

Peg + Cat Digital Media Summative Evaluation

Preschool Family Study



Rockman et al

Research & Evaluation

Acknowledgements

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Executive Summary

Project Description & Study Methodology

Peg + Cat is a popular broadcast television series, developed by The Fred Rogers Company and airing on PBS, in which a girl named Peg and her sidekick, Cat, solve everyday problems using mathematics, creativity, persistence, and humor. *Peg + Cat: Developing Preschoolers' Early Math Skills* was a three-year project, funded by the National Science Foundation, that aimed to impact children's interest and engagement with mathematics, as well as their development of positive social-emotional skills. The project supported early math learning via the creation of additional *Peg + Cat* episodes, online games and digital storybooks, a science center summer camp, and early childhood educator professional development. This evaluation report focuses on the use and impact of three online games (*Don't Go Bananas*, *Symmetry Painter*, and *Music Maker*) and three digital storybooks (*The Big Dog Problem*, *The Election Problem*, and *The Perfect Ten Problem*) by families with preschoolers.

Rockman et al, an independent educational research and evaluation company, conducted the summative evaluation study of the six *Peg + Cat* digital media resources with 31 families, comprised of one parent and one 4 or 5 year-old child. Participating parents were asked to complete pre- and post-interviews and surveys, and to fill out a journal tracking their children's usage of the online games and digital storybooks over a one-week period. Children were asked to complete pre- and post-interviews. Families were randomly assigned to one of two conditions - Naturalistic and Guided. Parents in the Naturalistic Condition were told to use the six *Peg + Cat* digital media as they normally would, while parents in Guided Condition were told that one of the goals of the online games and digital storybooks was to support children's social-emotional skill development, and that they should try to talk with their children about these topics while using the digital media.

Key Findings

- **Children tended to use the *Peg + Cat* digital media:**
 - On tablet computers or laptops
 - At home
 - With their parents or by themselves
 - For about two hours total during the week of the study

- **Parents engaged more frequently with their children around technology overall after using the Peg + Cat digital games and storybooks.**
 - Over half of participating parents did not play any digital games with their children in the week before the study, but all families did so during the week of the study.
 - Parents helped their children fix technology issues, asked and answered questions about the games they were playing, and made connections between digital media and their children’s daily lives significantly more often during the week of the study than they had done the previous week.
 - Parents in the Guided Condition increased the frequency with which they asked their children questions about the digital media they engaged with together, and increased the number of connections they made between that digital media and their children’s daily lives significantly more than parents in the Naturalistic Condition.

- **Children who used the Peg + Cat digital games and storybooks engaged more frequently with math-related media & Peg+Cat media than they had beforehand, according to their parents.**
 - Parents reported that their children played significantly more math-related and Peg + Cat digital media, both alone and with them, during the week of the study compared to the previous week.
 - Most parents (74%) indicated that their children proactively asked to play the six online games and digital storybooks, rather than the parents having to make the request.
 - All participating parents thought that their children would be interested in playing the six online games and digital storybooks in the future.
 - Families who were exposed to the Peg + Cat digital games and storybooks sought out additional ways to interact with the content and characters.
 - Over half of participating parents reported that their children did not watch educational television programs or videos about math, or Peg + Cat specifically, alone or with them before the study. Parents indicated that their children had done so significantly more frequently during the week of the study.
 - Families in the Guided Condition engaged with Peg + Cat episodes and clips significantly more often than families in the Naturalistic Condition.

- **Children who played the Peg + Cat online games and digital storybooks became significantly more familiar with the featured characters than they had been beforehand.**
 - Children were able to recognize solving problems and helping others as roles that characters within the world of Peg + Cat play.
- **Parents already infused math into everyday activities with their children before the study began, but were able to incorporate additional topics that they encountered in the online games and digital storybooks.**
 - Parents were significantly more likely to discuss the topics of addition & subtraction, and greater than & less than with their children during the week of the study than they had beforehand.
 - Parents thought that the Peg + Cat online games were significantly better than the digital storybooks at helping them find new ways to talk about math and engage in math activities with their children.
- **Children were already moderately interested in problem-solving and confident in their problem-solving skills, and maintained their interest and confidence after using the Peg + Cat digital media.**
- **Children appeared to be slightly more interested in math activities and games after using the Peg + Cat digital media.**
 - Almost all children (97%, N=30) indicated that they would play the Peg + Cat digital media again.
 - Parents felt that the Peg + Cat online games were significantly better than the online storybooks at increasing their children's interest in math and motivating them to pursue other math activities.
- **Children who used the Peg + Cat online games and digital storybooks learned more about math than they had known beforehand.**
 - Parents felt that their children had learned significantly more about math from using digital technology during the week of the study compared to the previous week.
 - Parents thought that the Peg + Cat online games were significantly better than the digital storybooks at impacting their children's math understanding.

- However, parents in the Guided Condition tended to find specific digital storybooks (*The Big Dog Problem* and *The Perfect Ten Problem*) to be significantly more effective at helping their children learn math than parents in the Naturalistic Condition did.
- Most children (70%) thought that they had learned at least “a little” about math from the Peg + Cat digital games and storybooks.
 - Children demonstrated some significant knowledge gains around the mathematical concepts of zero and symmetry, but maintained or only slightly increased their level of understanding of other mathematical concepts covered in the Peg + Cat digital media.
- **Children who used the Peg + Cat online games and digital storybooks learned slightly more about social-emotional skills than they had known beforehand.**
 - When presented with an everyday scenario, slightly more children were able to come up with a positive social-emotional behavior as a solution after using the Peg + Cat digital media compared to beforehand (73% versus 64%).
 - Overall, children felt that they had learned the most about solving problems and taking turns from the Peg + Cat digital media.
 - Children thought that the digital storybooks had slightly more social-emotional content than the online games.
 - Specifically, *The Big Dog Problem* and *The Election Problem* were mentioned most often in relation to specific social-emotional skills, like solving problems (BDP), helping others (EP), calming down and persistence (both).
 - *Don't Go Bananas* was mentioned most often in relation to taking turns and asking for help.
- **Most parents felt that the Peg + Cat digital media were successful at addressing social-emotional skills.**
 - Most parents (84%) agreed that the Peg + Cat digital media had been successful at highlighting social-emotional skills.
 - Parents thought that the digital storybooks were slightly better at addressing their children’s social-emotional skills than the online games.
 - Parents in the Guided Condition were significantly more likely to feel that the storybooks impacted their children’s awareness of their own social-emotional behaviors than parents in the Naturalistic Condition.

- Specifically, parents rated *The Big Dog Problem* as the most effective Peg + Cat digital media resource for teaching their children positive social-emotional skills.
- However, the majority of parents (77%) had not observed any changes in their children's social-emotional behavior over the course of the week.
- Parents felt that the digital storybooks were slightly better than the online games at helping them be aware of and talk to their children about positive social-emotional behaviors.

- **Parents liked all of the Peg + Cat digital media resources.**

- Parents thought that the Peg + Cat digital media resources were educational, age-appropriate, and easy for their children to understand.
- Parents appreciated that the Peg + Cat digital media provided opportunities for them to talk about math with their children.
- Parents liked the focus on social-emotional learning, but felt that the messaging in the online games and digital storybooks was too subtle and could be called out more explicitly for families.
- In general, parents thought that the online games had been significantly more enjoyable for their children than the digital storybooks.
 - Parents in the Naturalistic Condition felt that their children had enjoyed the online games significantly more than parents in the Guided Condition did.
 - Parents in the Guided Condition felt that their children had enjoyed the digital storybooks significantly more than parents in the Naturalistic Condition did.
 - Specifically, parents rated *Symmetry Painter* as the most enjoyable Peg + Cat digital media resource for their children, whereas *Music Maker* was rated as the least enjoyable.

- **Children tended to like the Peg + Cat online games more than the digital storybooks.**

- Children's ratings of how much they liked specific Peg + Cat digital media mirrored parents' perceptions of their children's favorite and least favorite online games and digital storybooks.
 - Specifically, children rated *Symmetry Painter* as the most enjoyable Peg + Cat digital media resource, whereas *Music Maker* was rated as the least enjoyable.

- Children liked the character of Peg best, followed by Cat.

Taken together, these findings suggest that exposure to rich digital media supported parents' engagement with their children around technology in general, and math-related media specifically. Furthermore, the six online games and digital storybooks helped parents talk with their children about novel math concepts, and afforded additional opportunities to discuss positive social-emotional behaviors in the context of problem-solving.

Parents indicated that each type of digital media resource had a different role to play in supporting their children's learning. The online games were more effective at scaffolding their children's mathematics' learning, interest and engagement, while the digital storybooks were more effective in supporting their children's social-emotional skill development. Interestingly, children were able to demonstrate increased understanding of mathematical concepts and identify social-emotional skills that were present in both types of digital media resources.



Finally, this study supports the idea that making parents more aware of social-emotional learning opportunities within math-related digital media can change how they think about and approach these resources with their children. Families who participated in this study indicated that making the objectives of the online games and digital storybooks even more explicit would help them better support their preschool children's social-emotional development during math activities. Thus, digital media designers are encouraged to more clearly state how these skills are embedded within the math resources that they create.


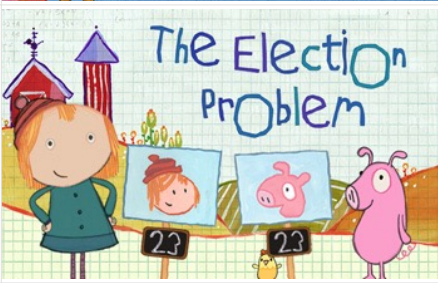
Project Description

Peg + Cat is a popular broadcast television series, developed by The Fred Rogers Company and airing on PBS, in which a girl named Peg and her sidekick, Cat, solve everyday problems using mathematics, creativity, persistence, and humor. *Peg + Cat: Developing Preschoolers' Early Math Skills* was a three-year project, funded by the National Science Foundation, that utilized *Peg + Cat's* media and philosophical approach to ultimately impact children's interest and engagement with mathematics, as well as their development of positive social-emotional skills to support early math learning. The project aimed to do so via several activities: 1) the creation of additional broadcast television episodes of *Peg + Cat*, 2) the development of three online games and three digital storybooks hosted on the PBS Kids website, 3) the design of a *Peg + Cat*-themed summer camp for a local science center, and 4) the implementation of a professional development experience for early childhood educators. This evaluation report focuses on the second activity - the use and impact of the six *Peg + Cat* digital media elements.

Three online games and three digital storybooks were developed as part of the *Peg + Cat: Developing Preschoolers' Early Math Skills* project (see Table 1). These digital materials were designed to highlight positive and helpful interactions among *Peg + Cat* characters, and to be available for use in classrooms and informal settings. The six online games and digital storybooks also addressed specific social-emotional skills, such as self-regulation, an effort-based mindset, perseverance, help-seeking, and mentoring. For reference, the six digital media are available on the PBS KIDS website (<https://pbskids.org/peg/games>).

Table 1. Description of *Peg + Cat* Digital Media

Digital Media	Description
	<p>Players can draw freely, or place stickers with characters, numbers, or musical notes on a blank canvas. Whatever players draw on one side of the screen is mirrored on the other side, depending on whether they have turned on the following options: Horizontal symmetry, vertical symmetry, or both.</p>
	<p>Players can select one of three scenes that contain bars of various heights. Players can adjust the height of the bars to change the pitch of the music being played. They can also adjust the tempo, and make Cat run quickly or slowly across the screen.</p>

Digital Media	Description
	<p>Players take turns with Peg, and spin a spinner to determine how many monkeys they need to find in the circus scene. Players try to collect ten monkeys, and can count how many they have and how many more they need. If they land on “bananas,” they lose their monkeys, and must start again.</p>
	<p>Peg and Cat need to mail several letters at a mailbox, but are initially scared to do so because Big Dog is in their path. They find out that Big Dog is friendly, and he helps them when they are not tall enough to reach the top of the mailbox. By working together, the group successfully mails the letters.</p>
	<p>Ramone hosts a talent competition with Peg, Cat, and Parrot as judges. The group takes turns rating the various acts, but must always end up with a total of 10 points for each contestant. When Parrot rates Pig’s act a 10, Cat helps Peg realize that she can rate it a zero in order to have Pig receive 10 total points.</p>
	<p>The Farmer holds an election to see who will watch over his farm in his absence. Peg runs against the Pig to win the most votes from one hundred chickens. Math concepts include large numbers, and greater than and less than. Peg sings a song about what she knows about math to ultimately win the election.</p>

Evaluation Methodology

Rockman et al, an independent educational research and evaluation company, conducted the summative evaluation of the six Peg + Cat digital media resources. The evaluation focused on two audiences: early childhood educators and families with preschool-aged children. This report describes results from the preschool family study.

The family study took place in Bloomington, Indiana over a one-week period. Thirty-one parents with a 4 to 5 year-old child were recruited to participate. All parents in the study were mothers of the participating children. Parent-child pairs were randomly assigned to one of two conditions: Naturalistic or Guided. Of the 31 families who participated in the Peg + Cat

digital media study, 15 were in the Guided Condition¹ and 16 were in the Naturalistic Condition. The age and gender of participating children were fairly evenly split, with slightly more boys in the Guided Condition than in the Naturalistic Condition (see Figures 1 & 2).

Figure 1. Participating Children's Gender By Study Condition

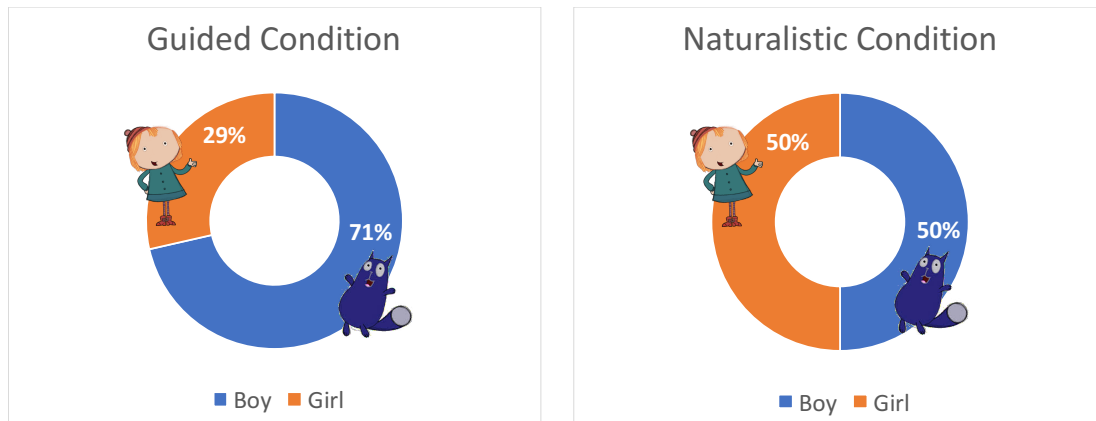
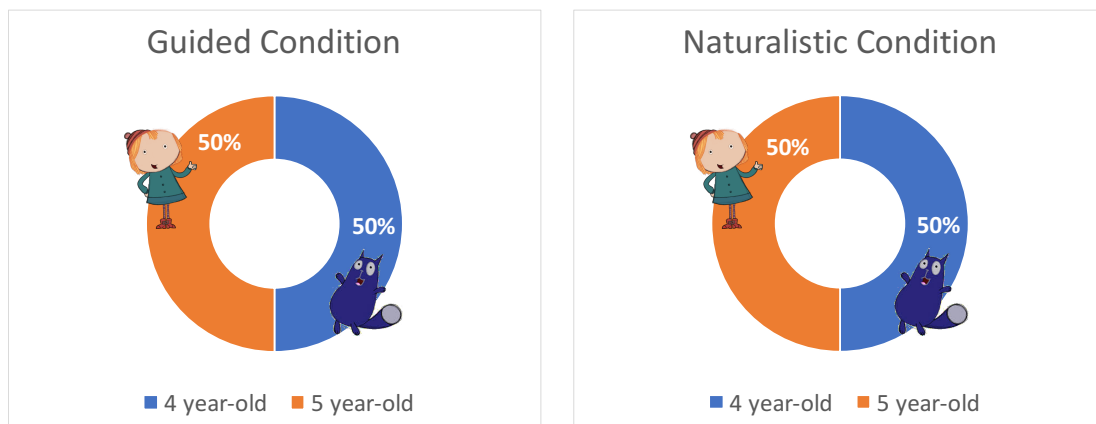


Figure 2. Participating Children's Age By Study Condition



Parents in both conditions completed a pre-interview, asking them about the kinds of mathematics activities and topics their children engaged in with and without technology. They also filled out a pre-survey, asking them to reflect back on the past week and the frequency with which their child used various technologies, utilized math-related broadcast or digital media, or encountered Peg + Cat media. Parents were also asked how they had

¹ Note: One child in the Guided Condition did not complete the post-interview, so her data was removed from subsequent analysis. However, her mother's survey and interview responses were still included.

engaged with their children around technology and the math topics they had discussed with their children the previous week. Finally, parents were asked to report the extent to which their children had engaged in various social-emotional behaviors, or learned something about math, problem-solving, or social-emotional skills in the prior week.

