

Interactivity, Interfaces, and Smart Toys

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Although computers can represent a medium for children's social and intellectual development, some researchers believe that using computers before age seven subtracts from important developmental tasks and other types of learning (J.M. Healy, *Failure to Connect: How Computers Affect Our Children's Minds—for Better or Worse*, Simon & Schuster, 1998). Those opposed to computers believe that computer-based activities are less effective in developing understanding and skills than are artifacts that young children can handle.

These anxieties extend to technologies such as smart toys. Some researchers (D.E. Levin and B. Rosenquest, "The Increased Role of Electronic Toys in the Lives of Infants and Toddlers: Should We Be Concerned?" *Contemporary Issues in Early Childhood*, vol. 2, 2001, pp. 242-247), for example, claim that electronic toys produce limited and repetitive interactions that might inhibit the healthy play and development of young children. They contend that playing with dolls, trucks, blocks, and similar toys encourages children to be the "creators and controllers of their play" and helps "parents play in imaginative, give-and-take ways with their infants and toddlers."

CACHET

Our recently completed research



Despite some technical hurdles, using smart toys and software for educational play shows promise.

project, Computers and Children's Electronic Toys (www.ioe.stir.ac.uk/cachet/), investigated how children use smart toys. Cachet combines recent interest in mobile learning, tangible interfaces, and the home use of technologies. This research aimed mainly to explore interactivity and interfaces in the context of smart toys that children could use alone or in conjunction with a computer.

Toys

We based these toys on Arthur and his sister D.W., two aardvark characters from the Marc Brown stories and cartoon series (<http://pbskids.org/arthur/>) familiar to more than 75 percent of the children in our study. The toys have a plush finish, resemble traditional soft toys, and—unlike some smart dolls—their sensors and batteries do not make them heavy and unwieldy. Arthur and D.W. stand 60 cm tall and have a vocabulary of about 4,000 words, motors to provide movement, and electronic chips to recognize inputs. Because

the toys cannot respond intelligently to spoken input, they depend on gestural interaction. If a child squeezes a toy's hand or wristwatch, the toy will ask questions. If a child squeezes the toy's toe, it will suggest a game.

Games include estimating a time—5, 10, 15, or 20 seconds—by squeezing the toy's hand when the time is up, saying the alphabet backwards and forwards, and tongue twisters. In addition to using them by themselves, children also can use the toys in conjunction with specially encoded CD-ROMs that feature language and number games.

Playing with the toy and the software

simultaneously requires an accessory: a radio transmitter that looks like a modem and connects to the computer's game port. A PC pack add-on increases the toy's vocabulary to 10,000 words, letting the toy "talk" to children, comment on their interaction with the software, and offer advice and encouragement. Children can elicit help and information from the toy by squeezing its ear. In this mode, the child interacts with both the computer and the toy, while the toy interacts with the computer and mediates the child's actions.

If two children play with the toy, the interaction possibilities multiply. If the toy is not present, a clickable onscreen icon of Arthur or D.W. provides help and information. If children have difficulty with a game, the toy or icon reminds them of this help. We focused on these toys because they deliver the same help content through different mechanisms.

Conducting the study

We developed a multidisciplinary

approach to provide multiple response-and-behavior indices appropriate to the social and cultural context of using the toy while also allowing for investigation of detailed interactions. Given that children can play with Arthur and D.W. by themselves or in conjunction with the compatible CD-ROM, we looked at toy use alone, software use alone, and using the two together. Using a common core of data collection methods across all sites, we looked at toy and computer use in children's homes, after-school clubs, and classrooms.

Twelve children aged five to six participated in the home studies and were visited three times over approximately two weeks. Half the children received the toy first and were given the CD-ROM during the midway visit, while we reversed this order for the other half. In all cases, the children kept both items for the second week and could thus play with the toy and PC together.

Classroom use was more controlled, with detailed, dual-source video analysis of 32 children aged four to five. Twenty-two children in the four after-school clubs participated in the study. All children received verbal instructions on using the software and viewed a demonstration of how to access the help facility. In the classrooms and at the after-school clubs, the researchers remained in the background but prompted activity when children became stuck.

Analyzing the data

To capture the multiple interactions experienced by pairs of children using both the toy and software and either one or the other, we used the following main categories when transcribing the videos: action and gesture, expression and gaze, and dialogue. We further divided these categories into between children; between toy and children; between toy, onscreen software characters, and children; and between children and researcher. We used these structured transcripts to code categories of interaction and explore a range of questions about

children's help-seeking preferences and social behaviors.

We compiled all data relating to the individual children in the homes and individuals or pairs in the after-school clubs to produce separate case studies. These studies contain personal details, field notes, complete video session transcripts, interviews, the diaries, test results, and the rating scale. This information let us analyze data for individuals and across children while building a detailed picture that includes the context of use, individual differences, patterns of play, and toy and software use.

