

The Wave of the Future

How Children Think About and Learn from
Touchscreen Technology

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July 7th, 2016

Today I'd like to talk to you about how children learn from educational apps and touchscreen media. Before starting my graduate program at UVA, I worked at an Apple store, where I became fascinated with children's interactions with touchscreens devices. I would watch children who had never used an iPad before pick it up like that (*snap*), while their parents often struggled to do simple things. So I started thinking more and more about how children interact with touchscreen devices, and I am particularly interested in how they use these devices to learn.

A Decade of Touchscreen Technology



- More than 80% of the top-selling apps under the Education category target children
 - 75% of children under age 8 have access to a touchscreen

Shuler, 2012

The swift rise of touchscreen technology has transformed how children interact with media. Media engagement that was once passive and one-sided, like with television watching, has become interactive and responsive. Touchscreen apps can respond to a child's actions, offer rewards for correct responses or hints after incorrect ones, and gradually increase in difficulty based on the child's performance. These intrinsic features of touchscreens have led to an abundance of apps that are geared towards teaching children everything from the *alphabet to *advanced biology. In fact, more than *80% of the top-selling apps in the Education category of the App Store are aimed at children. Parents and teachers are increasingly turning to these apps as a source of learning for even the youngest child and children's access to mobile devices is rapidly expanding.

Today, *75% of children under the age of 8 have access to a touchscreen device. So children have access to and they are using touchscreens, and app developers are marketing products directly to children and their families. As educational apps have expanded, research on the educational merits of touchscreens has closely followed and the results so far have been mixed. Some researchers have found that children have difficulty transferring information they learn from apps to the real world, and others have found that children **are** capable of learning from apps.

Broadly, I would like to know how children learn from educational apps and how this

compares to their learning from other, more traditional methods such as books and physical materials.

Research Questions

How do children think about touchscreens?

How do children learn from touchscreens?

To answer this question, I've explored two main topics. *The first is how children **think** about touchscreens, and particularly whether they recognize that touchscreens can be used for learning. I will talk to you today about two studies I've conducted to explore this question. One of these studies was conducted here, at the Virginia Discovery Museum, as part of our Living Lab program. Some of your children may even have participated in it! *The second topic I've studied is how children actually learn from touchscreen devices, and I'll tell you about two studies where I directly compared learning from an educational app to learning from a physical puzzle.

Research Questions

How do children think about touchscreens?

How do children learn from touchscreens?

So first, let's talk about how children think about touchscreens. Very little research has looked at children's understanding of touchscreen media or compared this to how they think about other, more traditional media like televisions and computers. So in my first study, I asked children to tell me what various media tools could do.

I was specifically interested in how children think about the functions of a touchscreen device, and whether children prefer to use touchscreen devices over other forms of media. I was also interested in whether children and adults think differently about touchscreens.

Study 1: Thinking about Touchscreens

- 43 children between 4 and 6 years old
- 16 undergraduate adults



In this first study, I tested 43 children, about 60% of whom were female. I wanted to get a range of ages, so I tested children between the ages of 4 and 6. I also tested 16 undergraduate adults so I could compare their answers to children's answers. Participants were shown images of 6 objects and were asked the same questions about each object. The objects were: a book, an iPad, a TV, an iPhone, a computer, and a home telephone. You'll notice that all of these devices are different forms of media. Some, like the book and the television have existed for quite a while and could be called "traditional" forms of media. Others, like the iPad and the iPhone, are new forms of media to all of us, although for preschoolers, the iPad and the iPhone have always existed. I presented each picture, one by one, in this order and asked participants a series of questions about each object.

Study 1: Thinking about Touchscreens

Function

- *Is this something people use for...work?*
- *Talking to other people?*
- *Learning about things?*
- *Playing games?*

I asked children and adults quite a few questions about each object, but today I'd like to focus on just two topics: function and preference. *I first asked participants about the functions of each object. For example, I asked whether each object could be used for work, or for talking to others. The functions represent a broad range of activities. Some of the objects can be used for all of these functions, and some can only be used for a few of these functions but I was really interested in what participants thought the functions of each device were, not whether or not they were "correct." And importantly for this talk, I asked children and adults whether each object could be used *for learning about things.

Study 1: Thinking about Touchscreens

Preference

- Learn about Dogs
- See a Map
- Hear Spanish
- Talk to Friend

After we talked about each object individually, I gave participants a preference task, where all 6 objects were displayed at once and they were asked which would be the BEST to use for different tasks. *These 4 tasks were “Learn about dogs”, “See a map”, “Hear Spanish”, and “Talk to a Friend”. So I would lay out all of the object images side by side and ask the participant “If you wanted to learn about dogs, which one of these would be the BEST to use?” Importantly, you could do any of the tasks with most of the objects, but some are more plausible to use than others.