Children in both conditions were asked to participate in a pre-interview during which they indicated their previous familiarity with Peg + Cat and math, talked about how they would respond to various social-emotional scenarios, and demonstrated their current understanding of various mathematical concepts that they would later encounter in the Peg + Cat digital media.

Parents in both conditions were asked to use the three online games and three digital storybooks together with their children the first time that their children experienced the digital media - helping them play the game, talking about the stories, or providing assistance. Their children could then explore the materials by themselves, with their parents, or with others over the course of the week, using the materials as much or as little as they wanted. Parents in the Guided Condition were also informed that one of the goals of the Peg + Cat digital media was to highlight positive social-emotional behaviors, and that these skills were embedded in the six activities. These parents were asked to draw their children's attention to the following skills that they might encounter while interacting together around the online games and digital storybooks: calming down when upset, asking for help, perseverance/persistence, sharing, helping others/working together, taking turns, and breaking down difficult problems into manageable pieces.

Parents in both conditions were asked to fill out a journal over the course of the week to track which Peg + Cat digital media their children engaged with, how long they played, who they played with, where they played, what they talked about, and if they had engaged in any other math-related activities during the week. At the end of the week, parents were asked to rate how enjoyable they thought each of the games and storybooks had been for their children, and how much they thought their children had learned about math from the individual digital media.

When families returned at the end of the week, parents in both conditions filled out a post-survey with questions similar to the pre-survey, as well as specific questions about the influence of the online games and digital storybooks on their children's interest, understanding, and engagement with math. The survey also contained questions about their own awareness, engagement and conversations around math and social-emotional behaviors with their children. They were also asked to rate how much they thought their children had learned about social-emotional skills from the individual digital media. In addition, parents completed a post-interview, answering questions about their children's social-emotional behaviors during the week, their own and their children's favorite and least favorite Peg + Cat digital media, their children's interest in the online games and storybooks, whether they felt

that the digital media was effective at addressing social-emotional skills and math content, and how the online games and digital storybooks compared to other math-related online content.

Children in both conditions participated in a post-interview with questions similar to the pre-interview. Additional post-questions included children’s most and least favorite game or storybook, their favorite Peg + Cat character, what they liked and disliked about each game or storybook, and what math concepts and social-emotional skills they learned from the Peg + Cat digital media.

Findings

Families’ Use of the Peg + Cat Online Games & Digital Storybooks

Although families had access to a range of technologies at home, they tended to use the Peg + Cat digital media on tablet computers or laptops.

All participating families had internet access at home. Families in the study tended to have access to smartphones, iPads or tablets, laptops, and televisions (see Table 2). Less than half of the participating families owned a desktop computer. There were no significant differences by study condition.

Table 2. Technologies Present in Participating Families’ Homes

Type of Technology*	Percentage of Parents Who Reported Owning
Smartphones	100%
Television	97%
iPads or tablets	94%
Laptops	84%
DVD players	71%
Gaming systems	68%
Desktop computers	48%
Digital devices for kids (Leapfrog, etc.)	26%

* Some parents listed more than one type of technology.

Most families played the Peg + Cat digital media on iPads or tablet computers (see Table 3). One parent noted that the online games and digital storybooks were difficult to use on a smartphone, and that tablet computers made it easier for multiple children to see and share the experience.

Table 3. Technologies Families Used to Play Peg + Cat Online Games & Digital Storybooks

Type of Technology*	Percentage of Families Who Used
iPads or tablets	90%
Smartphones	19%
Laptops	10%
Desktop computers	10%

* Some parents listed more than one type of technology that their children used.

Children tended to use the Peg + Cat digital media at home with their parents or by themselves.

Children mostly used the Peg + Cat digital media at home, although six parents reported that their children also used the online games and digital storybooks in other locations, such as in the car, at a family member’s house, at the parent’s workplace, or during a sporting event. Children tended to play the six Peg + Cat online games and digital storybooks most often with their parents or by themselves (see Table 4).

Table 4. Who Children Played Peg + Cat Online Games & Digital Storybooks With

Who Children Played With*	Percentage of Children
Parents	94%
Self (Alone)	84%
Siblings	42%
Friends	13%
Babysitter	6%
Other Adult Family Members	3%

* Some parents listed more than one person.

On average, children spent a little more than two hours total playing the six Peg + Cat online games and digital storybooks during the week of the study.

Most children (27 out of 31) explored all six Peg + Cat digital media. Slightly more families in the Naturalistic Condition (15 out of 16) were able to do so compared to the Guided Condition (12 out of 15). Children skipped *The Election Problem* most often (4 children), followed by *Music Maker* (3), *The Big Dog Problem* (1), *The Perfect Ten Problem* (1), *Symmetry Painter* (1), and *Don't Go Bananas* (1). Parents reported that their children did not play specific games and storybooks due to technical issues they encountered (i.e., media wouldn't load, or a lack of sound).

On average, parents (N=30) reported that their children played the Peg + Cat online games and digital storybooks for 127 minutes total (range = 43-255 minutes). They tended to spend the most time on *Symmetry Painter* and *Don't Go Bananas* (see Table 5).

For the most part, children played the online games and digital storybooks the same amount of time over the course of the week, regardless of study condition. The exception was *Symmetry Painter*, where children in the Naturalistic Condition played the game almost twice as much, on average, as children in the Guided Condition (44 minutes and 24 minutes, respectively).

Table 5. Total Time Children Spent Using Peg + Cat Digital Media

Digital Media	Range of Total Time Spent (in minutes)	Average Total Time Spent (in minutes)
Symmetry Painter	0-140	34.83
Don't Go Bananas	7-80	31.77
Music Maker	0-40	16.87
The Perfect Ten Problem	0-35	15.10
The Big Dog Problem	0-33	14.67
The Election Problem	2-40	13.90

Changes in Parents' Media Use With Their Children

Parents engaged more frequently with their children around technology overall after using the Peg + Cat digital games and storybooks.

Parents were asked to report how they had used technology with their children during the week on both the pre-survey (the week before the study began) and the post-survey (the week of the study). It is important to note that parents were reporting their overall technology use, not just their use of math-related or Peg + Cat-specific media. For the most part, parents appeared to engage more with their children around media during the study than they had beforehand. Over half of participating parents did not play any digital games with their children in the week before the study, but all families did so as part of the study design (see Figure 3). One parent shared that the study was a good “reminder to me that he can get more out of technology when I sit with him.” During their engagement around digital media, parents helped their children fix technology issues, asked and answered questions about the games they were playing, and made connections between digital media and their children’s daily lives significantly more often during the week of the study than they had done the previous week (see Figure 4).

Figure 3. Frequency of Parents' Media Use With Their Children

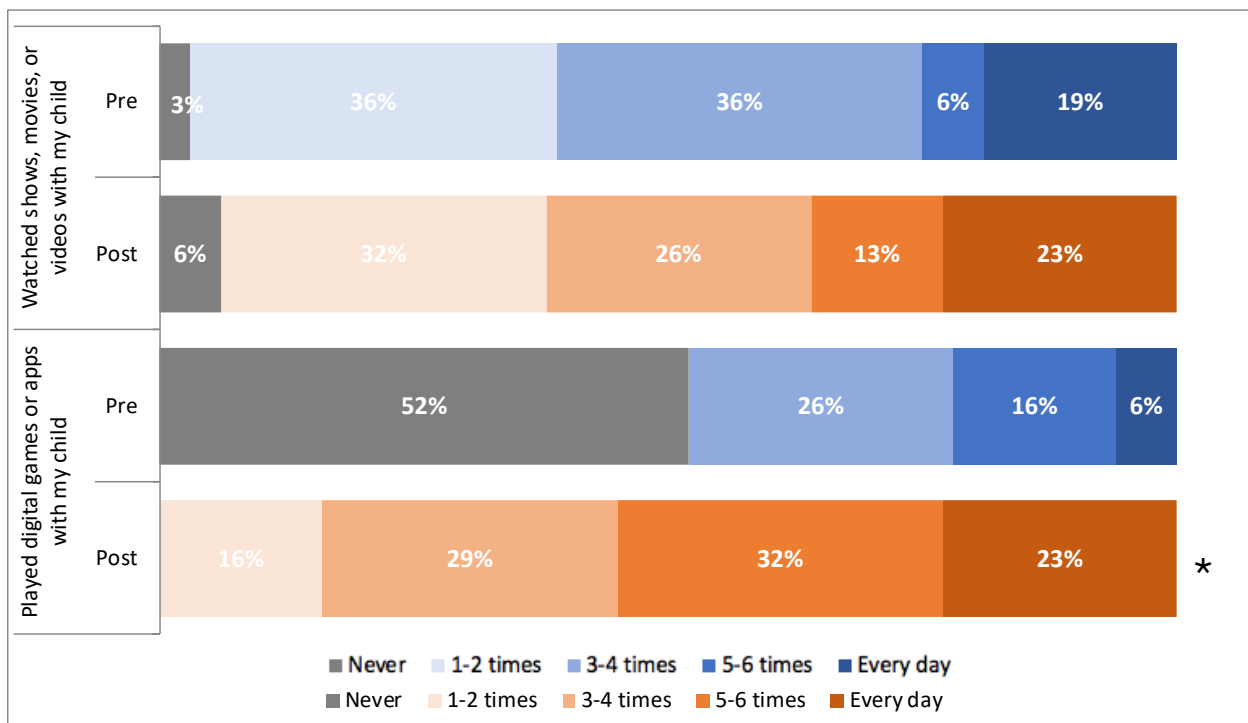
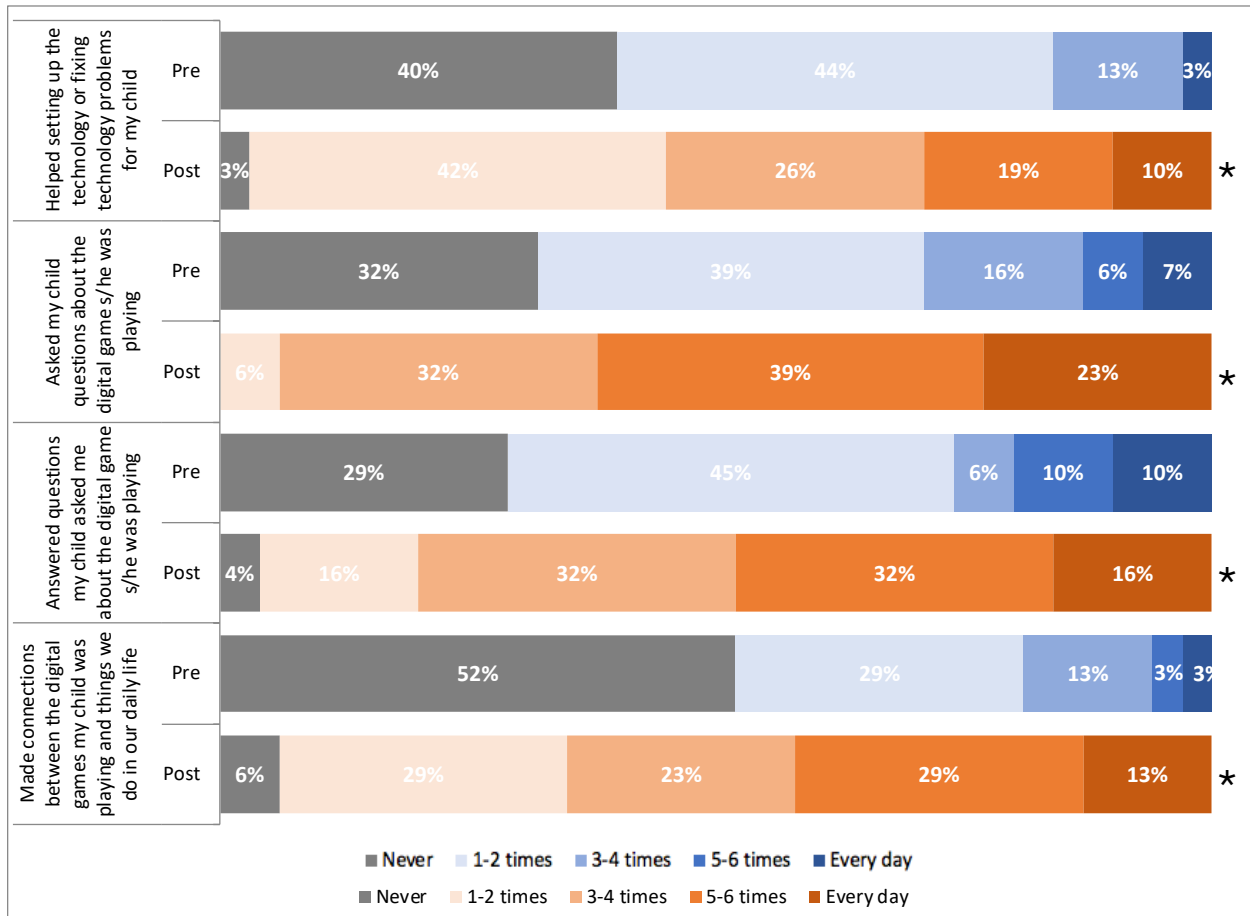


Figure 4. Frequency of Parents' Digital Media Engagement With Their Children



* Indicates a significant difference at the $p < .05$ level

Parents in the Guided Condition increased their engagement with their children around digital media more than parents in the Naturalistic Condition.

To explore possible differences by study condition, parents' change scores were calculated (i.e., the frequency of reported use the week before the study subtracted from the frequency with which parents used various technology with their children during the week of the study). There were no differences in the amount of time parents spent using media with their children by condition. However, parents in the Guided Condition did increase the frequency with which they asked their children questions about the digital media they engaged with together, and increased the number of connections they made between that digital media and their children's daily lives significantly more than parents in the Naturalistic Condition (see Figure 5).

Taken together, these findings suggest that parents engaged more deeply with their children around digital media than they had beforehand. Furthermore, those who were prompted to

look for connections between the Peg + Cat digital games and storybooks and social-emotional behaviors did so more often, suggesting that explicitly calling out these features can enhance parents' engagement with their children around technology, in general.

Figure 5. Differences in Parents' Media Engagement Change Scores by Study Condition



* Indicates a significant difference at the $p < .05$ level

** On a scale from 0 to 4, with 0 = "Never," and 4 = "Every day."

Children who used the Peg + Cat digital games and storybooks engaged more frequently with math-related media than they had beforehand, according to their parents. They also interacted with their parents around math-related media more often.

Parents were asked to report how their children had used technology to explore math content during the week of the study, as well as the week prior. Parents reported that their children engaged more with math-related media overall during the week of the study, and that they did so with a parent present more often than they previously had (see Figures 6 & 7). Most parents reported that their children played math-related educational games with and without

them during the week of the study more often compared to the previous week. This is not surprising, given that families were asked to use math-related digital media as part of the study design. However, families were not told how often to use the digital media (and could have been using non-Peg + Cat online games or websites as well), so children and their parents were still choosing to utilize math-related digital media more frequently than they had in the past. One parent stated that the games made him more aware of “specific things to work on with my child.”

Interestingly, over half of participating parents reported that their children did not watch educational television programs or videos about math with or without their parents before the study, but indicated that they had done so significantly more frequently during the week of the study. This finding seems important, given that watching math-related content on television or online was not something that families were asked to do as part of the study design. Thus, participating families seemed more motivated to explore math-related broadcast media than they had previously been. There were no significant changes in children’s use of math-related media by study condition.

