PEG+CAT Content Study:

Report to CPB-PBS *the Ready To Learn Initiative*

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EDC Learning transforms lives.

SRI Education

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Contents

Study in Brief

This report presents results from the CPB-PBS *Ready To Learn PEG+CAT* Content Study. *PEG+CAT* is a unique transmedia property that emphasizes early mathematics and problem solving. Each episode is structured around a specific mathematical problem the characters are trying to solve together. It includes video episodes, interstitial video, online games, and a tablet-based app, that allows children and their families to engage with the same characters, settings, and narratives on multiple devices, across various physical and social settings. The study examined how a sample of 59 four-year-old children engaged with and learned from selected sets of *PEG+CAT* videos and interactive games over five less-than-hour-long interactions. These five independent, unmediated interactions took place in a controlled learning laboratory setting.

This study is one of an interrelated series of studies included in the Ready To Learn summative evaluation, being conducted by EDC's Center for Children and Technology and SRI Education's Center for Technology in Learning (EDC/SRI). EDC/SRI are serving as the external summative evaluators on behalf of the Ready To Learn partnership among the US Department of Education, the Corporation for Public Broadcasting, and PBS.

Key Findings

Children's Learning:

- Children's performance improved significantly from pretest to post-test on one shape identification item (identifying a cylinder) on a researcher-developed measure aligned to the *PEG+CAT* study experience.
- For 3 items (related to identifying 3-D shapes), there were non-significant gains in performance between pre- and post-test.
- Children's performance on the standardized assessment (REMA) improved modestly from pretest to posttest. The result is positive (statistically significant) but not conclusive.

Parent Perspectives:

- Nearly all parents reported strong, positive impressions of *PEG+CAT* and viewed the resources as having considerable potential to support children's mathematical learning. A number of parents reported that interacting with the *PEG+CAT* materials appeared to influence children's behavior at home and that children talked about *PEG+CAT* at home, after and in-between study sessions.
- Half of the participating parents reported that they worked with their children on activities related to *PEG+CAT* at home.

Children's Engagement:

- Children showed signs of positive engagement, like watching intently, counting along, or "interacting" with characters while watching *PEG+CAT* videos and playing *PEG+CAT* games.
- Children consistently sat still and paid focused attention during video viewing sessions. Their level of engagement with interactive games varied.
- Most children were able to identify and talk about the characters, setting, and other story elements of the videos, but fewer were able to describe the mathematical problem and the solution around which the episode revolved.
- Children were able to engage with the games independently during the majority of sessions, but some form of support was necessary during other sessions.

Introduction

EDC and SRI researchers conducted this study to provide new information about how preschool children may learn as a result of direct engagement with transmedia resources outside of formal instructional environments like preschool classrooms. These transmedia experiences, developed by public media producers and made widely available by PBS, included use of *PEG+CAT* video episodes, interstitial video, online games, and a tablet-based app. These resources allow children and their families to engage with the same characters, settings, and narratives on multiple devices, across various physical and social settings.

This study contributes to several important areas of research. First, this study focuses on how new educational media resources may support learning for children growing up in low-income communities where there are often fewer resources available to children that can help them to develop the skills and content knowledge associated with success in school. Second, by focusing on *PEG+CAT*, created by Jennifer Oxley and Billy Aronson, and produced by the Fred Rogers Company, the study extends a long line of research that investigates the potential benefits of public media developed materials.

Public Media, Transmedia, and *PEG+CAT*

The Ready To Learn program and the public media organizations that produce educational content with support from Ready To Learn are focused on producing and deploying educational content to support learning in homes, at school, and in out of school settings. The current initiative is focused on producing high-quality early learning materials that support children's exploration and development at home and outside of traditional instructional environments.

Multiple interventions involving adult-supported engagement with public media videos and transmedia suites have been effective at supporting math, literacy, and science learning in lab, school, and home settings, and have been associated with gains in literacy, science, and math, as well as school readiness skills (e.g., Fisch, 2004, Penuel et al, 2012, Pasnik & Llorente, 2013). Such resources often provide access to dynamic, multi-sensory representations of concepts, places, or people that would not be practical (or sometimes, possible) otherwise. Additionally, a number of public media interventions that target young children—and the digital resources on which they are based—attend carefully to pedagogical design, and the learning and developmental needs of the participants (e.g., Fisch, 2004, Piotrowski & Linebarger, 2010).

The Corporation for Public Broadcasting and PBS, in partnership with the U.S. Department of Education and their producing partners, are pursuing a "transmedia approach" to supporting early mathematics. *PEG+CAT* is a centerpiece of this effort. The *PEG+CAT* experience includes video episodes, interstitial video, online games, and a tablet-based app that allows children and their families to engage with the same characters, settings, and narratives on multiple devices, across various physical and social settings. The title characters in the program, Peg and Cat, along with their friends and adversaries, present children with an animated, fictional universe where solving important problems requires children to explore and rehearse both mathematics concepts and social-emotional skills.

Developers of transmedia properties intend to create experiences that can support both intentional and incidental learning opportunities, across a range of settings. Children can view videos or play games at home, perhaps while waiting for care providers to attend to their own essential tasks. Children with access to the Internet via portable digital devices can play an app or video while in transit to school or daycare sites. And children can engage in these activities on their own, with siblings, with friends, and with caregivers. Each of these experiences can potentially contribute to children's learning and understanding of targeted skills, concepts and language.

PEG+CAT producers identified two principal goals for this transmedia property: 1) to enhance children's learning of mathematics (skills and content), and 2) to support children in becoming persistent and resourceful in solving problems. This study focuses on the first of these goals.

Early Mathematics

The study focuses specifically on how transmedia experiences can support young children's learning about shapes and patterns outside the preschool classroom. Parents, educators, and researchers all recognize that the years before children begin kindergarten are essential for developing skills and knowledge foundations that will be crucial for learning in later years (Chetty, Friedman, Hilger, Saez, Schazenbach, & Yagan, 2011; Isaacs, 2008). There is growing recognition, too, about the importance of early mathematics learning, and increasing awareness of the tremendous potential all children have to develop a broad range of quantitative thinking skills. Early mathematics achievement is a strong predictor of later school achievement, and this predictive power is, arguably, greater than the predictive power of early literacy achievement (Claessens, Duncan, & Engel, 2009; Duncan et al., 2007).

The National Association for the Education of Young Children (NAEYC) and the National Council of Teachers of Mathematics (NCTM) jointly have called attention to the need for appropriate, challenging, and effective early childhood mathematics programs (2002; 2010). Yet most preschool teachers are not trained in early mathematics content, the developmental trajectory of young children's acquisition of mathematics skills, or teaching strategies to promote mathematics learning (Ginsburg, Lee, & Boyd, 2008). Many existing methods of teaching early mathematics appear insufficient to help many children, especially those from lower income households and English learners, achieve mathematical learning outcomes equivalent to their English-speaking middle-class peers. Children who fall behind in mathematics early on face long odds of ever catching up to their more mathematically proficient peers when it comes to high-school graduation rates, college readiness, and income as adults (Duncan, et. al., 2007; NAEYC & NCTM, 2010).

