An Initial Examination of Designed Features to Support Computational Thinking in Commercial Early Childhood Toys

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Abstract: A number of commercial toys have been developed and marketed for young children that purportedly support the development of computational thinking and coding skills. However, we have yet to specify how these toys are supposed to support computational thinking. In this poster, we provide an initial examination of designed features in 20 commercial toys marketed to 5 and 6 year old children.

Introduction

Several toys have begun to appear commercially that purport to help children with computational thinking and coding skills. For instance, Learning Resources has released a "Programmable Robot Mouse" toy that is intended to help children develop computational thinking skills by interacting with a series of buttons on the toy's body that determine how the toy will move. The Robot Mouse is just one example in a marketplace that is becoming rapidly populated with computationally-themed toys. As a research team, we are interested in how such toys are actually used and the extent to which they support computational thinking among young children. As a first step, we present in this poster the beginnings of an analytical framework for viewing the computational potential of these toys and an initial frequency analysis of some designed computational features in coding toys currently on the market.

Commercial toys as designed play artifacts

Play has been recognized as fundamental, both developmentally and socially (Piaget, 1962; Vygotsky, 1978). Indeed, learning scientists have argued that play is an underutilized resource that can be made more prominent in the design of novel immersive learning environments (Enyedy, Danish, Delacruz, & Kumar, 2012). As a parallel point, we believe that specific handheld artifacts are also an important component of play to examine. With commercial toys, we assume that particular forms of play are intended in the design of those artifacts.

Taking that assumption seriously, we posit there are a set of intended features associated with coding toys that we designate as *ideational* and *physical*. Ideational features rely upon the primitive operational meanings and the presumed perspective of the designer. For instance, pressing a button with a forward facing arrow on the Robot Mouse toy is intended to map onto a forward move instruction. It is akin to aspects of what Norman (1988) refers to as the mental model mapped to a user interface. It refers to the way in which the behavior of the artifact could be understood. The physical features are those visible and manipulable aspects that are associated with material affordances (Norman, 1988). The button on the Robot Mouse with the forward facing arrow affords pushing, implying it is part of the toys operation. Other computational-themed toys may have physical features such as instruction tiles that afford grasping and placing in specific locations.

We characterize intended play with these toys as involving a dynamic integration of physical features and ideational features. Intended play practice may be that the child is supposed to help an agent (such as a modified mouse) navigate a space (the floor) to complete a journey by way of giving algorithmic instructions. The purported computational relations are then assumed to be particular mappings of ideational features to physical features that instantiate some aspect of computational thinking. Given those assumptions, we provide an examination of several computation-themed coding toys marketed for young children.

Data sources and analysis

Each toy found in our initial search was screened for inclusion/exclusion based on the following criteria (1): proposed target audience of children ages five to six years old and (2) marketed as a learn-to-code toy or product. A final sample of twenty toys were selected, including Bee-Bot, Blue-Bot, Code-a-pillar, Coding Jam, Coji Robot, Cubetto, Dash, Dot, Finch Robot, FurReal Proto Max, Bunny Trails, Robot Races, Kibo, Let's Go Code Activity Set, Ozobot, Puzzlets, Robot Mouse, Robot Turtles, Siggy Scooter, and Unruly Splats.

As a next step, these toys were examined and reviewed based on evaluation of their components, structure, manuals, and/or observation of their use in some informal youth play activities. From review of these toys, we identified five categories for how coding is 'physically' instantiated. These include tangible, screen-based, button-based, non-electronic, and blended forms. Five computational thinking skills were also identified from comparable recent research (e.g., Ehsan, Beebe, & Cardella, 2017). We coded each toy with one or more of the following: *algorithmic thinking*, defined as requiring a sequence of steps to complete a task; *scaffolded debugging*, defined as support for finding or fixing goal-deviant errors, *problem decomposition*, defined as breaking a goal into subgoals or more restricted actions; *abstraction*, defined as defining reusable routines or sequences; and *pattern recognition*, defined as identifying repeating sequences or structures.

Figure 1. Youth playing with some of the examined toys, including Robot Mouse (left), Cubetto (center), and Ozobot (right).

Findings

Figure 2 below shows the distribution of physical features across the twenty toys. *Button-based* media involve physical button features and are represented by the Robot Mouse and Bee-Bot. *Tangible* media are physical pieces that are placed or manipulated as represented by Cubetto. Figure 3 also shows the distribution of computational thinking skills that are presumed to be specific ideational/physical mappings intended by design. We found that all of the examined toys incorporated algorithmic thinking. Only six covered abstraction. Initial findings indicate the primary focus of most current coding toys targeting five and six year old children is on teaching algorithms and scaffolded debugging.

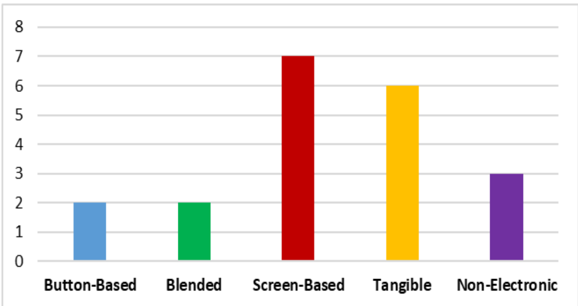

Figure 2. Physical Features.

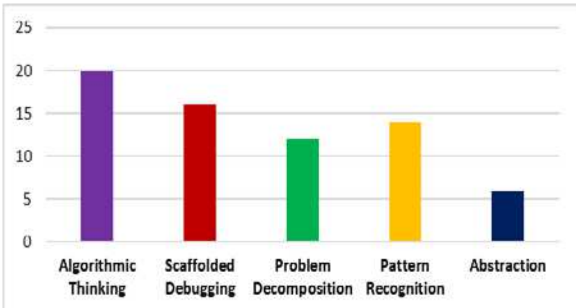

Figure 3. Computational Thinking Skills.

Conclusion

Within the commercial sector, toys that are intended to promote computational thinking are mobilizing a variety of ideational and physical features. The primary emphases tend to be through tangible and screen-based (i.e., tablets) media using visual programming languages. Algorithmic thinking and scaffolded debugging appear to receive more emphasis. Future research should explore how commercial early childhood toys can be integrated with curriculum to include lesser represented computational thinking skills such as abstraction. In future work, we will examine whether these intended features and computational thinking skills are indeed realized when children are playing with these toys in early childhood education settings.

References

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