Figure 6. Frequency of Children’s Math-Related Broadcast Media Use, According to Their Parents

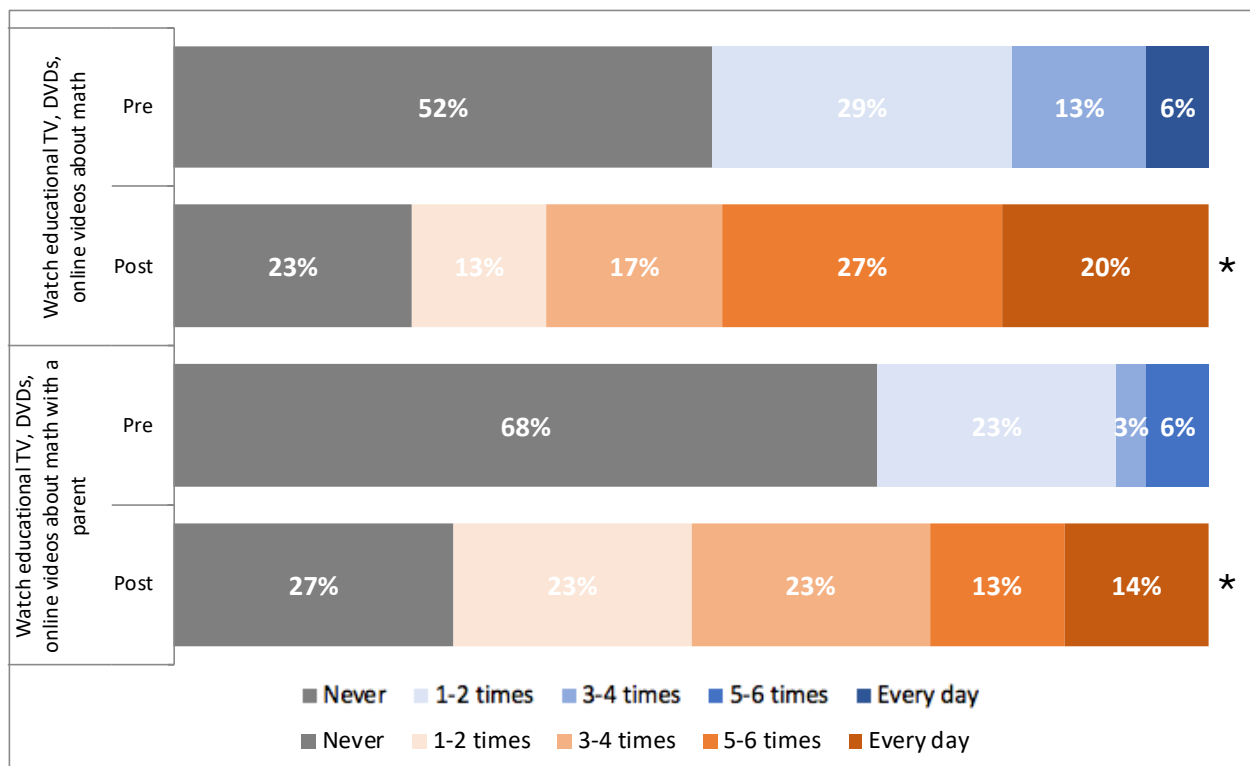
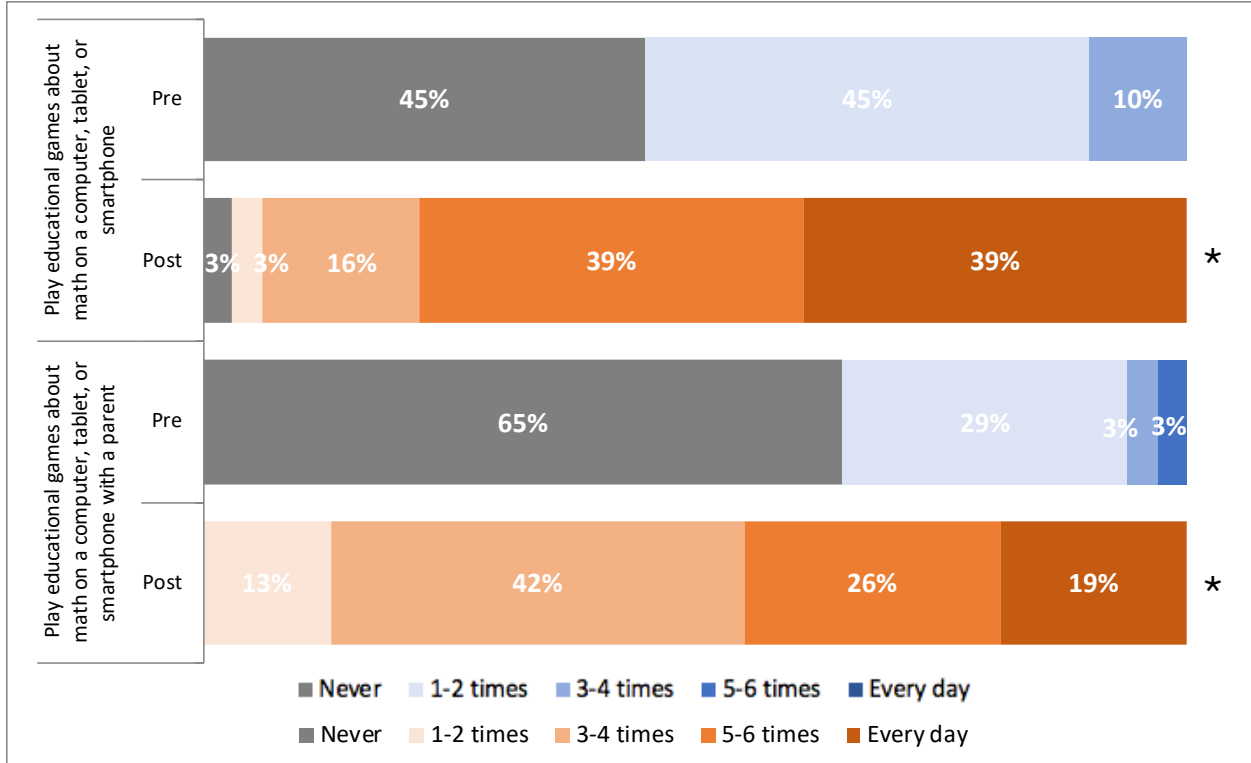


Figure 7. Frequency of Children’s Math-Related Digital Media Use, According to Their Parents



* Indicates a significant difference at the $p < .05$ level

Children who used the Peg + Cat digital games and storybooks engaged more frequently with Peg + Cat media than they had beforehand, according to their parents. They also interacted with their parents around Peg+Cat-related media more often.

Parents were asked to report how frequently their children had watched clips or episodes of Peg + Cat and used Peg + Cat digital media, during the week of the study, as well as during the previous week. Parents reported that their children engaged more with Peg + Cat media overall during the week of the study, and that they did so with a parent present more often than they previously had (see Figures 8 & 9). Most parents reported that their children played Peg + Cat digital media with and without them significantly more during the week of the study compared to the previous week. Again, this is not surprising, given that families were asked to do so as part of the study. What is surprising is that during their post-interviews, most parents (74%, N=31) indicated that their children proactively asked to play the six online games and digital storybooks during the week of the study, rather than them having to cajole their children into playing:

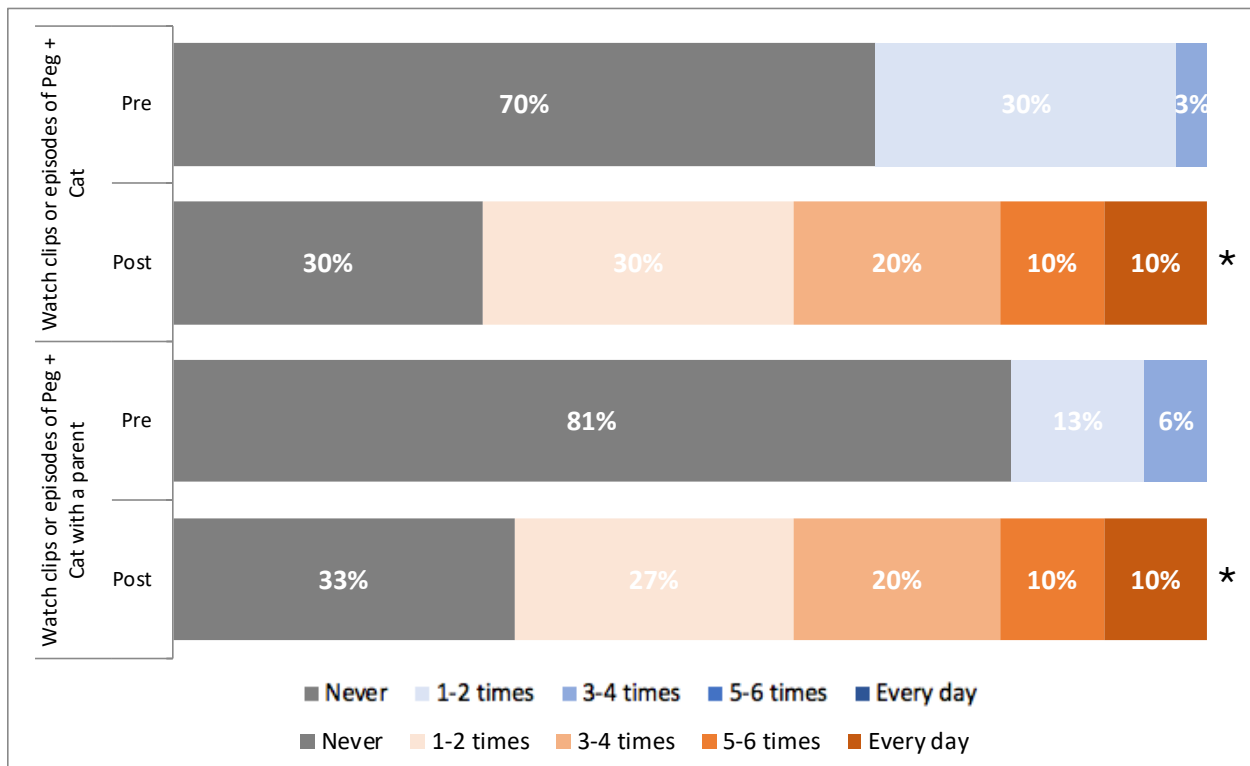
“He wanted to play beyond his allowed time.”

“He wanted to do *Symmetry Painter*. He would remind me, ‘I need to play my games.’”

Children who had to be reminded to focus on the six Peg + Cat digital media either were more interested in exploring additional Peg + Cat games or other digital media on the PBS KIDS website. During their post-interviews, all parents thought that their children would play the Peg + Cat digital media in the future: “When kids are familiar and confident, it is something he can play on his own. It meets my requirements of a learning game.”

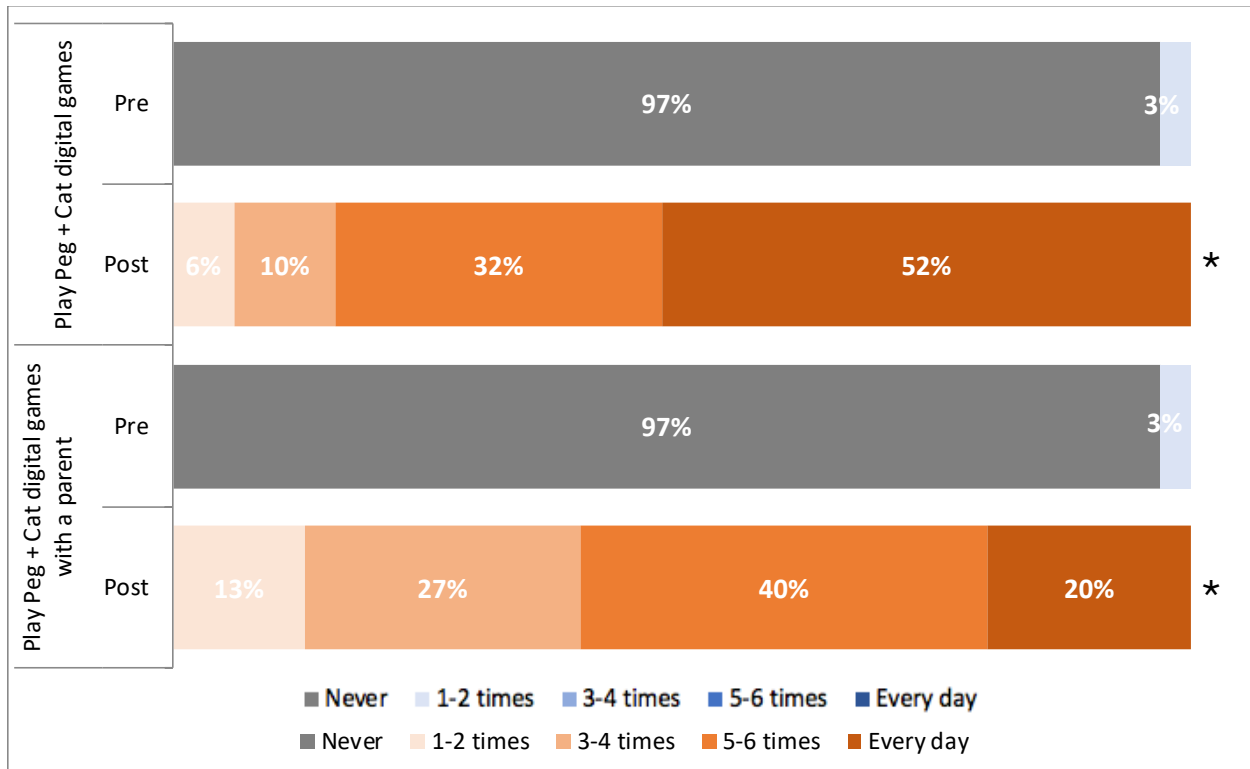
Furthermore, the majority of parents reported that they or their children had not watched an episode or clip of Peg + Cat during the week before the study, but they did so significantly more often during the week of the study. Since watching the show was not part of the study instructions, it seems that families who were exposed to the Peg + Cat digital games and storybooks became more motivated to seek out other ways to interact with the content and characters.

Figure 8. Frequency of Children’s Peg + Cat Broadcast Media Use, According to Their Parents



* Indicates a significant difference at the $p < .05$ level.

Figure 9. Frequency of Children’s Peg + Cat Digital Media Use, According to Their Parents

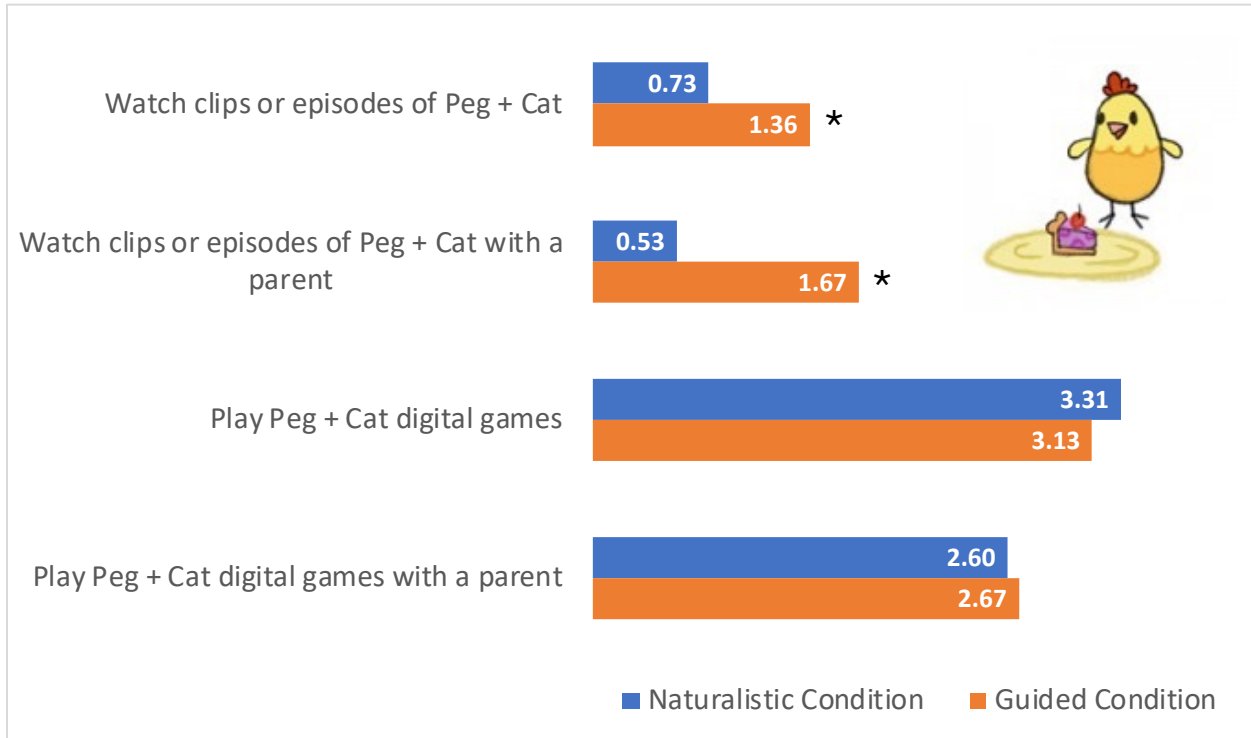


* Indicates a significant difference at the $p < .05$ level

Parents in the Guided Condition increased their engagement with their children around Peg + Cat broadcast media more than parents in the Naturalistic Condition.

To explore possible differences by study condition, parents’ change scores were calculated (i.e., the frequency of reported use the week before the study subtracted from the frequency with which their children used Peg + Cat media during the week of the study). Parents in the Guided Condition significantly increased the frequency with which they watched Peg + Cat clips or episodes with their children compared to parents in the Naturalistic Condition (see Figure 10). This finding is interesting given that there were no significant differences in the reported amount that parents played Peg + Cat digital games by condition. Therefore, parents in the Guided Condition appeared more motivated to seek out additional opportunities to engage with their children around Peg + Cat than those who were asked to play the games and digital storybooks as they normally would.