A substantial body of research shows that high-quality mathematics instruction can lead to improved mathematics outcomes for disadvantaged children, and that teachers and caregivers are able to support children's early mathematics learning when provided with appropriate guidance and information (Casey et al., 2008; Kersch, Casey, & Mercer Young, 2008; Wolfgang, Stannard, & Jones, 2001). Preschool classroom curricula and curricular supplements have been shown to support learning gains for children when they are well aligned with children's physical, social, and cognitive development (Starkey, Klein, & Wakeley, 2004; Chambers et al., 2006; Clements & Sarama, 2008; Linebarger & Piotrowski, 2009; Neuman, Newman, & Dwyer, 2010; Penuel et al, 2011).

Early Mathematics Outside Preschool Environments

Local efforts to improve formal early learning environments can include adopting new curricula, using new resources, expanding teacher preparation and offering professional development. While these in-classroom investments are important, there is also evidence that supporting children in learning early mathematics through structured, supported engagements between children and their parents and caregivers is a promising strategy (Starkey, Klein, & Wakeley, 2004, McCarthy et al, 2012). Home environments and family relationships are important contexts for mathematics-rich interactions for preschool and school-aged children (Anderson, 1997; Ginsburg, Inoue, & Seo, 1999; Swarchuk, 2009; Goldman & Booker, 2009; Goldman et al., 2010; Esmonde et al., 2011). Activities that take place at home, and among parents/caregivers and children can influence preschoolers' development of mathematics skills and knowledge (Young-Loveridge, 1989; LeFevre, Clarke, & Stringer, 2002; Aubrey, Bottle, & Godfrey, 2003; Sheldon & Epstein, 2005; LeFevre et al., 2009; Anders et al., 2012) There is little research on the influence of children's independent experiences with educational content and how such engagements may support mathematics learning. This study is designed to make a modest contribution to filling this knowledge gap.

Study Design

The purpose of the *PEG+CAT* Content Study was to explore, in a controlled environment, to what extent children can learn mathematics from *PEG+CAT* content outside of instructional environments and relationships, how parents[1] perceived the resources, and how well children are able to engage with these resources independently. This study was conducted in the spring of 2014 in the New York City and San Francisco Bay Areas.

All children who participated in the study were provided with opportunities to view *PEG+CAT* videos and play *PEG+CAT* digital games and activities under controlled, non-instructional conditions, in "lab" spaces at EDC and SRI offices. The study used a pre/post design with no comparison or control group.

Researchers collected data using standard and researcher-developed, experience aligned assessments, researcher observations, and parent observations of children's behaviors during and outside study times.

Research Questions

The *PEG+CAT* Content Study design focused on three research questions. The first question addressed the degree to which children learned new mathematics knowledge and skills. Two assessments, one a standard measure (the Research Based Early Mathematics Assessment (REMA), short form), and one developed by the research team (*PEG+CAT* Item Sets, PCIS), were used to collect data to address this question:

RQ1: Do children who engage with selected *PEG+CAT* videos and games independently in a controlled, non-instructional environment over the course of five sessions improve in target mathematics skills as measured by:

(a) a standardized early childhood mathematics assessment; and

(b) a researcher-developed measure, aligned to the videos and games included in the study experience?

The second question addressed parents' perspectives of the transmedia content and their children's mathematics experiences. Parents were asked to respond to a set of open-ended questions during the fifth week of the study that asked about their impression of the resources as supportive of learning, and about their child's behavior with regard to any references to the *PEG+CAT* resources.

1 "Parents" refers to all primary caregivers, no matter their relationship to the child.

RQ2: How do parents view the potential of *PEG+CAT* content to support children's mathematics learning?

The third question addressed children's engagement with the transmedia and also addressed the potential need for mediation or support for children's use of the games, videos and activities. Researchers completed observations during children's study activities, and parents also completed observation check lists to contribute their perspective on their children's engagement and perceived need for any assistance.

RQ3: How do children attend to particular *PEG+CAT* media experiences? What assistance or support, if any, do they require to participate while engaging in the media experiences?

Sample

The final study sample included 59 children (aged between 4 years, 1 month and 5 years, 5 months) from low-income communities in the New York metropolitan and San Francisco Bay areas. The initial study sample included two additional children, one of whom withdrew from the study after the first session (CA) and the other who withdrew after the second session (NY). The research team recruited children through existing relationships with Head Start centers, public preschools, and community based programs where 50% or more of the children served are from low-income backgrounds (i.e., qualify for subsidized preschool and/or free or reduced price lunch). The recruitment process involved: identifying and talking with preschool and district program directors about the study; distributing informational flyers to parents at preschool sites; talking with teachers and other care providers about the study; and talking with parents at center-related events about the study.

Families attended a total of five sessions during the study. Participating families received a stipend of $50 per visit to EDC/SRI in acknowledgement of their participation. Where appropriate, families also received stipends to cover travel costs to the study site.

Researchers asked parents/caregivers to complete surveys that would provide background information about the children (and families) participating in the study, including basic demographic information and family perspectives on mathematics and technology. Parent surveys indicate that the study sample was ethnically diverse: 60% Hispanic/Latino, 25% African American, and 14% Mixed/Other. In terms of technology at home, a majority of NY families had broadband Internet access (57%), but far fewer CA families reported such access (23%). Television was the most common media/technology platform used by families, particularly for supporting learning. According to parent reports, 40% of participating children watched educational TV daily, compared to 20% who played digital games.

Prior to participating in the study, parents tended to agree or strongly agree that young children can learn math, that math learning can happen everywhere, and that parents can support math learning. Most parents reported supporting math learning at home at very high rates, especially for well understood mathematics such as counting (97%), recognizing or drawing shapes (92%), number identification (85%), recognizing/making patterns (75%), addition (73%), and subtraction (61%).

Treatment

Researchers conducted a detailed review of all learning materials developed by *PEG+CAT* producers, closely attending to focal mathematics skills and the strategies designers built into the resources to support learning. Following review, researchers selected specific *PEG+CAT* content that targeted two mathematics skills: patterns and shapes (3D/2D). Researchers selected and sequenced the videos and games to create an experience that would allow children to have more than one opportunity to engage with those particular mathematics skills. Below we provide details about the resources and the sequence in which children experienced them.

Focal Skills and Media Resources

Researchers identified and chose to include the strongest assets focused on patterns and shapes. The patterns games and episodes selected focused on both auditory patterns (for example, Beethoven playing the first notes to his 5th Symphony) and visual patterns (for example, the diagrams of short-short-short-long sausages). The patterns-focused resources included *The Beethoven Problem, Big Gig*[2] *Patterns game, The Dinosaur Problem* and *the Chicken Dance* game.