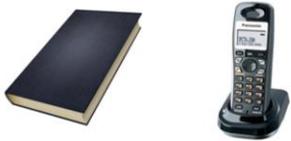
Study 1: Results

- Children and adults agreed: Books are used for learning
- But children did not think that iPads and iPhones were used for learning!
 - Only half thought an iPad was for learning and a third thought an iPhone was for learning
- Children said touchscreens were for playing games, taking pictures, and talking to others

I'm going to focus today specifically on the results relevant to learning. When asked about books, *children and adults agreed that a major function of books is learning! Indeed, all adults said books were used for learning and 81% of children said books were used for learning. This is not that surprising, since we use books for educational purposes all the time, even with young children. But when we questioned our participants about whether touchscreen devices could be used for learning, we saw sharp differences between children and adults. Again, all adults said yes, iPads and iPhones can be used to learn about things. *But only half of our children said an iPad could be used to learn and about a third of children said an iPhone could be used to learn. This is significantly less than the amount of children who claimed a book could be used to learn. *Children mainly thought that touchscreen devices were used for playing games, taking pictures, and talking to other people.

Study 1: Results

Children Preferred:



Adults Preferred:



I also wanted to see whether children and adults showed an overall preference to use touchscreen devices for a variety of tasks. *I found that adults preferred to use a computer for most tasks, including to learn about something. *In contrast, children claimed that a book was the best way to learn about a topic like dogs. This matches the previous finding, where 80% of children said books were used for learning. Children and adult also differed in their claim for the best way to talk to a friend, with *adults favoring the iPhone and *children favoring the home telephone. What we see from these results is that although children do show different preferences based upon the task, they do not show an overall preference for touchscreen devices over other devices. Adults, however, show a strong preference for computers to accomplish the given tasks, which is only overridden for the specific task of talking to a friend.

Study 1: Discussion

- Children and adults disagree about the utility of touchscreen devices
- Children do not prefer touchscreen devices over other tools, while adults show a bias towards newer technology

What will children do when presented with a choice?

So in my first study, I found that children and adults disagree about what touchscreen devices are used for. Adults recognize that touchscreens are highly multifunctional and can do many things. Children believe touchscreen devices have fewer functions, and interestingly, they feel touchscreen devices are not generally used for learning.

*Children also do not show a preference for using touchscreen media over other, more traditional forms of media. Adults, however, do prefer newer forms of technology like the computer and the iPhone.

However, a limitation of Study 1 is that I only asked children about these devices in the abstract. *What if children were actually presented with a book and a touchscreen and asked which one would be best to use for learning? Would they continue to claim the book is ideal for learning, as we saw in Study 1? Or would they claim the touchscreen was a better learning tool?

Study 2: Touchscreens as Learning Tools

- 70 children between 3 and 6 years old
- 6 learning topics



In Study 2, I presented 70 children with my friend Sarah, who was a doll. Sarah the doll had 6 different topics she wanted to learn about. For example, Sarah wanted to learn about trees. She had a book about trees and an iPad with an app about trees, and children were asked to choose which item would be the best for Sarah to use for learning. For half of the topics, I presented children with a book versus an iPad, and for half I presented a book *versus an iPhone. Since in my previous study, half of the children thought an iPad could be used for learning but only a third thought an iPhone could be used for learning, I thought I might see differences between these two types of touchscreens.

Study 2: Touchscreens as Learning Tools



The 6 topics that Sarah the doll wished to learn about were trees, cooking, today's weather, Virginia, vacuum cleaners, and yesterday's football game. You'll notice that for two of these topics, today's weather and yesterday's football game, the information is time-sensitive. As a side question, I was interested in whether children would recognize that for those two topics, the touchscreen was the better choice because it would have the most up to date information. Based on my previous study, I hypothesized that children would generally prefer to use the book to learn about each topic, but that older children might recognize that the touchscreen was a useful way to learn about the most up to date information for certain topics.