Figure 10. Differences in Parents' Peg + Cat Media Engagement Change Scores by Study Condition



* Indicates a significant difference at the $p < .05$ level

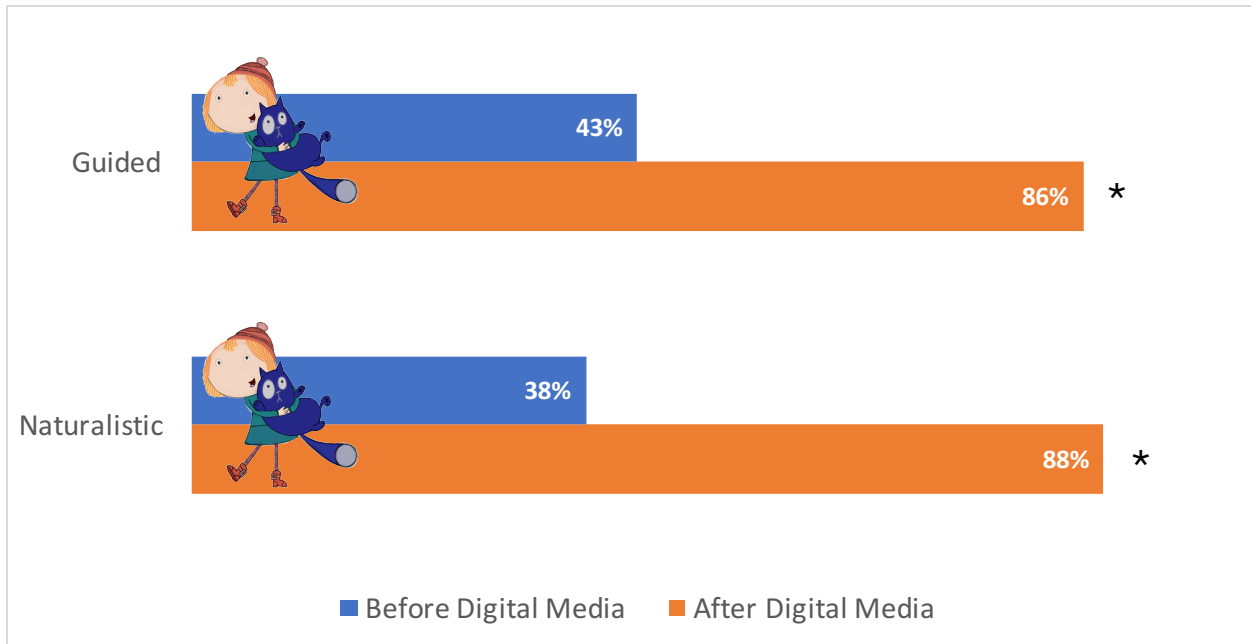
** On a scale from 0 to 4, with 0 = "Never," and 4 = "Every day."

Changes in Children's Familiarity With Peg + Cat Characters

Children who played the Peg + Cat online games and digital storybooks became significantly more familiar with the featured characters than they had been beforehand.

Children participating in the study were shown pictures of Peg, Cat, and Ramone both before they encountered the digital media and one week later. They were asked whether they knew the names of the characters pictured and what those characters do. In both conditions, less than half of the children knew who Peg and Cat were at the start of the study (see Figure 11).

Figure 11. Children’s Familiarity with Peg and Cat by Study Condition



* Indicates a significant difference at the $p < .05$ level

Even children who recognized Peg and Cat beforehand had difficulty articulating the characters’ roles, with most saying that they had seen them on television (see Table 6). After the study, the majority of children in both conditions could name the two characters. Furthermore, after using the digital media, children in both conditions were more likely to state that Peg and Cat solve problems, and to reference viewing them as being in the online games and digital storybooks (see Table 7).

Table 6. Children’s Awareness of Peg and Cat’s Roles BEFORE Digital Media Exposure*

Guided (N=7)	Naturalistic (N=10)
<ul style="list-style-type: none"> • On television (2) • Save/Help someone (1) • Sing/Dance (1) • Explore (1) • Did not answer (1) 	<ul style="list-style-type: none"> • On television (6) • Solve problems (3) • Game/Storybook activity (1) • Play/Have fun (1) • Pick apples (1) • Did not answer (1)

* Note: Some children listed more than one role/activity.

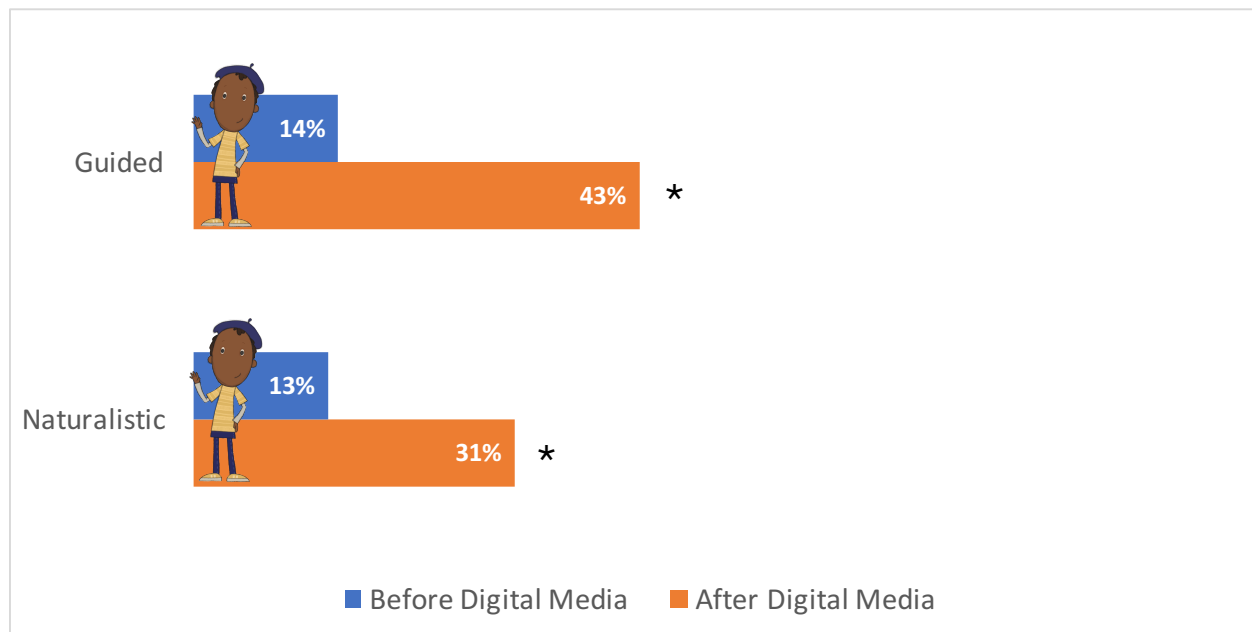
Table 7. Children’s Awareness of Peg and Cat’s Roles AFTER Digital Media Exposure*

Guided (N=12)	Naturalistic (N=14)
<ul style="list-style-type: none"> • Solve problems (5) • Game/Storybook activity (4) • Do things (2) • Make things (1) • Did not answer (2) 	<ul style="list-style-type: none"> • Solve problems (5) • Game/Storybook activity (4) • On television (3) • Play/Have fun (3) • Save/Help someone (2) • Do things (1) • Did not answer (2)

* Note: Some children listed more than one role/activity.

Children in both conditions were less familiar with the character of Ramone (see Figure 12). Very few children could identify Ramone by name at the beginning of the study. Of those who recognized him beforehand, most recalled seeing Ramone on television (see Table 8).

Figure 12. Children’s Familiarity with Ramone by Study Condition



* Indicates a significant difference at the $p < .05$ level

Table 8. Children’s Awareness of Ramone’s Role BEFORE Digital Media Exposure*

Guided (N=2)	Naturalistic (N=6)
<ul style="list-style-type: none"> • On television (1) • Paints (1) 	<ul style="list-style-type: none"> • On television (3) • Paints (1) • Solves problems (1) • Game/Storybook activity (1) • Writes (1) • Did not answer (1)

* Note: Some children listed more than one role/activity.

After exposure to the digital media, children became more familiar with the character, with those in the Guided Condition demonstrating slightly higher awareness. However, less than half of the children in both conditions could identify Ramone by name at the end of the study. Furthermore, after using the digital media, children in both conditions were more likely to state that Ramone helps others and to reference viewing him in the online games and digital storybooks (see Table 9).

Table 9. Children’s Awareness of Ramone’s Role AFTER Digital Media Exposure*

Guided (N=8)	Naturalistic (N=11)
<ul style="list-style-type: none"> • Helps (5) • Game/Storybook activity (4) • Do things (2) • Did not answer (1) 	<ul style="list-style-type: none"> • Helps (5) • Game/Storybook activity (4) • Solves problems (2) • On television (2) • Dresses up (1) • Talks to Peg and Cat (1) • Counts (1) • Mayor of Moohaven (1)

* Note: Some children listed more than one role/activity.

Taken together, these results suggest that the online games and digital storybooks increased children's familiarity with the characters from Peg + Cat, and clued them into the characters' roles. In particular, children were able to recognize solving problems and helping others as roles that characters within the world of Peg + Cat play.

Changes in Parents' Math Engagement With Their Children

Parents already infused math into everyday activities with their children before the study began. However, they were more likely to do so around the topics of addition/subtraction and greater than/less than during the week of the study.

Parents reported engaging in a range of activities together that involved math, such as baking, playing board games, singing songs, and building with blocks. Many parents shared everyday opportunities they saw for incorporating math into conversations with their children: "We use real life situations - count mailboxes on the way to town, add up our groceries, turn stuff into math problems. I am a past kindergarten teacher, so I try to integrate learning into everyday." During the week of the study, they continued to engage in these kinds of everyday activities, but also incorporated new concepts that they encountered within the online games and digital storybooks: "We like to play card games like Go Fish and Uno. It's a great way to identify numbers, compare, and add/subtract. We measured ingredients for a recipe, and played Magnatiles and Legos. We created story problems. We tried to find things in real life that were symmetric, since that was a new concept for him."

Specifically, parents were asked to indicate whether they had or had not helped their children learn a range of math skills in the week before the study began compared to the week of the study (see Table 10). Overall, parents felt that they helped their children with addition/subtraction and numerical comparisons like greater than/less than significantly more during the study period than they had before the study. Surprisingly, parents were less likely to indicate that their children had learned positional words during the week of the study compared to beforehand. Although this result was not statistically significant, it may be reflective of the fact that there was less explicit focus on positional words (e.g., above, below, over, under, etc.) within the design of the Peg + Cat digital media. There were no significant differences between parents in the Guided vs. the Naturalistic study conditions.

Table 10. Math Concepts Parents Thought That They Helped Their Children Learn

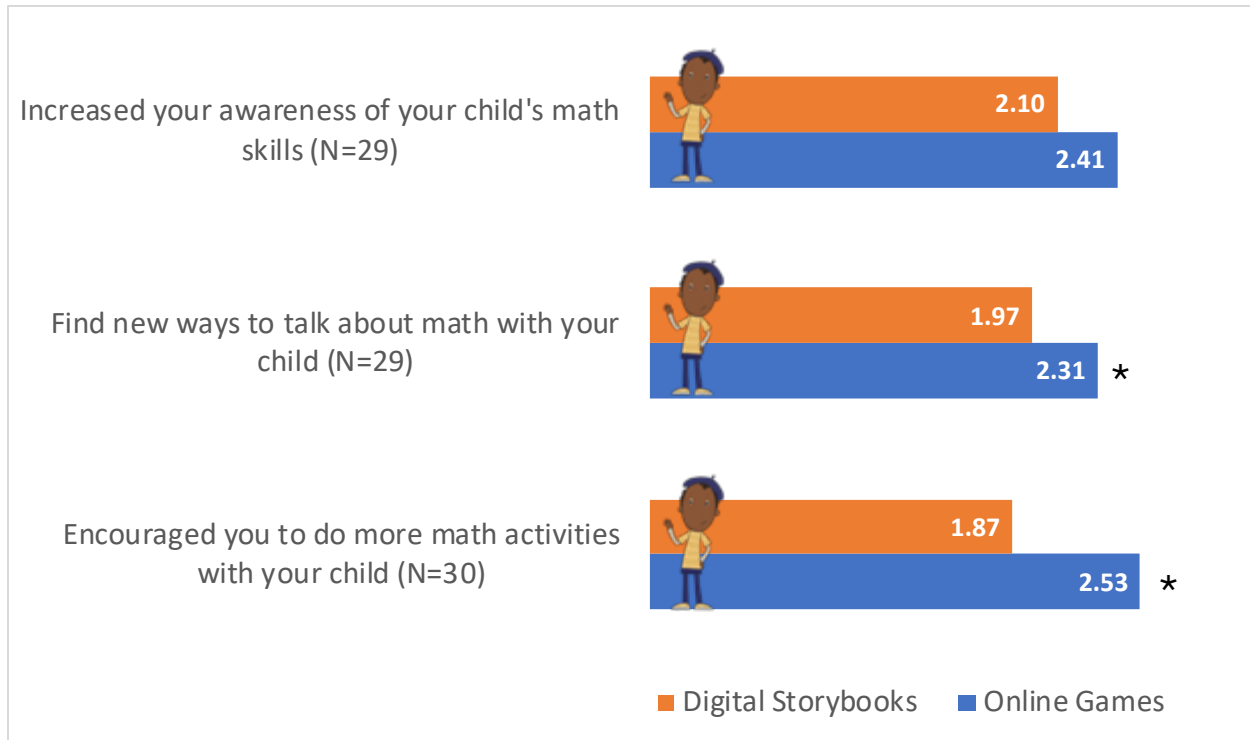
Math Concept	Percentage of Parents Before Digital Media	Percentage of Parents After Digital Media
Counting (n=30)	90%	100%
Ordinal numbers (n=30)	57%	60%
Shapes (n=30)	73%	80%
Patterns (n=30)	60%	67%
Addition/Subtraction (n=30)	57%	80%*
Multiplication/Division (n=28)	7%	4%
Numeric comparisons, > or < (n=29)	28%	69%*
Measurement (n=30)	67%	73%
Positional language (n=29)	83%	66%

* Indicates a significant difference at the $p < .05$ level.

Parents thought that the Peg + Cat online games were better at helping them find new ways to talk about math and engage in math activities with their children.

Parents felt that the Peg + Cat online games had more impact than the digital storybooks on the math activities and conversations they engaged in with their children, but they thought that the two forms of digital media functioned similarly in terms of their ability to make parents aware of their children’s math skills (see Figure 13**). There were no significant differences based on whether parents were in the Guided or Naturalistic study conditions.

Figure 13. Parents' Perceptions of Digital Media's Usefulness for Math Engagement



* Indicates a significant difference at the $p < .05$ level

** On a scale from 0 to 3, with 0 = "Not helpful," and 3 = "Very helpful."

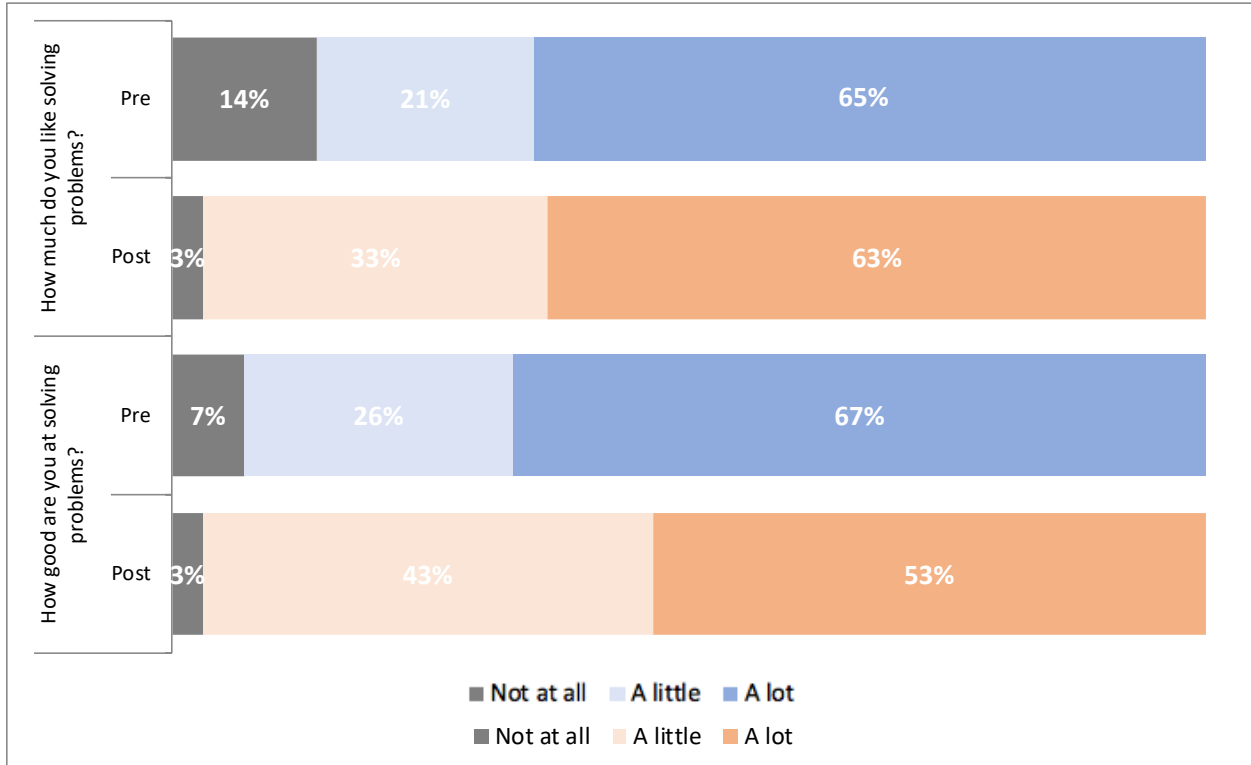
Changes in Children's Math Interest & Engagement

Children were already moderately interested in problem-solving and confident in their problem-solving skills, and maintained their interest and confidence after using the Peg + Cat digital media.