The videos and games that focused on 2D and 3D shapes (e.g., spheres, cylinders, and pyramids, which are less common in preschool) included *The Golden Pyramid Problem, The Sparkling Sphere Problem, Magical Shape Hunt* game, and *Big Gig Magic Cylinder* song.

Researchers also elected to include resources that focused on counting and number relationships because these are skills with which children were likely to be familiar coming into the study and provided a way to introduce the characters, narrative, and media experiences they would encounter in subsequent sessions. The introduction video (*The Three Bears Problem*), helped introduce participants to the characters and format of *PEG+CAT*. Additionally, *The Dinosaur Problem*, which was included in the study experience for its focus on patterns, also contains content related to number relationships and counting.

Technology

The transmedia content included in the study dictated the selection of the technology platforms. Videos and games were accessed using a laptop (Chromebook), while activities included in the Big Gig App required use of a tablet. We chose to use the Nabi, a touch-screen tablet specifically designed for use by younger children, that

2 A newer version of the Big Gig app was released after the study concluded.

includes such features as bright and engaging colors and a soft, easy-to-hold, protective wrapper that minimizes potential damage to the screen if the device is dropped. Researchers constructed a website that provided easy access to the study videos and online games (see figure 1 below).

Figure 1. *Ready To Learn* Content Study Web Site

RTL Content Study Transmedia Links

Session	Video Episode	Interactive Game
1	*The Three Bears (Episode 101A)*	*Big Gig App (Count by Ones)*
2	*The Dinosaur Problem (Episode 108A)*	*Chicken Dance game*
3	*The Beethoven Problem (Episode 108B)*	*Big Gig App (Patterns)*
4	*The Sparkling Sphere Problem (Episiode 112B)*	*Big Gig App (Magic Cylinder)*
5	*The Golden Pyramid Problem (Episode 102B)*	*Magical Shape Hunt game*

Typical Session Experience

Parents who agreed to join the study were asked to attend five sessions over a five-week period. Each session included a specific set of activities that would take between 45 and 75 minutes, including a break and small snack. Parents were asked to attend each of the sessions with their child. Children who missed two or more sessions were excluded from the study, and the majority of participants attended all five sessions.

The principal learning opportunity during each session was children's direct engagement with *PEG+CAT* resources. Beyond the careful curation of resources, there was no formal instruction, feedback, or guidance provided to the children during study sessions from researchers or parents. Researchers were present and provided assistance as requested by children, making sure the child had the best opportunity to participate in each session. This included ensuring the technology was functioning properly (i.e., correct video was playing, correct game was loaded), answering any questions the child may have had about how to start playing a game, and making sure the child was comfortable. During a typical session, a researcher would work with the same family from week to week. Sessions began with assessment tasks, followed by video viewing and/or game play. During these activities, parents and researchers would observe, make notes, and complete checklists while the child interacted with the video and game resources. At the end of each viewing/play session, researchers would ask the child a short list of questions about the experience. Each session concluded with a round of assessment tasks. Parents were asked to observe, but not interact with their children during sessions.

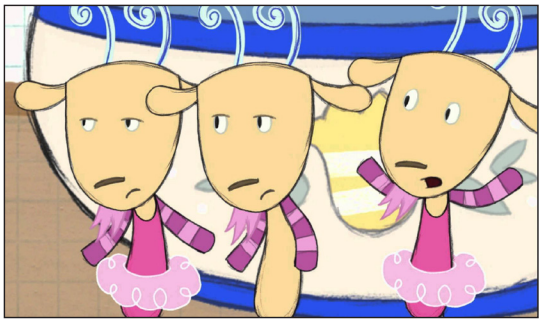
Below is a detailed description of activities that took place during each of the five sessions of the study:

Session activities

Session 1:

- Parents and children participated in a short orientation to the study, the lab setting, and the materials children would view and with which they would be engage.
- Children participated in a pre-assessment with a trained researcher using a standardized assessment. They also watched one video and played one game. The assessment took place in a room where the child's parent was present, though was engaged in the completion of a parent survey. The session lasted approximately 45-55 minutes.
- Snacks were provided for children and parents.
- Selected content: *The Three Bears Problem* (Episode 104A) (see figure 2), *Big Gig* App - counting by 1s

Figure 2. *The Three Bears Problem*



Sessions 2 - 4:

- Children a) completed a brief set of experience-aligned pre-assessment tasks, (b) engaged in a media experience (1 video and 1 online game/activity); (c) completed a small set of experience-aligned post assessment tasks.
- Parents were present during the media experience and assessments but did not participate in the media or assessment activities. Instead, parents observed their children's media experiences and completed a short reflection form noting their child's interactions with the media, and documented their reflections and perspectives on a range of issues such as: their child's level of engagement, the kinds of mathematics present in the media, their child's ability to navigate a game or activity, the nonacademic content present in an episode or game, and how the content might relate to other activities the child typically does at home. Sessions lasted approximately 35-45 minutes.
- Snacks were provided for children and parents.
- Selected content:
  Session 2: *The Beethoven Problem* (Episode 108B), *Big Gig Patterns* game
  Session 3: *The Dinosaur Problem* (Episode 108A) (see figure 3), *Chicken Dance* game
  Session 4: *The Golden Pyramid Problem* (Episode 102B), *Magical Shape Hunt* game

Figure 3. *The Dinosaur Problem*

Session 5:

- Children were pre-tested with a small set of experience-aligned tasks. Following a final media experience (1 video and 1 online game/activity), children were post-tested using a small set of media-aligned items and the standardized assessment. This session lasted approximately 60-75 minutes.
- Snacks were provided for children and parents during a 15-minute break.
- Selected content: *The Sparking Sphere Problem* (Episode 112B) (see figure 4), *Big Gig Magic Cylinder (see figure 5)* song game