Study 2: Results

- Younger children chose books and touchscreens equally
- 6-year-olds chose touchscreens to learn about trees, today's weather, and vacuum cleaners
 - But they chose books to learn about cooking
- Children did not treat the iPad and the iPhone differently

My first result is that 3, 4 and 5 year old children showed no significant preference for either books or touchscreens. In fact, most individual children chose a mix of both books and touchscreens across the 6 trials of the study. However, 6 year olds did show a preference for using touchscreens to learn. *Specifically, they thought touchscreens were the best tool to use to learn about trees, today's weather, and vacuums. But when it came to cooking, *6 year olds claimed a book was the best tool to use. For the remaining two topics, Virginia and yesterday's football game, 6 year olds showed no preference between books and touchscreens. And finally, *children did not answer differently if the touchscreen presented was an iPad or an iPhone, despite my prediction.

Study 2: Discussion

- Generally, children did not prefer either books or touchscreens as a learning tool
- 6-year-olds showed a preference for touchscreens but only for specific topics

Contrary to my hypotheses based on Study 1, children did not prefer to use a book to learn, but they also did not prefer to use a touchscreen to learn. Instead, children chose both books and touchscreens as optimal learning tools. *Only the oldest children, 6 year olds, showed a particular preference for touchscreen devices, but this was only for certain topics, like trees. For cooking, 6 year olds actually preferred to use a book to learn. And although older children favored a touchscreen to learn about today's weather, they did not for the other time sensitive topic, which was yesterday's football game. So 6 year olds seem to still be developing their recognition that touchscreens have more information and are more up to date than books. Indeed, older children would often claim the touchscreen was the better tool because it had "more information" or "can do lots of things." These children are tapping into the key for why touchscreens are great learning tools, which is their connection to the internet. Research on this topic has shown that children develop their understanding of what the internet is and how it works well into middle childhood and even adolescence. So the majority of the children in my study may have been too young to really understand the utility of a touchscreen, but it seems like the oldest children were beginning to grasp it.

Research Questions

How do children think about touchscreens?

How do children learn from touchscreens?

After exploring how children conceptualize learning from touchscreens, I wanted to delve into how children **actually** learn from these tools. As I mentioned before, touchscreen technology differs from other forms of media like television and even computers. A touchscreen device is interactive and responsive, and app developers have utilized this in countless interesting ways. Yet our interactions with a touchscreen are still 2D experiences, set apart from our 3D world. How does this affect children's ability to learn from a touchscreen? As educational apps flood the market and parents become more concerned with their children's technological literacy, this question becomes crucial.

Study 3: Learning from Apps

How does learning from apps compare to learning from more traditional materials?



To begin to tackle this question, I directly compared how children learn from apps to how they learn from non-technological tools. I want to know: How does learning from apps compare to learning from more traditional materials? To explore this, *I designed a study that directly compared a physical puzzle to an app version of this puzzle. In our study, children were taught about the states and territories of Australia. I chose to use these materials for two main reasons. First, the puzzle is based on a standardized educational curriculum used to teach geography in Montessori preschools and the app is designed by Montessori educators to closely match the traditional puzzle, down to matching the color of each state. Therefore, they serve as an excellent controlled comparison of traditional learning vs app learning. Second, I expected Australia's states to be unfamiliar to children but reasonable for them to learn. I was initially going to use Canada but children couldn't quite say Saskatchewan.

Study 3: Learning from Apps

- Thirty-two 5-year-olds randomly assigned to a condition

Puzzle Condition (n = 16)



App Condition (n = 16)



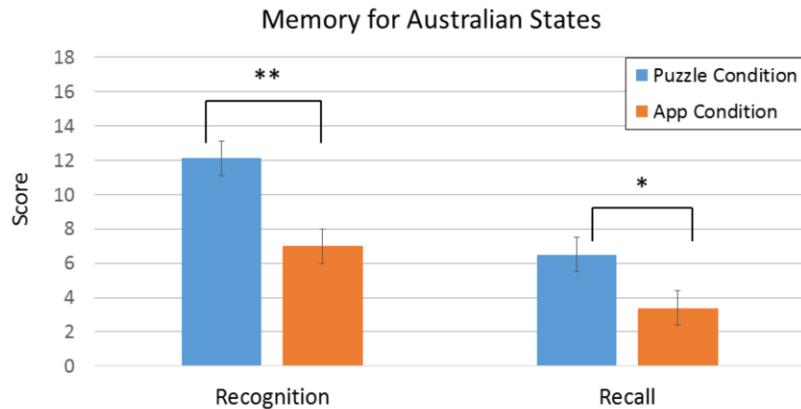
I ran 32 five year old children in my initial study. They were randomly assigned to either the puzzle condition or the app condition. In the puzzle condition, children were given a lesson by the experimenter on the states of Australia and then allowed to interact with the physical puzzle by themselves. In the app condition, children were introduced by the experimenter to the app of Australia and then allowed to interact with the app by themselves. The idea here is that when children use apps, it's generally without parental guidance. The app becomes the teacher. So I am interested in whether apps, by themselves, are capable of teaching children in the same way that a lesson with a puzzle can.

