education as signature pedagogies, we investigate how computational thinking at such an early age can underpin a child's disposition to learn in later years.

The starting point of this research, the work presented in this paper, consists of an example methodology for including computational thinking in early years education. This is implemented in an iPad prototype, the reasoning behind the particular device is due to current trends of including touch-screen mobile devices in youngsters' daily activities.

### Early years education in the UK and pedagogical practice

In accordance with convention we use the term 'early years' to refer to the bridge between preschool and the first two years of compulsory school education. Within the UK, there are regional variations in the provision of early-years education, especially across the devolved nations (Brown et al. 2014), with some children accessing non-compulsory education from the age of three and all children entering compulsory schooling from the age of five (Miller *et al*, 2012).

According to Steven (2010), pedagogical practices within early years settings typically include traditional didactic teaching practices, along with explorative learning, questioning, scaffolding skills acquisition and developing the individual child's disposition to learn. Particularly in western societies, early-years pedagogical models place particular emphasis the role of game-based learning (Farquhar and White, 2014).

Computation thinking is typically thought of as comprising of several key factors that aid in learning to algorithmically solve problems. The focus of this work is on pattern recognition, however the methodology can be extended to other areas of computational thinking (that is left for future work).

**Signature pedagogies**

Shulman (2005) proposed the concept of signature pedagogies where students' skills and knowledge are developed towards specific disciplines. It could be argued that signature pedagogies can be seen at every level of education (Shulman, 2005) and Miller *et al* (2012) argue that early years education is an example of signature pedagogy, particularly in the context of digital skills.

By facilitating educational practitioners in the development of computational thinking skills in young children who are still in early-years education, 'signature pedagogy' is established for later computing skills these children will develop in later years.

**Mobile devices within an early-years educational setting**

As a result of the proliferation of education apps aimed at early-years education, tablet computers such as the iPad are being increasingly seen as devices for informal education, as well as family entertainment (Merchant, 2015). Many children are now entering formal educational settings having had previous experience of informal learning on mobile devices. This is leading to a pedagogical shift where computing technology, including mobile technology, is being used to develop key skills, such as literacy, within the early year teaching environment (McClean, 2013; Palaiologou, 2014). Mobile devices such as tablet computers are typically appealing to young children and touch-screen interfaces mean that children can interact independently with technology from a young age (Neumann and Neumann, 2014).

The ability to display and change images on a display means that it is accessible for young children without a dependency on number or letter/word recognition (Giorgis *et al*, 1999).

## 2. Prototype Description

The system developed gradually teaches early years a particular aspect of computational thinking (pattern spotting) via play with minimum instruction. A description of the prototype now follows.

The pupil is shown a screen with increasingly more abstract (less related to real-life) objects. This is an iterative learning process, until the early years is able to pattern spot at an abstract level. We exemplify a game play bellow:

*The first game play:* the user is presented with four different very detailed objects, familiar to the early years namely pictures of family members (a carer is required to upload these into the system), two of these pictures are identical.

Once the child clicked on the equal objects the game will

*Present the pupil* with four different very detailed objects. These are everyday objects generally familiar to most toddlers, such as teddy bears, but not specific to the particular toddler, two of these pictures are identical.

Once the child clicked on the equal objects the game will

*Present two new pictures*, again detailed objects present in every day life, for an example we refer the reader to Figure 1a.

If the child does not recognise the same objects for four clicks, the game will return to the previous pictures, else if the child clicks on the same object again after less than 4 attempts, then

*The system will present* 4 everyday objects, two with the same colour.

The same iterative process as above happens, once the child makes less than 4 attempts and correctly identifies the colours, the systems moves onto shapes (Figure 1b).

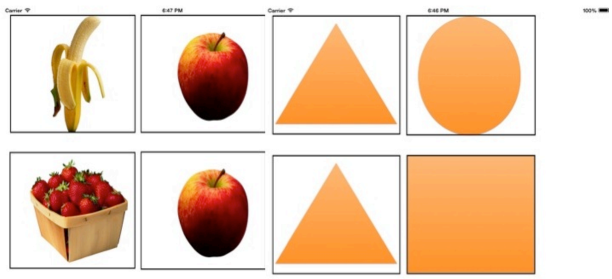

***Figure 1a**: The user is presented with 4 buttons, in this iterative step the recognition involves objects from everyday life. **Figure b:** in this iterative step the recognition of objects is of a more abstract nature*

All the objects presented are under the same category. Planned future work includes extending the design to accommodate for learning across categories, and then pattern spotting of different categories. So, for instance, the child could be presented with a picture of a banana, an apple, a teddy bear and a towel, and the system would expect the child to recognise the banana and the apple as the "same" or belonging to the same category. This step would involve considerable consideration of current literature on preschool categorical learning (references) to determine whether this type of pattern spotting might be best taught at a later age, since the current target of the system is 3-5 years of age.

## 3. CONCLUSIONS AND FUTURE WORK

We have presented a methodology (implemented in a prototype) for iteratively teaching early years pupils aspects of computational thinking and hypothesise that these will have a positive impact on their future learning.

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