Figure 4. *The Sparking Sphere Problem*

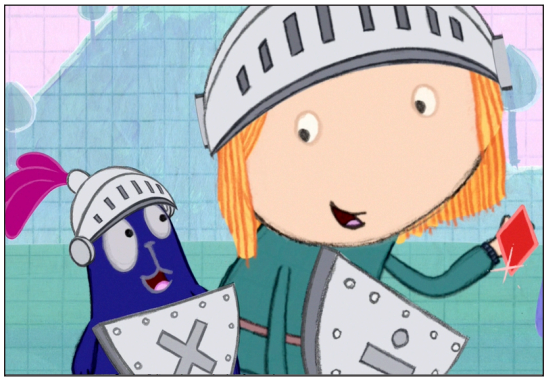


Table 1. Sequence of *PEG+CAT* Content Study Transmedia

	Focus	Data Collection	Video	Game
Session 1	Counting; Number relationships	REMA pretest Parent Survey Observation Parent checklist	*Three Bears Problem* (Chromebook)	*The Big Gig Count by Ones* (Nabi Tablet)
Session 2	Patterns	Session 2+3 pretest Observation Parent checklist Session 2 posttest	*The Dinosaur Problem* (Chromebook)	*Chicken Dance* (Chromebook)
Session 3	Patterns	Observation Parent checklist Session 3 posttest	*The Beethoven Problem* (Chromebook)	*The Big Gig Patterns* (Nabi Tablet)
Session 4	Shapes	Session 4+5 pretest Observation Parent checklist Session 4 posttest	*The Sparkling Sphere* (Chromebook)	*The Big Gig Magic Cylinder Song* (Nabi Tablet)
Session 5	Shapes	Observation Parent checklist Session 5 posttest REMA posttest	*The Golden Pyramid Problem* (Chromebook)	*The Magical Shape Hunt* (Chromebook)

Methods

To address the research questions, researchers relied on a variety of data sources, including direct assessments of children's mathematical learning; researchers' observations of children interacting with the *PEG+CAT* videos and games; and parent surveys and written observations/reflections. Table 2 highlights the data sources related to specific research questions and Table 3 shows the data sources and the number of responses for each.

Table 2. Research Questions and Methods

Research questions	REMA (Standardized assessment)	*PEG+CAT* Item Sets (Researcher-developed measure)	Researchers' observations	Parent checklist and reflection tool	Parent Survey
RQ1: Children's mathematical learning outcomes			✓		
RQ2: Parents' perspectives on educational potential of *PEG+CAT* materials				✓	✓
RQ3: Children's engagement with *PEG+CAT* media	✓	✓			

Table 3. Number of Participants for each Data Source

	REMA Assessment		PCIS Assessment		Researcher Observations	Parent checklist & reflection tool	Parent survey
	Pretest	Posttest	Pretest	Posttest			
Session 1	60	NA	NA	NA	60	58	60
Session 2	NA	NA	60	60	60	60	NA
Session 3	NA	NA	NA	59	59	57	NA
Session 4	NA	NA	59	58	59	58	NA
Session 5	NA	59	NA	59	59	60	NA

Children were occasionally accompanied by more than one adult.

Child Learning Outcomes

To examine children's mathematics knowledge, the research team relied on two tools. One was a standardized assessment of children's mathematical learning, the Research-Based Early Mathematics Assessment (REMA), short form; Weiland et al., 2012) the best available standardized assessment of children's mathematics skills.

However, researchers needed an additional assessment because the *PEG+CAT* resources curated for the Ready To Learn content study experience addressed mathematical skills that are not necessarily the focus of the REMA (e.g., auditory patterns and 3-D shapes). Researchers were also interested in assessing children's understanding of focal mathematical skills immediately following the opportunity to learn them through exposure to the *PEG+CAT* resources, that is, during the sessions in which children had viewed videos and played the games that addressed the relevant skills. Therefore, researchers developed the *PEG+CAT* Item Sets (PCIS), which were closely aligned to *PEG+CAT* experience and administered before and after the sessions during which children engaged with media that targeted specific skills.

Research-Based Early Mathematics Assessment (REMA)

The REMA is designed to assess children's mathematics learning in prekindergarten through second grade. The short version of the REMA, which was used in our study, was developed by Weiland and colleagues (2012) based on the full REMA (Clements, Sarama, & Lui, 2008); this assessment measures preschool and kindergarten children's early numeracy and geometry skills. The 19 items selected to be part of the short version of the REMA assess mathematics skills that are considered essential in preschool and kindergarten (NGA/CCSSO, 2010; Clements & Sarama, 2009)—recognition of number and subitizing, shape composition, and patterning (Weiland et al., 2012).

Each item includes a game-like activity that involves the assessor reading a verbal prompt and, at times, demonstrating with manipulatives. Children are required to provide a verbal response, point, or engage with manipulatives.

Rasch analysis conducted on the short version of the REMA provides evidence of high item reliability (approximately 1.00) and high person reliability (ranging from 0.68 to 0.76) (Weiland et al., 2012). Findings also indicate that the REMA

short form has adequate concurrent validity (correlations of 0.74 were reported with the full version of the REMA and the Woodcock Johnson Applied Problem subtest) and adequate discriminant validity (correlations of 0.64 were reported with the Peabody Picture Vocabulary Test 3rd Edition and the Letter Word DIF in the short version of the REMA).

The *PEG+CAT* Item Sets (PCIS)

To examine children's understanding of the concepts and activities included in the *PEG+CAT* sessions, the research team developed a series of item sets specific to each session. Using information gathered from the videos and games, the PCIS were used to assess children's understanding of shapes and patterns in the specific context of the session. Items in the PCIS involved game-like activities that require assessors to read a verbal prompt; in response, children were required to provide a verbal response, point, or engage with manipulatives. The items included in the PCIS are aligned to the concepts and videos shown in the *PEG+CAT* sessions (see Appendix A for the full assessment).

Each item set was developed to examine the child's learning in that particular session, and each item was designed to function descriptively within the set, focusing on particular skills present in the *PEG+CAT* games and videos (see above). The item sets were not designed to function as a battery or total score, and we did not analyze them as such. Instead, we analyzed each item individually from pre test to post test.

Data collection of child learning measures

Trained assessors administered the REMA before Session 1 and at the conclusion of Session 5, and the PCIS during sessions 2 through 5.

The videos and games included in the content study experience were curated to provide two opportunities for children to learn about patterns and shapes, the two focal mathematical skills. Sessions 2 and 3 focused on patterns; sessions 4 and 5 focused on shapes. The PCIS pre-test for patterns was conducted at the start of session 2, and the post-test, which was broken into two segments and was conducted after sessions 2 and 3. Similarly, the PCIS pre-test for shapes was conducted at the start of session 4, and the post-tests were conducted at the end of sessions 4 and 5 respectively. Because the pre-tests included topics related to two sessions, they were longer than the post-tests; also sessions 2 and 4, which included the pre-test as well as post-test, were approximately 15 minutes longer than sessions 3 and 5. Table 4 below provides a summary of the assessment schedule.

Table 4. Ready To Learn Content Study Assessment Schedule

	Pretest	Posttest
Session 1	REMA pretest	
Session 2	PCIS Session 2 & 3 Pretest	PCIS Session 2 posttest
Session 3	None	PCIS Session 3 posttest
Session 4	PCIS Session 4 & 5 Pretest	PCIS Session 4 posttest
Session 5	None	PCIS Session 5 posttest; REMA posttest

Data analysis for child learning measures

To examine children's understanding of the concepts and activities included in the *PEG+CAT* sessions, the team conducted a series of item-level descriptive analyses and a series of non-parametric analyses. The item sets were developed to be descriptive in nature at the item level, not as a battery assessment. Researchers conducted comparative analyses at the item level using the Wilcoxon matched-pairs signed-ranks test, which tests the equality of matched pairs of observations (Wilcoxon, 1945). The null hypothesis is that both distributions are the same. To correct for multiple comparisons, the Benjimini-Hochberg adjustment was used to control the expected proportion of incorrectly rejected null hypotheses. A paired t-test was used to analyze the REMA data.