When asked whether they liked or were good at solving problems, children tended to answer affirmatively both before and after using the Peg + Cat digital media (see Figure 14). There were no significant differences by study condition.

Most problems that children provided as examples were social-emotional issues, like getting along with others, arguments with siblings, and sharing. Only five children at the beginning of the study and three children at the end of the study mentioned a math-related example (e.g., "numbers at school."). After using the Peg + Cat digital media, two children in the Guided Condition and one in the Naturalistic Condition shared a related example (e.g., "solve when monkeys are hiding," "solving Peg's problems playing the Peg + Cat games").

Figure 14. Children’s Interest & Confidence Related to Problem-Solving



Children appeared to be slightly more interested in math activities and games after using the Peg + Cat digital media. Parents felt that the Peg + Cat online games made their children more interested and engaged with math than the digital storybooks.

When asked whether they liked doing math activities and games, children tended to answer affirmatively (see Figure 15). Although the result is not statistically significant, children seemed slightly more interested in math activities and games after using the Peg + Cat digital media. Overall, parents reported on the post-survey that the Peg + Cat online games had more impact than the digital storybooks on their children’s math interest and engagement (see Figure 16**). There were no significant differences based on study condition.

Almost all children (97%, N=30) indicated that they would play the Peg + Cat digital media again (“because it is super awesome”). Several noted specific games or storybooks that they would definitely try again; however, they also indicated that they wanted to explore other Peg + Cat games on the PBS KIDS website in the future.

Figure 15. Children's Interest in Math Games & Activities

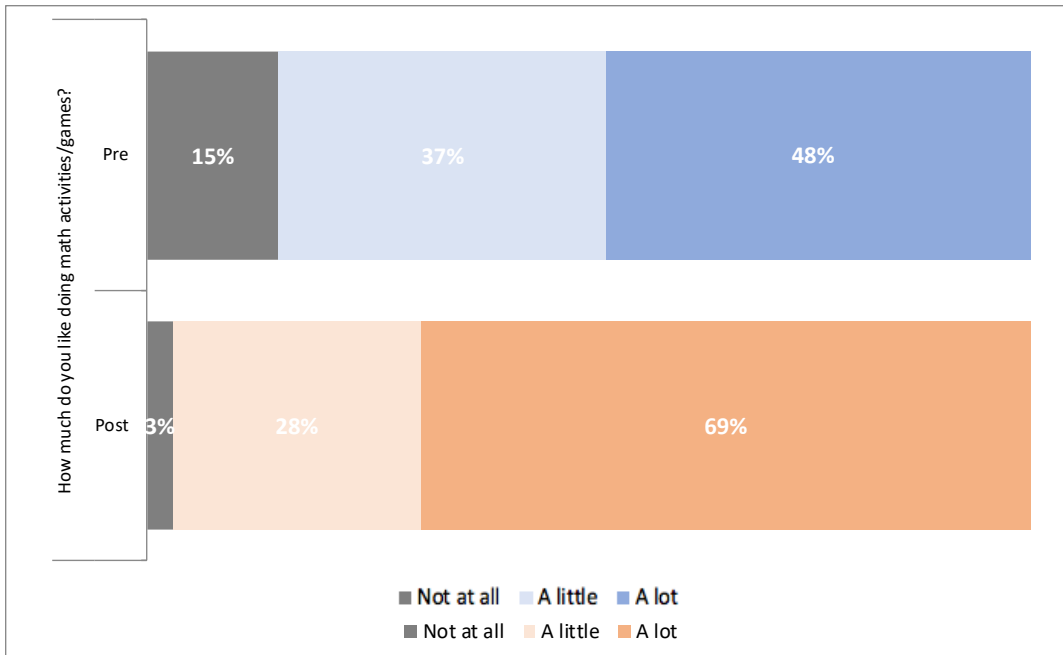
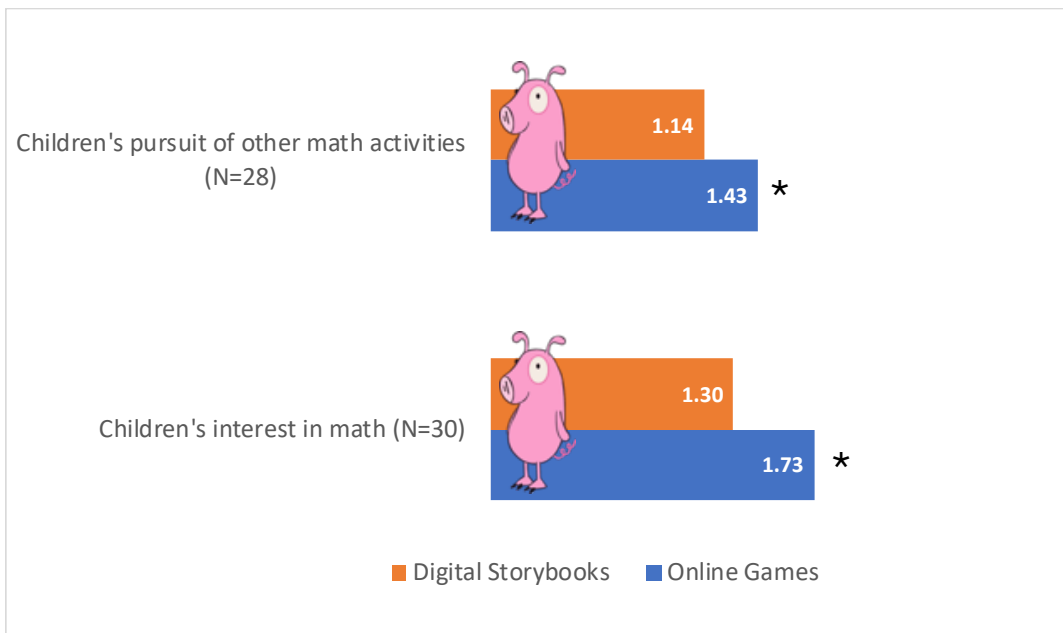


Figure 16. Parents' Perceptions of Digital Media Impacts on Children's Math Interest & Engagement



* Indicates a significant difference at the $p < .05$ level

** On a scale from 0 to 3, with 0 = "No influence," and 3 = "Great influence."

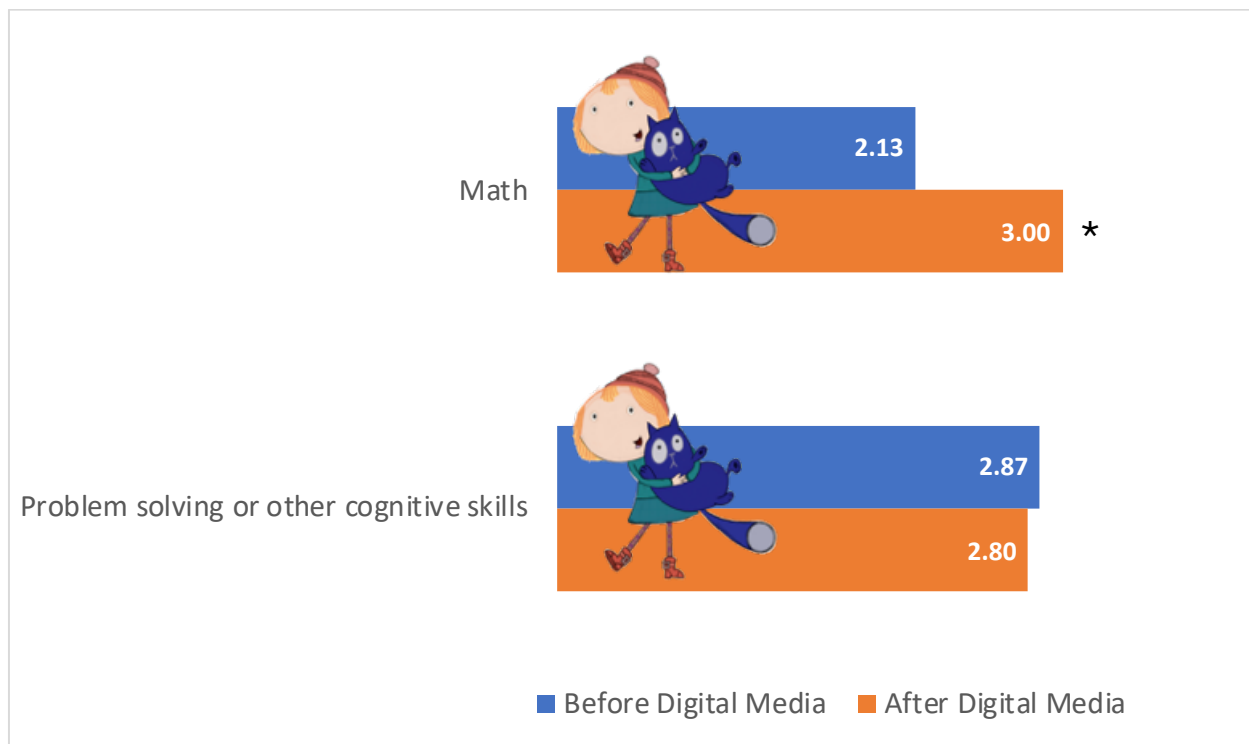
Changes in Children’s Math Understanding

Children who used the Peg + Cat online games and digital storybooks learned more about math than they had known beforehand, according to their parents.

Before the study began, parents thought that their children had learned “only a little” about math from using digital technology the previous week (see Figure 17). However, after the study concluded, parents felt that their children had learned significantly more about math from using digital technology (including Peg + Cat digital games and storybooks) during the week. There were no significant changes perceived by parents in what their children learned about problem-solving or other cognitive skills from digital technology.

In terms of specific math content or skills, parents thought the Peg + Cat digital media resources were good at addressing addition (16 out of 31 parents), counting (15 parents), symmetry (9 parents), and greater than/less than concepts (7 parents). One parent shared, “I’m pleased with how much he learned. When we were in here, he had no idea of the greater than symbol, but now he knows what it means. He also kind of knows what symmetry means.”

Figure 17. Parents’ Perceptions of Children’s Learning From Digital Media



* Indicates a significant difference at the $p < .05$ level

** On a scale from 1 to 4, with 1 = “Nothing,” and 4 = “A lot.”

Most children agreed that they had learned something about math from the Peg + Cat digital media.

The majority of children (70%) thought that they had learned something about math from the Peg + Cat online games and digital storybooks (see Figure 18). There were no significant differences in the amount of math children said that they had learned by study condition. The following are some things that children indicated that they learned about math:

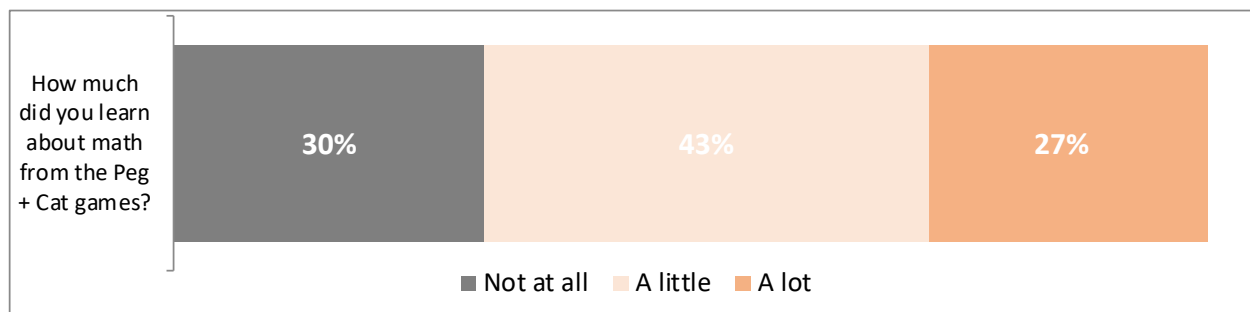
“Things that can be the same or different, or longer or shorter.”

“Splitting something into two groups.”

“Numbers, counting, getting to 10, giving zero more to Pig.”

“Counting, adding and subtracting. $5+5 = 10$.”

Figure 18. Children’s Perceptions of Math Learning From Peg + Cat Digital Media

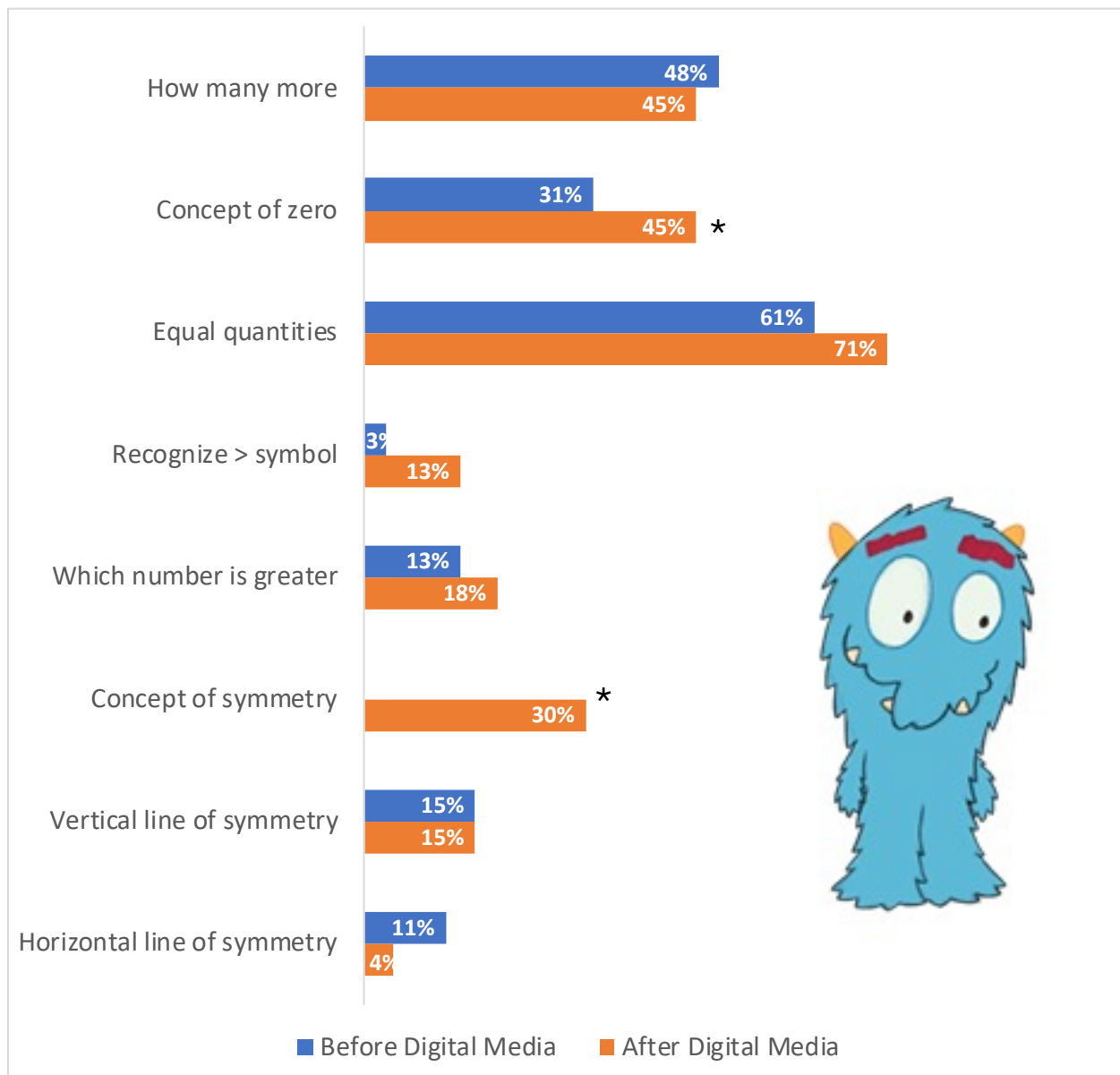


In practice, children did demonstrate some significant knowledge gains around the mathematical concepts of zero and symmetry, but maintained or only slightly increased their level of understanding of other mathematical concepts covered in the Peg + Cat digital media.

During their interviews, children were asked to respond to three different word problems that highlighted math concepts that are present in the Peg + Cat digital media: 1) how many more are needed to reach a total from *Don’t Go Bananas*, 2) the concept of zero from *The Perfect Ten Problem*, and 3) splitting quantities evenly from *The Big Dog Problem*. They also were asked to identify the greater than symbol and to identify which of two numbers was greater (*The Election Problem*) Finally, children were asked to define the term “symmetry” and draw vertical or horizontal lines of symmetry (*Symmetry Painter*).