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RESULTS

Although the study focused on one particular type of toy, our approach has proven valuable in laying the groundwork for future research.

Toy characteristics

Interview questions revealed a considerable diversity of views about the extent to which children attributed human characteristics to the toys. Some knew batteries powered the toy, but younger children tended to think the toy had feelings and could think and talk by itself.

Invited to suggest ways in which the toys could be improved, several children mentioned that they would like it to be able to walk, perhaps because this would make the toy more lifelike. Although some children seemed to imbue the toy with sentient qualities, parents' comments suggest that this did not translate to a greater degree of dialogue or other forms of interaction. Most children viewed the toy as just that and some preferred to play with it switched off, taking the toy to the dinner table or making a bed for it next to the child's own.

At the first visit, parents tended to find the toys scary or feared they would stifle imaginative play. Yet by the end of the loan period, half the parents claimed the toys provided some educational value and said they would buy one at an affordable price. Although parents found the ways in which the toy and software interacted impressive, children seemed to take it for granted.

In homes, the time spent playing with the toy or software decreased as the novelty diminished—from about 45 minutes per day to less than 15 minutes, with interest in the toy wearing off faster than interest in the software. Those who received the toy after receiving the software played with it less frequently, if at all, partly because the help features were not generally needed—the software had already been explored. However, in this sequence we also found that children viewed the toy mostly as an adjunct to the software and rarely played with it away from the PC.

Children sometimes placed the toy on a table, next to the computer screen, even though the radio transmitter has a four-meter range. Although this made the toy seem more like a peripheral than an interaction partner, placing the toy on the child's lap could interfere with mouse manipulation. Paired children avoided this problem because one would typically control the mouse and the other the toy.

Interacting with toys and software

Although the toys can verbally interact with the children at a basic level, the spoken interaction could detract from the possibility of extended child-toy interaction and role-playing. Initially intriguing, the toy's vocabulary presents only an illusion of reciprocity and seems too limited to imply real personality. Most children found the toy's talking monotonous or irritating and eventually switched it off.

We found no evidence that these toys make either a beneficial or detrimental difference to the children's ability to engage in child-led imaginative play.

The children enjoyed the tactile nature of the toys more than the toy's interactivity, which challenges the view that technological toys are psychologically damaging.

Detailed video analysis revealed that young children can make the connection between two different interfaces and coordinate the experience received through their convergence. Our evidence suggests that children as young as age four are not disconcerted when faced with feedback and interaction possibilities from different artifacts.

Many children required assistance from the researcher or a peer to elicit help from the toy or onscreen icon. Some children also ignored the help that Arthur or D.W. provided. Even when they took notice of the help prompts, however, they did not necessarily interpret them correctly.

Help features

We analyzed the toy's role in supporting the child's learning in terms of *scaffolding*: how a more knowledgeable partner can assist the cognitive development of a less able one and gradually foster the development of successful independent task performance. Considerable research has explored this concept in relation to software, but with emphasis on desktop computers. We extended this research by examining how children requested and used assistance from the toy, the accompanying software, or other people.



To understand how children use the help available to them, we combined the descriptive results across contexts and with detailed activity analysis from the school studies. Initially, children were more likely to seek help from human companions. Although they often failed to notice the unsolicited clues the toy or onscreen icon was giv-

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ing, when prompted by their human companion, they became competent at using the toy to elicit hints and encouragement. The children were discerning users and recognized the help content's questionable value.

The toy's presence showed a statistically significant increase in incidences of help being successfully implemented, with children actively seeking help and adults actively engaged in prompting or assisting the children in their software use. However, the toy and no-toy conditions made little difference in how often children refused or ignored the offered help.

These findings suggest that system developers interested in software scaffolding might reap benefits from considering tangible interfaces instead of screen-based ones. The onscreen icon and the toy provided the same feedback content, with only the method for invoking and delivering this feedback differing.

While all the children in our study enjoyed using the software, interest in the toy appeared to be age-related, with parents reporting much more interest from younger children. Their poor feedback makes these toys unimpressive interaction partners. Nevertheless, the technology has potential, and generalizing

from findings relating to the specific toys in the study suggests several areas for future development.

Using existing work on software scaffolding could improve the type and mode of feedback by linking it to the children's performance. Because the youngsters were more likely to interact with each other or with the researcher when the toy was present, tangible interfaces offer promise for improving interaction between peers.

Children or their families failed to discover some of the toy's functionality, such as the alarm clock. This shows the tradeoff between a toy being complex enough to maintain interest and simple enough for use by very young children.

In preschool settings and the early years of primary school, the computer is usually used as a free play activity without the benefit of adult mediation. There may be value in developing this technology for such circumstances, but this would require close analysis of the contingent help adults can provide. Likewise, the plausibility issue must be overcome. Finally, girls' attraction to the toy could provide an avenue for redressing an imbalance in the greater appeal of technology to boys than girls. ■

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