Parent's Views of *PEG+CAT* Transmedia Learning Materials

Parent survey

Parents of all participating children also completed a survey during Session 1 (See Appendix D). The purpose of the survey was to collect important background information (e.g., home language, parents' educational background) about the families participating in the study and to gather information on how, if at all, families engage with video and digital games at home. The survey also asked respondents to provide information about home-based practices and activities that target the development of mathematical skills and understandings.

Data analysis of parent survey data

To examine the quantitative data collected in the survey, the research team conducted descriptive analysis by calculating frequencies and percentages for the binomial, categorical, and ordinal data, and means and standard deviations for the continuous data. To identify patterns in the qualitative responses, researchers examined all open-ended questions to develop potential coding categories. To identify patterns in the qualitative responses, researchers examined all open-ended questions to develop potential coding categories. Open-ended responses were then coded to identify meaningful patterns that could inform findings.

Parent/Caregiver checklist and reflection tool

Researchers asked parents/caregivers to observe all video viewing and game play sessions in which their child participated, and document their reflections in the Parent Checklist and Reflection Tool. The purpose of parents' observations was to gather information about how parents viewed the *PEG+CAT* resources as well as their reflections on how their child was engaging with the materials, and what she or he might be learning as a result of the experience. The checklist included a series of yes-no questions, designed to capture parents' impressions during the video viewing and the game play components of each session, and a set of open-ended questions that asked parents to articulate, if they chose to, more detailed observations about the *PEG+CAT* resources. During the final session, researchers included additional items that asked parents to reflect back on the experience as a whole, including any changes in child behavior at home that they felt were related to their participation in the study.

Data analysis of parent checklist and reflection tool

Researchers conducted descriptive analysis of parents' responses to the yes-no questions included the Parent Checklist and Reflection Tool. They also calculated the frequencies and percentages for each item, and determined whether patterns in parents' responses were statistically significantly different across items. Researchers reviewed parents' responses to the open-ended questions, and identified salient themes based on these reviews. Individual reflections were subsequently coded for the themes and themes were then counted and, in many cases, turned into percentages. Themes were then used to identify meaningful patterns across questions and respondents as well as to interpret the quantitative results.

Children's Engagement with *PEG+CAT* Transmedia Learning Materials

Researcher observations

To identify and describe children's engagement patterns with *PEG+CAT* videos and interactive games included in the experience, researchers relied on close observations of children. The observations, which were guided by a structured observation protocol, were conducted during all sessions of the study while children were viewing videos and playing games.

Researchers documented various features of children's attention to the transmedia, and provided descriptions to support their observations; specifically, we were interested in identifying the extent to which children's behaviors provided evidence of their engagement with the transmedia, whether they are able to complete the experience independently, and the frequency and type of assistance children required in order to complete the experience.

At the conclusion of the video-viewing, researchers asked children to describe what they had noticed in the video, the problem Peg and Cat had encountered, and the solution that the characters had devised to address the problem. At the conclusion of game and app play, researchers asked children to describe what they had noticed in the game, and their opinion of the game, that is, whether children liked or disliked the game, why, and whether they had a part they liked best.

Data analysis of observations

Researchers analyzed observation data with the overarching goal of describing (a) patterns of attention observed among children during media experiences, and (b) the extent to which children required/requested adult support to engage in the viewing and/or online game/activity. These analyses offer a systematic description of the enactment of the experience—that is, how children engaged with the media during the study and what elements they were able to describe.

Researchers obtained overall frequencies of the close-ended responses relating to whether or not a child exhibited certain behaviors during video viewing and gameplay (e.g., Child was sitting still, yes=1, no=0). Next, we conducted Pearson's Chi-Square analyses to determine if there were differences across the five videos and five games in how children engaged with the specific digital assets. Due to the small sample size of 58–61 children or "cases" (the

sample size varied depending on the session; and one case included all the sessions one child completed), results of the chi-square analyses should be interpreted with caution, as there were several analyses that had cell sizes less than 5.

Researchers used a grounded theory approach with constant comparison to analyze the open-ended responses. We compared the responses within a case and across sessions to identify the major themes. Four members of the research team individually coded 4 different cases (8% each for a total of 32% of the data), taking detailed notes on emerging themes. After discussing our individual findings, we developed a preliminary coding schema, which we then used to code an additional 5 cases (6.6% each for a total of 26.4% of the data). After meeting again to discuss our findings, we refined the coding schema (see Appendix H) and coded 6–7 additional cases each to complete coding of all observation data.

Results

Researchers observed changes in children's mathematical skills over the course of the five-week experience; parents views of *PEG+CAT* materials, including their potential to support children's mathematical learning; and children's engagement with the *PEG+CAT* experience and the extent to which they required adult support while interacting with the videos and games.

Child Mathematics Outcomes

Researchers analysis of the assessments (both the standardized measure, the REMA, and the researcher-developed measure, the PCIS) reveal the impact of *PEG+CAT* resources on children's mathematical skills and the extent to which these resources represent opportunities to learn specific mathematical skills and concepts.

Child learning outcomes for the Research-based Early Mathematics Assessment (REMA short form)

Children's performance on the standardized assessment (REMA) improved from pretest to posttest. While the result is positive, it is not conclusive.

Researchers found a small, statistically significant increase (on average of 1.42 points) between pretest (mean = 48.69, SD = 6.53) and posttest scores (mean = 50.12, SD= 5.38) when analyzing children's performance on the standardized assessment. (Table 5, below, provides the complete results.)

Table 5. *Ready to Learn* Content Study REMA Results

Variable	Number of Observations	Mean	Standard Deviation	Min	Max	Significance
Pretest	59	48.69	6.53	35	68	
Posttest	59	50.12	5.38	35	60	
Difference	59	1.42	4.90	-13	13	$p < 0.05$

The significant difference in pre/post assessment scores should be interpreted conservatively. For context, children in the control condition of the 2013 PBS KIDS Transmedia RCT experienced more than twice the increase in their REMA scores from pretest to posttest (RCT Control: 2.97 mean score increase vs. Content Study: 1.42 mean score increase), despite receiving no intervention.

The REMA was chosen for use in this study because it is the most appropriate standard measure available; currently, no standard assessments are designed to measure change in learning over such a short period of time, nor do any assessments cover the range of content addressed in the *PEG+CAT* materials. Therefore these findings suggest that the *PEG+CAT* resources show promise for supporting children's mathematical learning and merit further study, with more rigorous research designs and more sensitive instrumentation.