Children correctly answered questions about the concepts of zero and symmetry significantly more often after exposure to the Peg + Cat digital media. They also slightly increased their understanding of the concepts covered in *The Election Problem* and *The Big Dog Problem*. There were no significant differences in children’s learning of math concepts by study condition. Taken together, these findings suggest that both the online games and the digital storybooks supported increases in children’s understanding of mathematics concepts.

Figure 19. Math Concepts Children Learned From Peg + Cat Digital Media

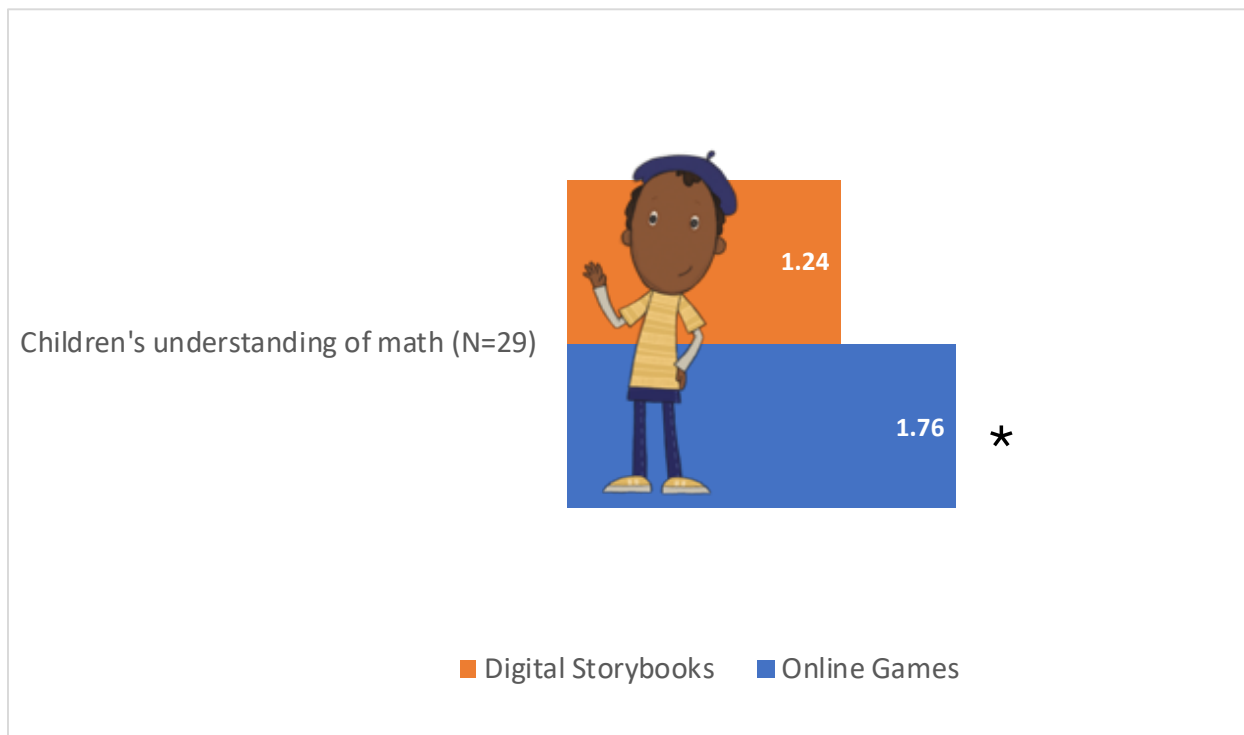


* Indicates a significant difference at the $p < .05$ level

Parents thought that the Peg + Cat online games made their children more knowledgeable about math than the digital storybooks.

Overall, parents felt that the online games had more impact than the digital storybooks on their children’s math understanding (see Figure 20**). There were no significant differences based on whether parents were in the Guided or Naturalistic study conditions.

Figure 20. Parents’ Perceptions of Digital Media Impacts on Children’s Math Understanding



* Indicates a significant difference at the $p < .05$ level

** On a scale from 0 to 3, with 0 = “No influence,” and 3 = “Great influence.”

At the end of the weeklong study, parents were asked to rank each online game and digital storybook based on how effective they thought it was for helping their children learn math (see Table 11). Parents ranked *Don’t Go Bananas* the highest and *Music Maker* the lowest. Similarly, when asked during their post-interviews to indicate which Peg + Cat digital media resources were effective for highlighting math skills, parents mentioned *Don’t Go Bananas* as being the most effective (18 out of 31) and *Music Maker* as being the least effective (16 out of 31).

Table 11. Parents' Ratings of Effectiveness of Peg + Cat Digital Media in Helping Children Learn Math Concepts & Skills

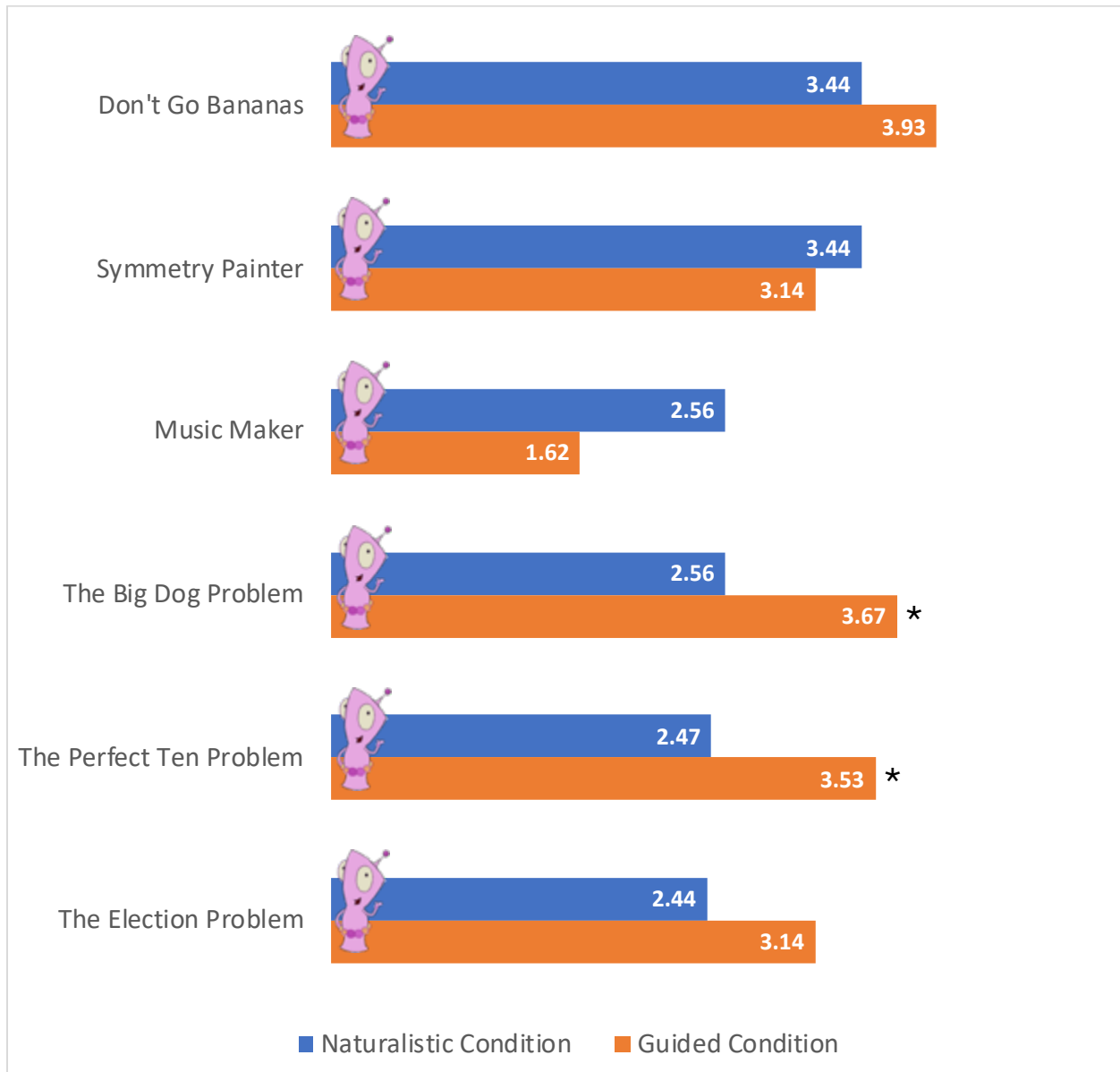
Digital Media	Mean Rating*
Don't Go Bananas (N=31)	3.68
Symmetry Painter (N=30)	3.30
The Big Dog Problem (N=31)	3.10
The Perfect Ten Problem (N=30)	3.00
The Election Problem (N=30)	2.77
Music Maker (N=29)	2.14

* On a scale from 1 to 5, with 1 = "Low" and 5 = "High."

Parents in the Guided Condition tended to rate specific digital storybooks as more effective at helping their children learn math than parents in the Naturalistic Condition did.

Parents in the Guided Condition ranked *The Big Dog Problem* and *The Perfect Ten Problem* as significantly more effective at helping their children learn math than parents in the Naturalistic Condition (see Figure 21).

Figure 21. Parents' Perceptions of Their Children's Math Learning From Peg + Cat Digital Media by Study Condition**



* Indicates a significant difference at the $p < .05$ level

** On a scale from 1 to 5, with 1 = "Low" and 5 = "High."

Changes in Children's Social-Emotional Learning

After experiencing the Peg + Cat digital media, children's approaches to everyday scenarios changed slightly to incorporate more positive social-emotional behaviors.

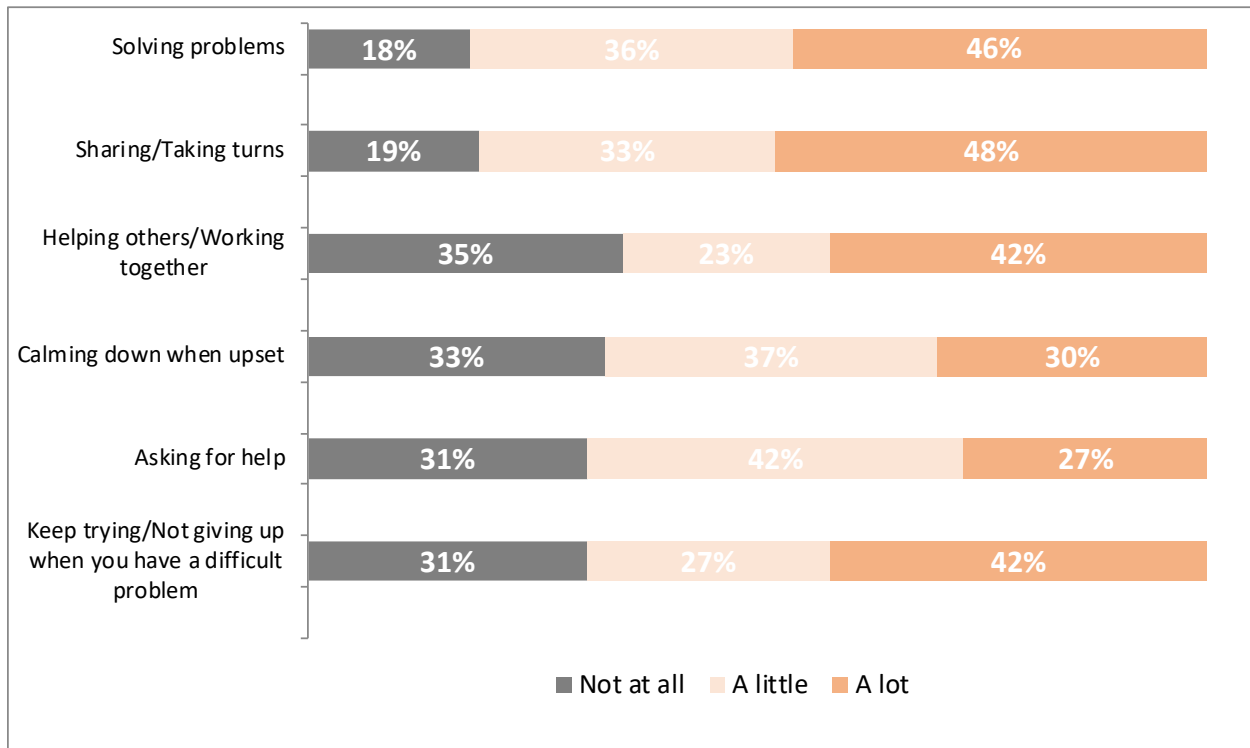
During their interviews, children were asked to indicate what they would do in two different hypothetical situations. The first everyday situation was trying to complete a difficult puzzle that they couldn't figure out. At the beginning of the study, most children indicated that they would ask for help (57%, N=30), or keep trying until they figured the puzzle out (13%), with some children bringing up both solutions. The remaining children (36%) either did not have an answer or provided a non-social-emotional behavior as a solution. After utilizing the Peg + Cat digital media, a slightly larger number of children indicated that they would ask for help (70%) or try to calm themselves down (3%). As before, the remaining children (27%) did not provide a social-emotional behavior as a solution or could not provide an answer to the question.

The second everyday situation that children were asked to reflect on was a time when they were very upset about something, like not being able to find an object. Children were asked how they stopped themselves from being upset. Both before and after using the Peg + Cat digital media, the same percentage of children (57%) provided social-emotional solutions, such as calming down, asking for help, verbalizing one's emotions, and taking a break from the activity.

Overall, children felt that they learned the most about solving problems and taking turns from the Peg + Cat digital media.

During their post-interviews, children were asked to indicate the amount that they felt they had learned from the Peg + Cat digital media about various social-emotional skills. Children reported learning the most about solving problems and taking turns (see Figure 22). There were no statistically significant differences by study condition.

Figure 22. Children’s Perceptions of Social-Emotional Learning From Peg + Cat Digital Media



Children thought that the digital storybooks had slightly more social-emotional content than the online games did.

Children were asked to identify which online game or digital storybook they felt that they had learned specific social-emotional skills from (see Table 12). *The Big Dog Problem*, *The Election Problem*, and *Don’t Go Bananas* were the three Peg + Cat digital media resources that children mentioned most often in relation to specific social-emotional skills.

In *The Election Problem*, children observed that Peg counted backwards from five. Children who played *Don’t Go Bananas* tended to notice that they were taking turns with Peg, and that Ramone provided assistance during the game:

“Peg and me both spun the wheel.”

“*Don't Go Bananas* - Peg and me took turns. Peg's boyfriend, Ramone, came to help her and make it a game.”

Children also noted various social-emotional skills that were covered in *The Big Dog Problem*:

“They take turns sharing the red letter.”

“Helping in *The Big Dog Problem*. Big Dog helped lift Peg and Cat up to reach mail box.”

“[Peg and Cat] tried to figure it out before asking.”

Table 12. Percentage of Children Who Learned Specific Social-Emotional Skills From Peg + Cat Digital Media (N=30)*

Digital Media	Solving Problems	Sharing /Taking Turns	Helping Others	Calming Down	Asking for Help	Keep Trying
The Big Dog Problem	43%	30%	20%	20%	20%	30%
The Election Problem	30%	3%	30%	20%	20%	30%
The Perfect Ten Problem	27%	10%	20%	3%	10%	10%
Don't Go Bananas	33%	33%	27%	13%	27%	10%
Symmetry Painter	10%	10%	13%	10%	0%	13%
Music Maker	7%	3%	10%	7%	7%	13%
None	10%	0%	7%	10%	7%	10%
Did Not Answer	20%	17%	30%	37%	30%	23%

* The top online game or digital storybook for each social-emotional skill is highlighted in blue.

Most parents felt that the Peg + Cat digital media were successful at addressing social-emotional skills. However, the majority of parents had not observed any changes in their children’s behavior over the course of the week.