Study 3: Test



I tested children in two ways. First, are they able to recognize each state and second, are they able to recall the name of each state? I'd like to show you an example of each. So here is a video clip showing first recognition test questions and then recall test questions.* Children were tested on the same tool they had used to learn, so this child learned from the puzzle and was then tested on the puzzle. Recognition questions were asked before recall questions because recognition is easier and we wanted to gradually move towards the harder questions so that children would not get discouraged and we would be able to test both aspects of their memory. Children were given partial credit for remembering most of the name, for example saying New Wales instead of New South Wales.

Study 3: Results



On this graph, we can see children's performance on both types of questions, split by condition. Our puzzle condition is in blue and our app condition is in orange. On the x-axis at the bottom, we have our two memory tests, recognition and recall. On the y-axis on the left side, we have their score for each kind of test, with a maximum possible score of 18. You can see that children in the puzzle condition did significantly better than children in the app condition on both recognition and recall tests. Children also did significantly better on recognition than on recall within both of the conditions.

Study 3: Discussion

- Children in the puzzle condition learned more than children in the app condition
- Artificial lab setting
- Memory tests after only a slight delay

How will children engage with and learn from these materials at home?

So this study found that children learned significantly more of Australia's states in the puzzle condition than in the app condition. However, this was a somewhat artificial exploration of learning. *It took place in a lab with an unfamiliar experimenter, and children were tested on what they had learned after only a slight delay. Since I am interested in how children actually learn from these tools in the real world, I decided to conduct a second study where children would be able to take these tools home with them. *I wanted to know: How will children engage with and learn from these materials at home?

Study 4: Learning from Apps at Home

- Twenty-six 5-year-olds randomly assigned to a condition
- Used materials at home for 7 days
- Tested after initial lesson and after home exposure

Puzzle Condition (n = 13)

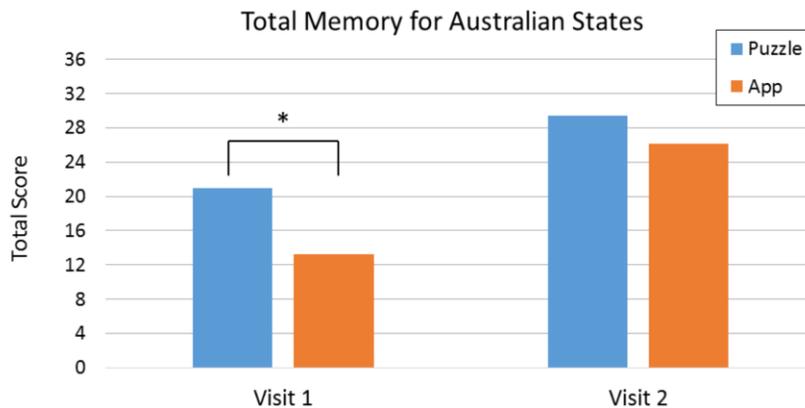


App Condition (n = 13)



My final study was conducted with twenty six 5 year old children who were split between my two conditions, puzzle and app. The initial procedure was identical to Study 1: children came into the lab and interacted with the materials in the same way and were given an initial memory test to see how much they learned from their interactions. *Then, children took home the material they had worked with for one week. During this week, parents filled out a diary that tracked the amount of time their child used the material. After 1 week, children returned to the lab for a second post-test that was the same as the initial memory test.

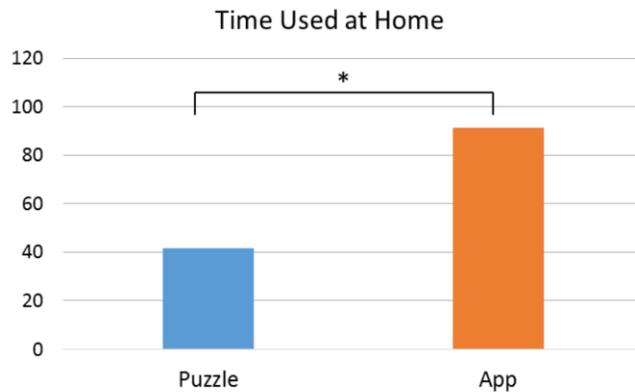
Study 4: Results



On this graph, we have the difference between conditions for our two time-points: Visit 1 which is their initial lesson with the material and Visit 2 which is one week later. There was a strong relationship between the recognition test and the recall test, so I combined them to look at children's overall memory. On the x-axis at the bottom, instead of our two memory tests we have the two different times that children were tested: Visit 1 and Visit 2. On the y-axis on the left side, we have their total score, with a maximum possible score of 36.