Child learning outcomes for *PEG+CAT* Item Sets (PCIS)

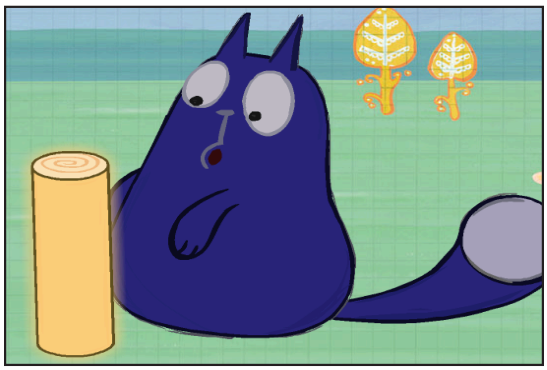
For a small number of items on the PCIS, children's post-test performance improved compared with their pre-test performance. Although gains were statistically significant for only one item (in which children were asked to identify a cylinder), the gains on a number of items are noteworthy. Below we provide more details about these items and offer some conjectures to help interpret these impacts on children's mathematical skills.

Children's performance on an item that asked them to identify a cylinder, improved significantly between the pretest and the post-test.

To assess their ability to recognize the 3-D shapes to which they were introduced in the *PEG+CAT* episodes, one set of items in the PCIS required the assessor to show the child images of characters from the *PEG+CAT* episode *The Golden Pyramid Problem*, and ask the child to name the shape the character is holding. One item in this set involved the assessor pointing to an image of Cat holding a cylinder (See Figure 5), and asking the child to identify the shape. Although no child was able to name the shape in the pretest, 17 of 58 children were able to correctly name the shape at posttest, a gain that was found to be statistically significant.

In this instance, a number of features—both in *The Golden Pyramid Problem* as well as in the design of the assessment item—are likely to have reinforced children's recognition of the cylinder. The cylinder (specifically, a "magic" cylinder) is central to the plot of the episode—the shape appears on the screen for an extended period of time; on numerous occasions, characters point to the shape and name it as a cylinder; on one occasion, one of the characters (Ramone) offers a definition of a cylinder ("a tube with circles on its ends") and on another occasion, Peg compares a cylinder to a cube ("a cube has squares on the top and bottom, a cylinder has circles"). The assessment item used a screen capture to represent the cylinder in exactly the same way as children encounter it in the episode, held by Cat.

Figure 5.
The Golden Pyramid Problem



Although the episode and the corresponding suite of items in the assessment also included two other character-shape pairs (Toad holding a cube and Peg holding a rhombus), there were fewer features in the episode supporting children's learning of these shapes in the same manner as for the cylinder. Children's correct responses increased from pre- to post-test for the cube and the rhombus as well, but more modestly, from zero at pretest to 4 and 5 respectively.

For a number of other items, there were noteworthy gains in children's performance between pre- and post-test. However, these gains were not statistically significant after adjusting for multiple comparisons.

For five items—four focused on 3-D shapes and one focused on patterns—more children were able to provide the correct response during the posttest than during the pretest. Table 6 below highlights these items (please see the Appendix I for comprehensive tables showing the trends in children's performance for all items). While not statistically significant, these gains are notable, as they suggest the potential of the *PEG+CAT* materials to enhance children's understanding of 3-D shapes and patterns.

Also notable is the fact that children's gains are concentrated in the same session, in a suite of items that follow *The Golden Pyramid Problem* episode, which targets shapes. It is likely that some of the design features of the episode might have advanced children's mathematical skill. In this episode, the shapes on which we measured learning gains—namely, the cylinder, cube, and pyramid—appear on the screen for a considerable length of time, and are defined (e.g., a pyramid has triangles on its sides), sometimes in terms of familiar referents (e.g., a cube looks like a box), and repeatedly identified (by the characters pointing to the shape while naming it).

Finally, the greatest pre-post gains were observed in the items for which the post-tests were conducted during session 5, after children had had two opportunities to learn 3-D shape recognition from the *PEG+CAT* study experience—once in session 4, when they viewed *The Sparkling Sphere Problem* and played the Big Gig Cylinder game, and again in session 5, when they viewed *The Golden Pyramid Problem* and played the *Magical Shape Hunt* game. As such, it is likely that children may have benefited from two sessions worth of exposure to the mathematical skill of 3-D shape recognition.

Table 6. PCIS Items for Which Noteworthy Pre-Post Gains Were Observed

PEG+CAT Episode/ Game	Target Skill	Description of item	Pretest		Posttest		Change Pre to Post	
			% Correct	n	% Correct	n	% Correct	n
Big Gig Patterns	Pattern Completion	Using a screenshot from the *PEG+CAT* Game App, The *Big Gig,* the assessor slides their fingers across a 1, 3, 1, 3 pattern, then asks the child to tell them what number comes next.	35.59%	21	54.24%	32	18.64%	11
The Golden Pyramid Problem	3D Shape recognition	The assessor places the following 3D shapes in a basket: sphere, cube, cylinder, and pyramid, then asks the child to point to or pick up the cube.	38.98%	23	55.93%	33	16.95%	10
The Golden Pyramid Problem	3D Shape recognition	The assessor shows the child images of various 2D and 3D images from the *PEG+CAT* video, *The Golden Pyramid Problem*, and asks the child to point to the cylinder.	38.98%	23	54.24%	32	15.25%	9
The Golden Pyramid Problem	3D Shape recognition	The assessor places the following 3D shapes in a basket: sphere, cube, cylinder, and pyramid, then asks the child to point to or pick up the cylinder.	54.24%	32	67.80%	40	13.56%	8
The Golden Pyramid Problem	3D Shape recognition	The assessor shows the child an image of Mermaid holding pyramids from the *PEG+CAT* video, *The Golden Pyramid Problem*, then asks the child what shape Mermaid is holding.	3.39%	2	15.25%	9	11.86%	7

Parents' views of and experiences with *PEG+CAT* materials

Parents' reflections of the *PEG+CAT* materials, including their potential to support children's mathematical learning, are based on analyses of the Parent Checklist and Reflection Tool, completed by parents. Here we summarize parents' views of the *PEG+CAT* videos and games; we also report on parents' observations of their child's engagement with these resources during and after the study sessions.

Nearly all parents reported strong, positive impressions of *PEG+CAT* resources. Parents' opinions of the videos were consistently high, though their views of the games varied.

The vast majority of parents expressed appreciation of the *PEG+CAT* videos. Across sessions, the majority of parents (95%) agreed that the *PEG+CAT* videos were "good for young children". Most parents indicated that children enjoyed watching all *PEG+CAT* episodes included in the study (91%), and that they understood the content presented in the video and what the characters were discussing (89.8%). There were no significant differences in parent reports by video episode.