During their post-interviews, parents in both study conditions were told (or in the case of the Guided Condition, reminded) that one of the objectives of the six Peg + Cat digital media was to teach children about social-emotional skills. Most parents (26 out of 31) answered affirmatively when asked whether they thought that the Peg + Cat digital media had

successfully addressed these skills. However, most parents (77%) were unsure or had not yet seen any changes in their children's social-emotional behaviors during the week of the study. Parents who thought that they had noticed a change reported that their children had been better at calming down, sharing, taking turns, establishing routines, problem-solving, expressing their emotions, empathizing with others, and maintaining positive sibling interactions:

"Changes in his pattern, having a routine. Talking to Peg, telling her to calm down, and sympathizing started the second day [of the study]." - Parent in Guided Condition

"With sharing, he did well this week. Talking out a problem. He learned from Ramone to use his words." - Parent in Guided Condition

"He's generally mild-tempered. But he learned more about taking turns, applying turn-taking with siblings, and is more verbal about his needs."
- Parent in Naturalistic Condition

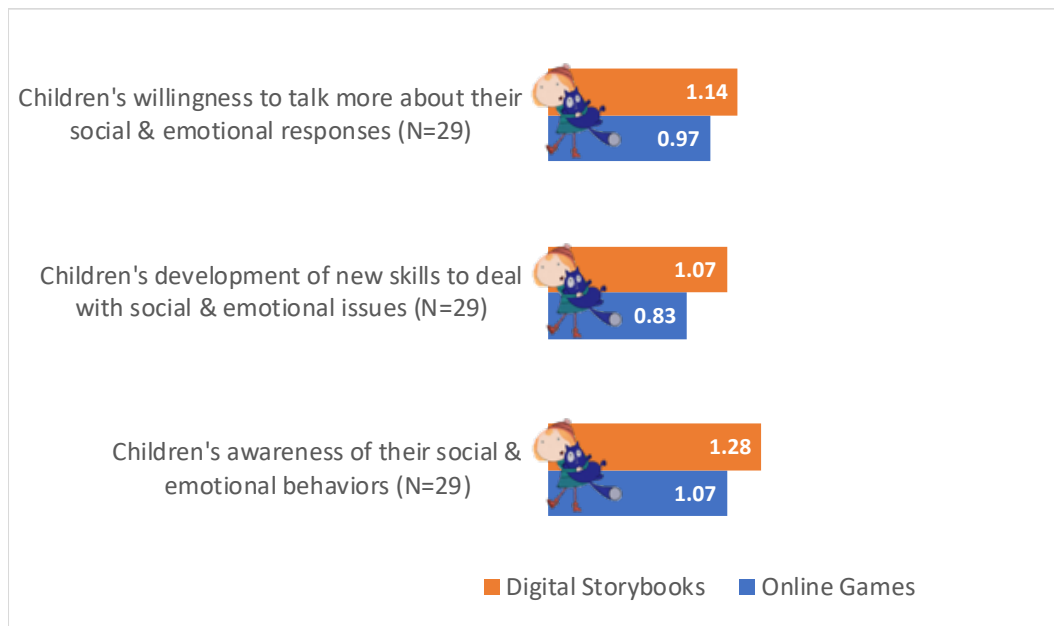
Parents in the Guided Condition tended to notice a wider range of social-emotional behaviors (12 total behaviors mentioned) than parents in the Naturalistic Condition (3 total behaviors mentioned). This is likely due to the fact that parents in the Guided Condition were asked to focus on social-emotional behaviors over the course of the study.

Although most parents felt that it might be too soon to see substantive changes, a few noted that the Peg + Cat digital media might help them address social-emotional topics with their children at a later date. One parent in the Guided Condition acknowledged, "It's a gradual thing. A week is too soon to see changes. We're always talking about these things, and we'll bring up the games in the future."

Parents thought that the Peg + Cat storybooks were slightly better at addressing their children's social-emotional skills than the online games. Parents in the Guided Condition were significantly more likely to feel that the storybooks impacted their children's awareness of social-emotional behaviors than parents in the Naturalistic Condition.

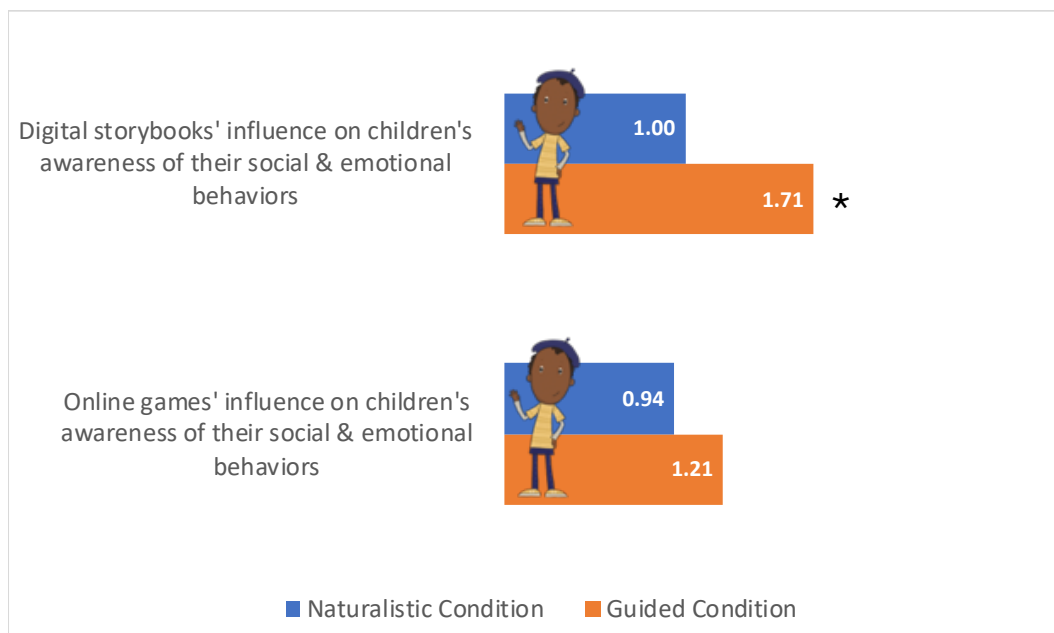
According to their post-survey responses, parents felt that the storybooks had slightly more impact than the games on their children's social emotional skills (see Figure 23*), although this difference was not statistically significant. Interestingly, parents in the Guided Condition were significantly more likely than parents in the Naturalistic Condition to feel like the storybooks influenced their children's awareness of social-emotional behaviors (See Figure 24). There were no other significant differences by study condition.

Figure 23. Parents' Perceptions of Peg + Cat Digital Media's Impacts on Children's Social-Emotional Skills



* On a scale from 0 to 3, with 0 = "No influence," and 3 = "Great influence."

Figure 24. Parents' Perceptions of Peg + Cat Digital Media's Impacts on Children's Social-Emotional Awareness By Study Condition



* On a scale from 0 to 3, with 0 = "No influence," and 3 = "Great influence."

At the end of the form in which families tracked their usage of the Peg + Cat digital media over the course of the week, parents were asked to rate each online game and digital storybook on how much they thought their children had learned about social-emotional skills from it. Overall, parents rated the digital storybooks higher than the online games in terms of their effectiveness in teaching their children about social-emotional skills (see Table 13). *The Big Dog Problem* was rated by parents as the most effective for social-emotional learning, while *Music Maker* was rated as the least effective. There were no statistically significant differences in rankings by study condition.

Table 13. Parents’ Ratings of Peg + Cat Digital Media’s Effectiveness for Social-Emotional Learning

Digital Media	Mean Rating
The Big Dog Problem	2.93
The Election Problem	2.46
The Perfect Ten Problem	2.37
Don’t Go Bananas	2.35
Symmetry Painter	1.53
Music Maker	1.14

** On a scale from 1 to 5, with 1 = “Low” and 5 = “High.”

Parents’ Social-Emotional Engagement With Their Children Around Peg + Cat Digital Media

Most parents indicated that they already addressed social-emotional behaviors with their children on a daily basis. Those in the Guided Condition were able to make explicit connections between social-emotional skills and Peg + Cat.

During their post-interviews, parents reported addressing social-emotional behaviors during everyday activities (9 out of 31 parents mentioned), in response to sibling relationships (6 out of 31 parents), and while using the Peg + Cat digital media (3 out of 31 parents). Parents in both study conditions noted that they discussed social-emotional skills with their children, such as sharing, helping or thinking of others, controlling one’s emotions, and taking turns. In

addition, parents in the Guided Condition shared that they talked with their children about strategies for calming down when upset, expressing one’s emotions, and being patient. Several parents in the Guided Condition (the group that was explicitly asked to call out social-emotional skills within the Peg + Cat digital media) shared some of the social-emotional behaviors they had discussed with their children during the week:

“We used *Don’t Go Bananas* to talk about waiting, having patience, and taking turns.”

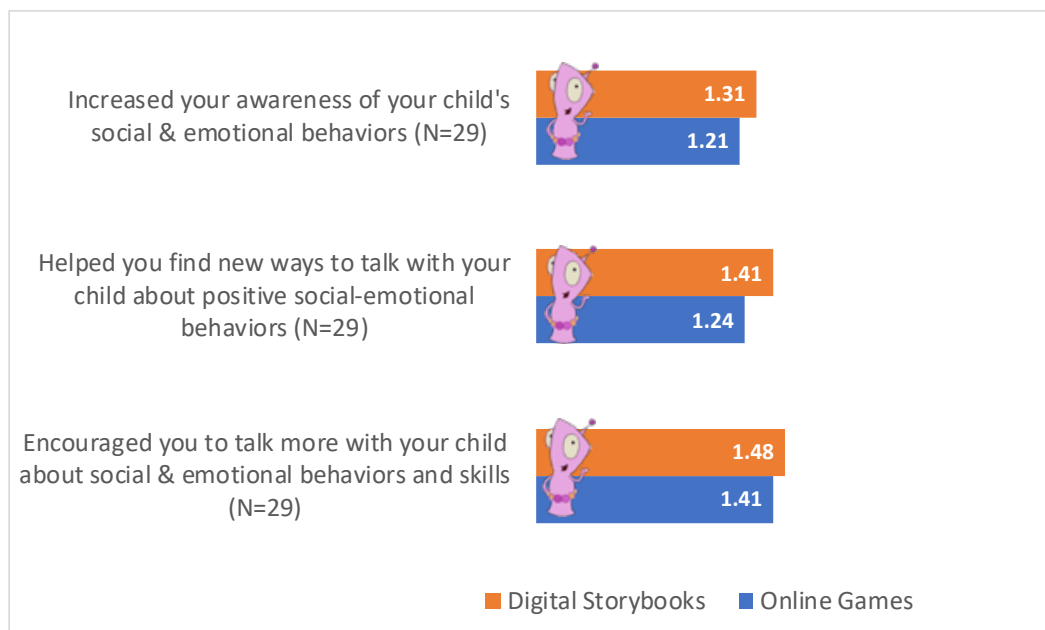
“We talked a lot about what is a really big problem.”

“I always try to encourage kindness, sharing, problem solving, etc...Counting backwards to calm down.”

Parents felt that digital storybooks were slightly better at helping them be aware of and talk to their children about social-emotional skills.

Parents thought that the storybooks were slightly better at helping them be aware of and talk to their children about their own social-emotional skills and behaviors (see Figure 25*). However, the differences between the two types of digital media were not statistically significant.

Figure 25. Parents’ Perceptions of Peg + Cat Digital Media’s Usefulness for Social-Emotional Engagement With Their Children



* On a scale from 0 to 3, with 0 = “Not helpful,” and 3 = “Very helpful.”

Parents were able to identify several instances in which the digital storybooks had helped them talk with their children about social-emotional behaviors. One parent in the Naturalistic Condition noted that the storybooks allowed her and her son to “talk about and repeat the lessons we just heard and relate them to his own experiences.” One parent in the Guided Condition shared that the “stories were follow-along and easier to bring up social-emotional [topics]. The games weren’t. I didn’t see problems in the games, more creating, than solving.” This parent elaborated that *The Big Dog Problem* helped her child “learn about having responsibility and calming down by counting backwards...The story had a beginning, middle, and end, so it was easy to break down and retell the problem.” Another parent in the Guided Condition noted that *The Big Dog Problem* “turned something scary into a positive,” and that *The Perfect Ten Problem* taught her daughter about “working together.” A different mother in the Guided Condition indicated that she and her child had discussed “sharing” while interacting around *The Big Dog Problem*, and “feeling left out and getting mad” in *The Perfect Ten Problem*.

Even though parents tended to think that the digital storybooks were better at addressing social-emotional skills, some were still able to find connections to social-emotional content in the online games. For example, several parents felt that *Don’t Go Bananas* helped their children “learn to take turns and learn to be patient.”

During their post-interviews, parents were able to identify specific Peg + Cat digital media resources that were helpful for talking about various social-emotional skills. For example, parents (11 out of 31) mentioned that *Don’t Go Bananas* was most useful for discussing taking turns with their children. Parents felt that *The Big Dog Problem* was most helpful for talking about problem-solving (7 parents said) and working together (6 parents said), and that *The Election Problem* was good for discussing perseverance (2 parents said). Finally, a few parents mentioned that *The Perfect Ten Problem* was helpful for discussing working together (2 parents).

Parents’ Opinions of the Peg + Cat Online Games & Digital Storybooks

Parents liked that the Peg + Cat digital media resources were educational, age-appropriate, and easy for their children to understand.

Overall, parents appreciated the educational focus of the Peg + Cat digital media:

“She usually likes to play music or painting games, which are not always kid-friendly or educational. I really like the Peg + Cat activities. I’m very impressed with *Symmetry Painter*, *The Big Dog Problem*, and *The Perfect Ten Problem*. I liked the content and the

way math was taught, the cooperation to solve math problems, and that [Peg] could always have the option to ask Cat for help.”

“I haven’t done many stories related to math. These games cross-integrate subjects really well. Most math games are only math.”

One parent shared, “We’re very protective of screen time. It was a nice foray into a first games’ experience. We felt comfortable.”

Parents liked that the concepts and objectives within the Peg + Cat digital media were clear and easy for their children to understand:

“It gets them thinking.”

“Simple math problems. He didn’t get frustrated.”

“[The Peg + Cat digital media was] educational, simple, and he could do it on [his own”).

For the most part, parents felt that the digital media was age appropriate for their children: “My child could understand without getting frustrated, and was very engaged in the stories.”

Parents appreciated that the Peg + Cat digital media provided opportunities for them to talk about math with their children.

Several parents shared that the Peg + Cat digital media resources provided them with opportunities to talk together more about math, which was something many of them had not done often with their children before (“It opened my eyes to new and different vocabulary.”). One parent indicated that using the Peg + Cat digital media resources together was a “good way to gauge [her daughter’s] skill,” while another parent shared that she “enjoyed playing with [her son]. It opened up conversations, and [provided] meaningful one-on one time.” Similarly, another parent felt that exposure to the Peg + Cat digital media “opened my eyes to ways to use technology to teach math and have math conversations.” One parent liked the games and storybooks because they introduced her son to “things we don’t do at home.”

Parents liked the Peg + Cat digital media’s focus on social-emotional learning, but felt that the messaging in the online games and digital storybooks was too subtle and could be called out more explicitly for families.

Parents in both the Naturalistic and the Guided Conditions appreciated the Peg + Cat digital media’s emphasis on positive social-emotional behaviors (“It helped because we talked about

the skills.”). However, parents thought that these skills could be more openly addressed in the online games and digital storybooks:

“To help children learn social-emotional learning, the skills should be more explicit. For example in *The Big Dog Problem*, the story should ask, ‘How can you work together to solve this problem?’”

“It brought my attention to ways to address social-emotional learning. With *The Perfect Ten Problem* and *The Election Problem*, it would have been helpful to be prompted [myself] for what [my child] could be prompted about.”

“It would have been cool if the stories have options that [children] can choose from... It would be good to see a solution happen [to the problem].”

One parent in the Naturalistic Condition thought that the social-emotional focus was “very subtle...It needs to be very obvious. I didn’t notice it at all.” In other words, parents wanted additional scaffolding for their children and for themselves to help them notice and find additional opportunities to engage together around social-emotional topics.

A few parents did not think that the Peg + Cat digital media had a social-emotional focus or did not like the way that those topics were portrayed within the online games and digital storybooks. One parent in the Guided Condition felt that using the Peg + Cat digital media to support positive social-emotional behaviors was “a stretch,” and indicated that she would not have used them for that purpose if not for her participation in the study. In addition, multiple parents indicated that they did not like when Peg was “totally freaking out” because they felt that it was too dramatic of a response and did not want their children to emulate getting upset first before solving a problem:

“Some of the language in the story - ‘Freaking out’ isn’t language we would use. It seemed like the problems weren’t that big. [Peg was] over-exaggerating.”

“My child didn’t think Peg’s problems were that big of a deal, even though Peg was ‘totally freaking out.’ If you don’t have a house, that would be a ‘big problem.’”

In general, parents (especially those in the Naturalistic Condition) thought that the Peg + Cat online games had been more enjoyable for their children than the storybooks. However, parents in the Guided Condition felt that their children had enjoyed the digital storybooks more than parents in the Naturalistic Condition.

Parents appreciated that “the games presented math problems appropriate for [their child’s] age level.” They liked the interactivity of the online games - something parents felt was missing from the digital storybooks: “I didn’t love the storybooks. I kept waiting for when he

would get to do something.” One parent suggested that the digital storybooks “could be more engaging, if the stories had visual words or highlighted concepts they wanted to teach.”

In contrast, parents appreciated that the digital storybooks provided more opportunities for them to have conversations with their children to find solutions to problems:

“The storybooks made me aware of how you can use to stories to open up questions and discussions.”

“I like the storybooks because they had real-life problems, make it fun, and explain it in kid terms.”

“*The Election Problem* and *The Big Dog Problem* stuck. ‘What can we do?’ We’d ask him for his ideas, which helps him think through options. Not giving up [and] finding the solution.”

Another parent shared that the visuals and “catchy” songs in the digital storybooks drew her daughter in, so much so that while reading the story, her daughter would tell Peg, “Don’t freak out. It’s okay.”

