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

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I. INTRODUCTION

Background
• Toys have begun to appear commercially that purport to help children with computational thinking and coding skills.
• 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.
• Robot Mouse is just one example in a marketplace that is becoming rapidly populated with computationally-themed toys.

Problem
• Commercial toys are marketed as supporting the development of computational thinking and coding skills, but we have yet to specify how these toys are supposed to support computational thinking.
• Little research has been done to evaluate how toys are actually used and the extent to which they support computational thinking among young children.

II. COMMERCIAL TOYS AS DESIGNED PLAY ARTIFACTS

Idiational Features
• Rely upon the primitive operational meanings and presumed perspective of the designer.
• Pressing a button with a forward facing arrow on the Robot Mouse toy is intended to map onto a forward move instruction.
• 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.

Physical Features
• 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 toy’s operation.
• In computational-themed toys, aspects of computational thinking are instantiated may have physical features that instantiate some aspect of computational thinking.

Intended Play
• Intended play with these toys involves a dynamic integration of physical features and idiational features.
• Intended play practice may be that the child is supposed to help an agent (such as the modified mouse) navigate a space (the floor) to complete a journey by way of giving algorithmic instructions.

III. METHODS

Each toy was screened for inclusion/exclusion based on the following criteria: (1) proposed target audience of children ages 5 to 6 years old and (2) marketed as a learn-to-code toy or product.


Five categories were identified how coding is ‘physically’ instantiated including: tangible, screen-based, button-based, non-electronic, and blended forms.

IV. RESULTS

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Figure 5. Physical features

• Figure 5 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 6. Computational thinking skills

• Figure 6 shows the distribution of computational thinking skills that are presumed to be specific idealational/physical mappings intended by design.
• Initial skills to investigate the primary focus of most current coding toys targeting 5- and 6-year old children is on teaching algorithms and scaffolded debugging.

Table 1. Computational thinking skills identified from comparable research and definitions of each skill

<table>
<thead>
<tr>
<th>Computational Thinking Skill</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Algorithmic thinking</td>
<td>Requiring a sequence of steps to complete a task</td>
</tr>
<tr>
<td>Scaffolded debugging</td>
<td>Support for finding or fixing goal-deviant errors</td>
</tr>
<tr>
<td>Problem decomposition</td>
<td>Breaking a goal into subgoals or more restricted actions</td>
</tr>
<tr>
<td>Abstraction</td>
<td>Defining reusable routines or structures</td>
</tr>
<tr>
<td>Pattern recognition</td>
<td>Identifying repeating sequences or structures</td>
</tr>
</tbody>
</table>

V. CONCLUSION

• Within the commercial sector, toys that are intended to promote computational thinking are mobilizing a variety of idealational and physical features.
• 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.
• Future work will examine whether intended features and computational thinking skills are indeed realized when children are playing with coding toys in early childhood settings.