Likewise, most parents (95%) were of the opinion that the *PEG+CAT* interactive games were good for young children, and that children enjoyed engaging with the games during the study. There were few occasions (14% of sessions) when parents were concerned that their child was bored with the game. While parents had generally positive views of the games, opinions varied from game to game. In particular, parents expressed stronger positive opinions about *Magical Shape Hunt* and *Chicken Dance* compared to the games in the Big Gig[3] App , especially with respect to teaching problem solving (as Table 7 illustrates).

Table 7. Parent Views of Games Addressing Problem Solving

***PEG+CAT* Game**	**Percentage of parents who thought the game addressed problem solving**
Magical Shape Hunt	94.7% (N = 54)
Chicken Dance	92.7% (N = 51)
Big Gig Magic Cylinder	74.5% (N = 41)
Big Gig Patterns	74.5% (N = 38)
Big Gig Count by Ones	72.2% (N = 39)

The Magical Shape Hunt was especially popular among parents for its focus on problem solving (94.7%) and vocabulary (84.2%), and almost all parents (98.2%) reported that their child enjoyed playing this game.

Overall (41%) the parents reported in Checklist responses that their children did not understand the purpose, rules, and procedures of at least one game, and that they needed help from an adult to start and continue playing the games. Parents expressed the most concerns that children found the Big Gig games confusing and difficult

3 A new and improved version of the Big Gig app was released after the study concluded.

to play, specifically Big Gig Count by Ones (35.8% of parents) and Big Gig Patterns (36% of parents); in contrast, only a few parents (10.7%) expressed the same concern about *Magical Shape Hunt*.

Parents reported that after *PEG+CAT* study sessions, they noticed changes in children's behavior at home.

In response to questions on the Parent Checklist and Reflection instrument, about half of parents (n=31, 54%) reported changes in their children's behavior at home after study sessions. These parents reported hearing their children talk about songs, shapes, counting, vocabulary, questions from interactive games, patterns, numbers and colors. One parent noted that her son "likes to make patterns with his toys like the video game" while another parent reported that her daughter had become really interested in "counting, dancing, asking questions, and writing" after "she saw the *PEG+CAT* videos and games".

In more than half of participating families (54%; n=31), parents reported that children asked to watch *PEG+CAT* videos or play *PEG+CAT* games at home. While most families had the necessary equipment to view the videos at home (i.e., a television), almost half the parents (41%; n=24) reported they had no way of accessing *PEG+CAT* resources outside the study. For example, one parent commented, "No he tenido la oportunidad pero si me gustarla. (I haven't had the opportunity but I would like to.)", while another parent said, "No porque no tengo aseso a esos juegos. (No, because I don't have access to these games.)", and a third parent noted that her child wanted "to know when are we going to get *PEG+CAT*. I want to know how to get them."

Overall, parents viewed the *PEG+CAT* resources as having considerable potential to support children's mathematical learning.

In Checklist responses, nearly all parents remarked on the educational aims of the videos and games—that is, parents held the view that the *PEG+CAT* materials were trying to teach mathematics, problem solving, and new vocabulary.

As the table below (Table 8) indicates, the majority of parents agreed that the *PEG+CAT* videos and games included in this study were addressing mathematics learning. In Checklist responses parents indicated that the mathematics topics covered by the videos and games were appropriate for preschool children. A couple of parents reported they liked how the mathematics topics were presented and taught in the videos. One said, "I think the video and game was good for my daughter. What caught my attention was patterns. She really loves patterns. I feel that it

Table 8. Parent Views About the Content Upon Which Videos and Games Focused

	% of video viewing sessions addressing this topic (N=292)	% of game play sessions addressing this topic (N=292)
Mathematics	93.2%	88.1%
Problem solving	96%	82%
Vocabulary	82.7%	60.5%

teaches the kids a lot about patterns and shapes." Another reported, "The teaching of the different shapes and sizes is the main thing that caught my attention. I loved the fact music is incorporated into the lesson. It makes learning easier."

Half of the participating parents reported that they worked with their children on activities related to *PEG+CAT* at home.

In Parent Checklist and Reflection responses, half (N=29) of parents indicated that they had interacted with their children at home on *PEG+CAT* related activities. One parent pointed out that she had "the opportunity to work with my son doing mathematics activities, vocabulary, and questions about games etc." Parents' comments about home-based activities emphasized the mathematics content represented in the episodes included in the study. Recognizing and identifying shapes was the common topic that parents reported working on (29%; N=16). For example, one parent noted that, because "the last session was about shapes, we played identifying shapes and tried to name them just like the last video," while another parent reported that she and her child "talk about shapes and count numbers."

Most parents (90%) indicated that they would watch the video or play the game with their child at home. One parent observed that she "enjoyed the activities as much as [her daughter]. The video was very funny and math-friendly. I would love to sit with my daughter and have fun watching and playing." Another parent remarked that she "would definitely watch it and play the game because it's educational. It shows numbers, patterns, and it's a nice learning activity." Finally, a parent who is also a preschool teacher reported that the videos and games gave her a few ideas and informed her teaching.

Children's engagement with the *PEG+CAT* experience

Analyses of researchers' observations and parents' reflections paint a picture of how participating children engaged with the *PEG+CAT* videos and interactive games during the five weeks of the study. Here we describe how children attended to the videos and games, variations in the patterns of children's attention, the amount and nature of adult support children required in order to engage with the media, and the extent to which children were able to summarize key elements of the videos and games.

Overall, children were positively engaged while watching *PEG+CAT* videos and playing *PEG+CAT* games.

Indicators of children's engagement in the media included physical behaviors, such as sitting still and attending to the screen while watching videos or playing games, as well as verbal expressions of interest, such as singing, humming, or counting along with Peg, "interacting" with the characters by responding to or repeating their comments, asking questions about the videos and games, or requesting to watch the video or play the game again.

Children paid focused attention during video viewings—for the vast majority of video viewing sessions (N=298), researchers noted that children sat still (91.2%) and paid attention to the events unfolding on the screen (94.9%). In some instances,

researchers also observed children clapping, snapping, or tapping their fingers; dancing, swaying, or nodding along in time to the music; pointing at the screen, leaning forward, or moving the laptop screen closer. One child was observed laughing, smiling, dancing in his seat, and singing along with *PEG+CAT* (to the 2, 4, 6, 8 song) while watching.

Aside from physical behaviors, children also expressed their interest verbally. While watching The Beethoven Problem episode, for example, one child was observed laughing at the jokes, counting the sausages, and singing along with the characters in addition to leaning forward, with elbows on the table, watching intently. Across all video viewings (N=298), salient patterns of verbal engagement included laughing at jokes (36% of sessions); commenting on or asking questions about the videos (34.3%); singing along with Peg (20.5% of sessions); talking over the video or responding to the on-screen characters, by counting with Peg, and repeating things Peg said (e.g., shape names or mathematics problems), shouting out observations, etc. (16.2% of sessions). Although children appeared positively engaged during video viewing, requests to view the video again were rare, occurring only in 1.7% of the sessions.