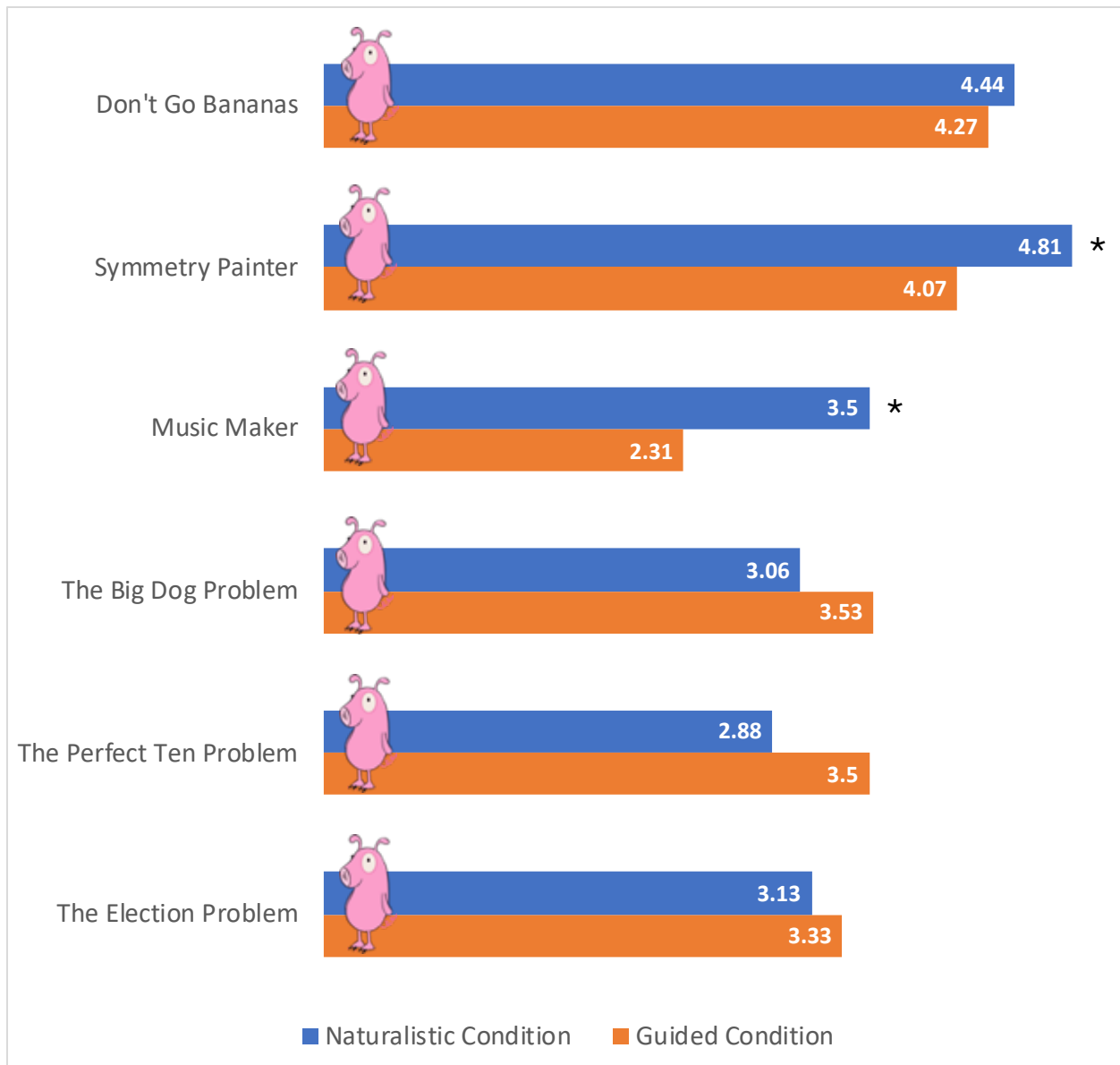
At the end of the week, parents were asked to rate each online game and digital storybook based on how enjoyable they thought it was for their children to play (see Table 14). Parents rated *Symmetry Painter* the highest and *Music Maker* the lowest (see Appendix on page 56 for parents’ feedback on specific Peg + Cat digital media). Interestingly, parents in the Naturalistic Condition rated these two games as significantly more enjoyable for their children than parents in the Guided Condition (see Figure 26). In fact, parents in the Naturalistic Condition rated all of the games as more enjoyable for their children than those in the Guided Condition. Alternatively, parents in the Guided Condition rated all of the storybooks as more enjoyable for their children than parents in the Naturalistic Condition.

Table 14. Parents’ Ratings of How Enjoyable Their Children Found Peg + Cat Digital Media

Digital Media	Mean Rating*
Symmetry Painter (N=30)	4.47
Don’t Go Bananas (N=31)	4.36
The Big Dog Problem (N=31)	3.29
The Election Problem (N=31)	3.23
The Perfect Ten Problem (N=30)	3.17
Music Maker (N=29)	2.97

* On a scale from 1 to 5, with 1 = “Low” and 5 = “High.”

Figure 26. Parents' Perceptions of Their Children's Enjoyment of Peg + Cat Digital Media by Study Condition



* Indicates a significant difference at the $p < .05$ level

** On a scale from 1 to 5, with 1 = "Low" and 5 = "High."

Children’s Opinions of the Peg + Cat Digital Games & Storybooks

For the most part, children liked the Peg + Cat online games more than the storybooks.

During their post-interviews, children were asked to rate each online game and digital storybook based on how much they liked it (see Table 15). Children’s ratings mirrored what parents thought had been the most to least enjoyable games for their children (see Appendix on page 56 for children’s feedback on specific Peg + Cat digital media). In contrast with parents’ ratings, there were no significant differences in the individual Peg + Cat digital media that children liked based on study condition.

Table 15. Children’s Ratings of How Much They Liked Peg + Cat Digital Media

Digital Media	Mean Rating*
Symmetry Painter (N=26)	2.77
Don’t Go Bananas (N=29)	2.62
The Big Dog Problem (N=29)	2.52
The Election Problem (N=29)	2.38
The Perfect Ten Problem (N=28)	2.21
Music Maker (N=29)	2.10

* On a scale from 1 to 3 with 1 = “Not at all” and 3 = “A lot.”

Children were asked who their favorite character from the online games and digital storybooks had been and why. They tended to like Peg the best, followed by Cat (see Table 16). Children liked Peg “because she’s a girl and solves problems.” One child liked her “because she’s bigger than me.” They liked Cat “because Cat helps Peg.” One child liked Cat because he is “silly” and liked “making him run in *Music Maker*.”

Table 16. Children’s Favorite Character From the Peg + Cat Digital Media (N=30)*

Character	Percentage of Children Who Mentioned
Peg	53%
Cat	40%
Ramone	7%
Big Dog	3%
Monkeys	3%
All	3%
None	7%

* Some children mentioned more than one character.

Conclusions

Parents in this study already engaged their children in everyday conversations and activities around mathematics and social-emotional skills on a regular basis. Yet the findings above suggest that exposure to rich digital media supported parents’ engagement with their children around technology in general, and math-related media specifically. Furthermore, the six online games and digital storybooks helped parents talk with their children about novel math concepts, and afforded additional opportunities to discuss positive social-emotional behaviors in the context of problem-solving.

Parents indicated that each type of digital media resource had a different role to play in supporting their children’s learning. Parents felt that the online games were more effective at scaffolding their children’s mathematics’ learning, interest, and engagement, whereas the digital storybooks were more effective in supporting their children’s social-emotional skill development. Interestingly, children were able to demonstrate increased understanding of mathematical concepts and identify social-emotional skills that were present in both the online games and digital storybooks. Taken together, these findings suggest that although parents may have seen one resource as being more effective than the other for a particular topic, in practice, both the online games and digital storybooks positively impacted children’s understanding of mathematics and awareness of social-emotional behaviors.

Finally, this study demonstrates that making parents more aware of social-emotional learning opportunities within math-related digital media can change how they think about and

approach these resources with their children. For example, parents in the Guided Condition tended to position the digital storybooks as tools for supporting their children's mathematics learning and social-emotional skill development significantly more often than parents in the Naturalistic Condition. This result suggests that simply prompting parents with the learning goals for digital media beforehand can impact how families' engage with and talk about those resources. Families in this study appreciated knowing that one of the objectives of the online games and digital storybooks was to support children's development of positive social-emotional skills within early math experiences, but families in both study conditions felt that the messaging had been too subtle. In the future, designers of educational digital media resources for preschool children should consider making the learning goals more explicit for families, and providing parents with strategies and talking points to engage their children around these ideas. In particular, since social-emotional skills are so embedded within early childhood mathematics learning, digital media designers are encouraged to clearly state how these skills can be supported within the math games and activities that they create for families.

Appendix: Families' Opinions of Specific Peg + Cat Digital Media

The Election Problem

Likes

Parents liked that *The Election Problem* was relevant to everyday life. One parent shared that her son was motivated to sway the chickens over to Peg's side after hearing the song she sang.

Children liked the story, and that Peg ultimately "won" ("Because Peg got more than Pig," "When she got a lot of chickens, and the pig got less than her"). Several children mentioned that they liked the characters, such as Peg, Pig, the Littlest Chicken, the hundred chickens, and the farmer. One child especially enjoyed when Ramone helped Peg.

Dislikes

The Election Problem digital storybook had a glitch and froze in the middle of the story for many families. Several parents thought that the numbers in the narrative were too large for their children to understand. The concept of greater than/less than was also seen as a complex topic.

A few children did not like the problem that Peg was trying to solve. One child thought that the story was too long and wanted something interactive that he could do on-screen.

The Big Dog Problem

Likes

Parents shared that their children liked the characters of Big Dog and Cat. One parent also indicated that her son liked turning the pages of the digital storybook himself.

Some parents were able to make connections between *The Big Dog Problem* and family math-related activities. For example, after reading the digital storybook one mother measured each of her children and discussed their different heights. Another parent felt that the counting and dividing of letters were both age-appropriate concepts.

Most children liked the overall problem to be solved in the story. They also enjoyed how Big Dog helped Peg and Cat ("How the dog lifted them up on its back," "I liked that they weren't tall enough and had to use the dog. That was silly"). Some children thought that the story was humorous, and that Big Dog was not as scary as Peg and Cat initially thought ("Peg and Cat

thought he was mean, but he was nice. It was funny"). Other things that children mentioned liking about *The Big Dog Problem* included mailing the letters, and that Peg had an important job to help do so.

Dislikes

A few parents had difficulty getting the digital storybook to load onto their devices. Others had trouble finding the math content in *The Big Dog Problem*: "I wondered where the math was. I didn't see the learning aspect." One parent did not like how Peg reacted in the story: "I didn't like how she said she was totally freaking out. She didn't need to get that upset. She freaked out first, and then solved problem."

Some parents and children felt that the storyline was boring. One mother shared that her daughter had liked the other two storybooks better because those stories had incorporated songs, whereas *The Big Dog Problem* did not.

The Perfect Ten Problem

Likes

Several parents shared that their children had enjoyed the songs within *The Perfect Ten Problem* digital storybook: "She danced to the Smallest song, and played it three times." One parent appreciated that the narrative modeled "using math to work together to solve problems."

Children liked the scoring system ("When they get a point"), and the parrot judge in the story. They also liked the contestants, especially the singing pirates. Several children mentioned liking how Peg and Cat solved the problem in the story:

"Because the circles on Cat's paws gave Peg an idea about zero."

"I liked adding zero to get ten."

"Cat had circles, and it made Peg have an idea when the Pig got ten."

One child liked that she got to do math, while using the digital storybook. Another "liked learning new numbers" from *The Perfect Ten Problem*.

Dislikes

As with the other digital storybooks, some parents had technical difficulties with *The Perfect Ten Problem*. A few parents felt that the story didn't hold their children's attention. One parent shared that her daughter didn't think that the big problem in the story made sense. Another felt that a judge giving a score of zero to a contestant was unrealistic.

One parent believed that the numbers used in the story were too complex for her child, while another thought that the math was not as obvious to her daughter (e.g., the zeroes on Cat's paws). This parent suggested that future stories might include a feature where the screen highlights important math words or symbols as they come up during the story.

A few children thought that *The Perfect Ten Problem* was a little boring. One child said that the story was hard to understand. Children provided no additional critiques.

Don't Go Bananas

Likes

Parents liked that *Don't Go Bananas* introduced simple addition and subtraction in a natural way. They also appreciated the game's interactivity and that actions that their children did impacted what happened on-screen. Parents observed that their children enjoyed searching for and selecting monkeys: "He liked trying to beat Peg at finding monkeys when it was her turn...He counted out loud." One parent shared that her daughter liked the monkey noises in the game, while another indicated that her daughter enjoyed the circus theme. One parent stated that her daughter "would count and laugh at the silly monkeys. She would talk to Peg when Peg was talking... She laughed and made facial expressions when the monkeys would jump away for the bananas."

Children also liked the interactive aspects of the game ("catching monkeys and spinning the wheel. Finding the monkeys, tapping on the screen, and they went into the stands"). In particular, children liked using the spinner and finding and tapping on the monkeys. Several children shared that they liked taking turns with Peg. One child liked seeing how many more monkeys he needed to get. Some children enjoyed the sillier aspects of the game as well ("You spin the wheel and made me do fun things").

Dislikes

A few parents thought that *Don't Go Bananas* could have been more challenging ("She didn't like that it didn't go to another level...She was looking for more."), although some shared that their children thought that the game was too hard. In particular, counting backwards in the game was identified as confusing at first. One parent observed her son clicking on the monkeys that were on the spinner rather than those within the circus scene. Another shared that her son got upset at the timer: "He couldn't click the monkeys in time, and got angry [and said that it's] not fair that Peg gets the easy monkeys."

Although most parents appreciated the turn-taking game mechanic ("I liked *Don't Go Bananas* for the positive reinforcements, modeling good (polite) behavior."), a few noted that their children became frustrated having to wait for Peg:

"She didn't like Peg's turn. That [Peg would] try to interrupt her. [My daughter] kept getting the one that takes away bananas. Peg kept getting the one that added monkeys."

A few parents shared that their children did not like that the monkeys disappeared from the screen. Children also indicated that they didn't always like getting "bananas" and losing the monkeys that they had already collected.

Music Maker

Likes

Parents shared that their children liked the music in *Music Maker*. One parent observed her daughter showing an older sister "how to make the 'best' sounds." Parents also thought that their children enjoyed manipulating the different bars within the game: "He really liked changing the height of the columns to make the music different."

Parents thought that relating music to math was "fun." In particular, one parent "loved that you could change the tempo of the music," while another talked about pitch with her daughter.

Children liked the music in the game itself, as well as the ability to change its speed and the height of the bars: "You could pause and unpaue, do it faster or medium, play guitar, and it makes beautiful music." A few children thought that Cat was funny, and liked that he looked exhausted when he was running fast across the screen.

Dislikes

Parents had trouble finding the math content in *Music Maker* or seeing the purpose of the game ("I'm not sure what it has to do with math," "I just didn't get it," "Not a lot to learn or talk about"). Some thought that the activity was too hard, while others felt that it was too easy ("It's not as interactive. There wasn't enough to do").

Parents shared that their children had difficulty understanding how the game worked ("He had a hard time figuring out that he had to move the bars up and down," "He didn't seem to get that changing the tubes affected sound"). Several parents had technical difficulties getting *Music Maker* to play on the PBS KIDS website.

Parents felt that the game could be improved with a simple introductory demonstration or set of instructions on how to play. Some parents also wanted to see various augmented features, such as allowing players to set patterns within the game or record the music they created for later playback. One parent suggested adding in treble or bass clefs to help children better understand the musical concepts inherent within the game.

A few children wanted to be able to do more with *Music Maker's* interface besides "just go up and down." One child said that it was "hard to tap [the bars] when Cat was walking around."

One child did not like the noises within the game and thought that they were too loud. Another child shared that he did not know how to play. Some children had trouble getting the sound to work and were frustrated that they could not get it to play audio. One child wished that the music in the game had accompanying lyrics.

Symmetry Painter

Likes

Parents found *Symmetry Painter* to be engaging for their children, and appreciated the opportunities it provided to foster creativity. They also liked the introduction of the novel word “symmetry” to their children’s vocabulary. One parent wasn’t “sure [her son] understands the math, but he loves the patterns.” Another parent indicated that her daughter enjoyed painting with the musical notes and the accompanying sounds they made.

Children who liked art and drawing enjoyed *Symmetry Painter*: “I liked painting and making it a shape.” They liked placing various colors, images, and stickers on the screen. Children appreciated having the freedom to “draw whatever we want” (“We get to paint all over the place.”). A few children liked the symmetrical mechanic of the game (“I draw, and the other side draws too,”; “I liked seeing the drawing appear on both sides.”). One child specifically liked being able to change the direction from horizontal to vertical symmetry.

Dislikes

Some parents felt like the math concepts within *Symmetry Painter* took a back seat to the activity (i.e., their children just wanted to color). Parents also did not see moments to address social-emotional learning within the game. A few parents felt that *Symmetry Painter* needed more instructions: “Once she figured it out, she really liked it. But took a while to figure out the functions. It could use more instructions to demo symmetry.”

One child shared that she didn’t like *Symmetry Painter* because she does not like to draw. Otherwise, children had no additional critiques of the game.