At visit 1, I replicated my initial study and found significant differences between the conditions. Once again, we see that children in the puzzle condition learned significantly more of the state names than children in the app condition. However, by the second visit, there was no significant difference between conditions. Children in the app condition learned just as many Australian states by their second visit as children in the puzzle condition. Why might this be? One factor might be the amount of time children spend with each tool. As I mentioned previously, parents tracked how much their child used the tool at home. Perhaps apps are more interesting and engaging for children than puzzles and they spent more time with the apps overall.

Study 4: Results



And indeed, children in the app condition, on average, spent about 90 minutes total playing with the app during the week. In comparison, children in the puzzle condition spent about 40 minutes total playing with the puzzle during the week. However, the amount of time a child spent with a tool did not affect their memory score. So children who spent more time playing with a tool did not necessarily score higher on the second visit. I am currently conducting research to explore one hypothesis for how children in the app condition caught up with their peers in the puzzle condition. It may be that it's not just about total time spent with the app, but rather the quality of that time. If someone is engaged with the child while using the app, will this boost learning?

Future Directions

- Combine the app with the lesson
- Explore impact of social interaction



To follow-up on the two studies I just presented, I'm running a third study where children interact with the app along with an experimenter who guides them in a lesson. In my first two learning studies, I chose to let children use the app on their own because I thought this best mimicked how children interact with apps in their daily lives. However, by superimposing the lesson from the puzzle condition onto the app condition, I can tease apart whether the differences I've found are due to a lack of social interaction in the app condition or whether they are caused by the physical differences between manipulating real objects versus virtual ones.

Recap: Studies 3 & 4

- Study 3: Children learned more state names in the puzzle condition than the app condition
- Study 4: Children learned more state names in the puzzle condition than the app condition during their initial session
 - After time at home with the materials, children performed equally well across conditions
- Children spent more time overall with the app

To summarize, in Study 3 I found that children in the puzzle condition learned more of Australia's state names than children in the app condition. In Study 4 I replicated this result but found that when the participants returned for a second test after using the materials at home for a week*, children in the app condition performed equally well as those in the puzzle condition. Overall, *children spent more than twice as much time with the app than with the puzzle. My future research aims to further tease this apart and will ultimately help us to answer the question: Is an app as good as the real thing?

Final Thoughts

Touchscreen research is rapidly growing

Touchscreens can be used in good and bad ways

Touchscreens offer an exciting new avenue for media research!

Today, I've presented 4 studies that have explored how children think about touchscreens as tools for learning and how they actually learn from touchscreens. I've been fortunate enough to join this field at an ideal time. Now that touchscreen devices have become such a stable part of our lives, research on how this technology affects us and our children is rapidly expanding. Just this year, two of our top psychology journals have lined up special issues specifically on children and mobile devices and this fall there will be a national conference specifically focused on this topic. So although we're just at the beginning of understanding touchscreen media's role in psychology, we can expect a wealth of studies in the next few years. *It's also worth pointing out that, like all tools, touchscreens be both good and bad. I've focused today on how touchscreens can be used for learning, but they have many other purposes. I know many parents are concerned about whether it's good or bad that their child does or does not use a touchscreen regularly. The short answer to that is that no one knows enough to be able to make a blatant judgement like that, although you will see many researchers who have firmly decided they are pro or anti touchscreens. Personally, I take the approach that touchscreens are just another tool and that parents should make their own judgements about the extent to which their children should use them. Many of the media recommendations, from the American Academy of Pediatrics for example, are based on research on television. But as we all

know, touchscreens are very different from television! They are much more interactive, as they can react and respond to our actions, and they offer greater possibilities. *Touchscreen devices have opened up a lot of doors for future media research, and I look forward to telling you more about that research in the years to come!

Thank You!

Advisor: Dr. Angeline Lillard

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Begum Koseler
Ashley Beamish
Emily Wright
Chiara Martignetti

Funding: American Montessori Society



Living Laboratory



Child Development Laboratories
at the University of Virginia

I would like to thank the members of my lab for their support and the Virginia Discovery Museum for inviting me to present and thank you all for listening!