Researchers noticed that children exhibited a pattern of distracted or disengaged behavior in approximately one-fourth (26%) of all video-viewing sessions in the study. There was no evidence that distraction or disengagement was more common during particular videos. Indicators of disengagement included children looking around the room or out of the window rather than at the screen, putting their heads down, closing their eyes, fidgeting, hiding under the table, running around the room, spinning around in their chairs, asking to stop watching or to color with their siblings, and clicking out of the video screen. Other types of distraction were external or circumstantial (e.g., a sibling in the room or a loud noises in nearby rooms).

Children were often engaged during *PEG+CAT* game play. For the majority of sessions (N =298), children remained seated (92.3%) and attended to the screen (94.3%) while playing. Researchers noted that children were focused on "winning" the game by completing it successfully; during game play sessions, children expressed excitement by clapping, yelling "Yes!" or "I did it!", looking at observer or caregiver for affirmation, or pumping their fists into the air. Other expressions of children's engagement included laughing, smiling, singing, dancing, trying to "interact" with the screen or the characters, narrating gameplay aloud (e.g., counting, naming shapes, etc.), and asking to play again and/or playing again on their own. While playing the *Chicken Dance* game, for example, a researcher noticed that the child "wanted to keep playing. Even after he accidentally clicked off the screen and it disappeared, he wanted to keep playing a few minutes later. He nodded his head when Peg asked him to help the chickens. He was smiling while watching and listening. He was making "cheep, cheep" sounds with his mouth, mimicking the chickens. He played the pattern game all the way through 4 times, persisting as the patterns got more complex. By the third round he was up from his chair, doing the dances, flapping his arms like a chicken. He was dancing along with the background music." Similarly, another researcher observing a child during a session of the *Magical Shape Hunt* noted that the child smiled, laughed at various points during gameplay, and wanted to play the game multiple times.

While children were more consistently engrossed during video viewing, their engagement with interactive games varied.

With interactive games, children appeared to find some games more engaging than others. According to researchers' observations, children seemed more engaged—expressing their interest physically and verbally—while playing the *Magical Shape Hunt* game (96.6%) and the *Chicken Dance* game (95.1%), than happened with other games. While

playing the *Magical Shape Hunt* game, a child enthusiastically responding "yes!" when the game asked, "Can you help the mermaid find her jewels?", and counted out loud along with Ramone at various points in the game.

Children were less engaged during the Big Gig[4] app sessions than they were during *Chicken Dance* and *Magical Shape Hunt* sessions. Some children became disengaged when they grew frustrated with an aspect of gameplay. Fewer children were reported trying to interact with all three activities in the Big Gig App (1.7%-13.3% compared to *Chicken Dance* and *Magical Shape Hunt*, both at 38.6%; $p<0.001$); fewer children wanted to play Big Gig: Counting by Ones (21.7%) and Big Gig: Patterns (19%; $p=0.001$); and Big Gig: Patterns had the largest proportion of children asking to stop playing (34.5%).

Children's apparent lack of engagement with the Big Gig App: Patterns might have been due to the issues they encountered while playing the game. For example, researchers noted that some children did not understand the purpose of the game or the need to press the numbers at the bottom of the screen, and pressed numbers randomly; in some instances, children were unable to play the games independently, and they required help and redirection from researchers. (See below for parents' reflections of the Big Gig App, and their perceptions of the challenges encountered by the children while playing the games in this suite.)

Most children were able to identify and talk about the different elements of the videos, but fewer were able to describe the problem and the solution at the center of each video episode.

At the conclusion of video viewing, researchers asked children to share reflections on what they had noticed, most children were able to distinguish and discuss different elements of the episode. In 86.7% of sessions, children provided a verbal response, referring to the storyline, characters, mathematics concepts, or actions of specific characters. Children's responses and their ability to recall plot, character, and other details related the episode may be seen as evidence of engagement (see Table 9 below for examples of children's responses).

Table 9. Children's Reflections on the Video, Immediately After Viewing

***PEG+CAT* Episode**	**Children's responses to the question, "Tell me about the video. What did you notice?"**
The Three Bears Problem	The little girl and her cat were singing with the bears and solving problems and singing.
The Beethoven Problem	The pig liked the song. A lot of people came to the 5th floor. The cat made a new song, found a pattern and he laughed.
The Sparkling Sphere Problem	The dragon was sitting on the sphere and then on the oval.
The Sparkling Sphere Problem	I saw a rectangle. Rectangle prism. I saw the circle.
The Golden Pyramid Problem	Was about the king stole the triangles and the dragon was going to tickle them and then cat got a balloon and then Peg said, a cylinder is like this and cat was moving the tree and Peg caught the cylinder. That was my favorite part.

4 The study used the original published version of the Big Gig. A newer version of the app became available after completion of the Content Study.

When asked about the problem ("What was the problem that Peg had?") and the solution ("How did Peg and Cat solve the problem?") at the center of each episode, children varied in how they responded (Table 10).

Table 10. Children's Reflections on the Problem and the Solution at the Center of Each Video

	Identification of the problem	Identification of the solution
No / Incomprehensible response	31.9% of sessions	37.9% of sessions
Some response	67.8% of sessions	61.1% of sessions

As Table YY indicates, a smaller majority of children were able to provide a response to questions about the problem/solution featured in each video. Describing *The Golden Pyramid Problem*, for example, one child noted, "The only problem I noticed was they couldn't find the pyramids… They found them in the king's castle in his hat", while another child pointed out that the problem in *The Dinosaur Problem* episode was that "they (Peg and Cat) don't know how to jump over big muddy puddle", which they solved "by doing the pattern". Other children provided details related to the mathematics and plot of the episode. For example, one child pointed out that in *The Sparkling Sphere Problem*, "they (Peg and Cat) had to save the wizard Ramone" by using "a sphere, [and a] rhombus": "They counted from 2 to 20 and Ramone popped out of the bubble and he float in the bubble …and he float[ed] in shapes."

Children were able to engage with the games independently more than half the time, but some form of support—typically from a researcher—was necessary for the other sessions.

There were a number of reasons why children required assistance to start or continue with game play (46% of sessions). In some instances, children did not understand specific features of the game or the audio directions, or were not clear about what they were required to do. Most notably, this was an issue with the three games of the Big Gig App, where some children (approximately 30%) found it difficult to see a highlighted white line and understand that they were supposed to match the number that was in this field. Observing one child playing this game, for example, a researcher noted, "The child didn't understand that the vertical, white highlighted area showed the number Cat wanted her to select. There were a handful of instances when she instead chose the next number in the pattern, getting the answer incorrect." (Again, the version of the app available for this study has been replaced by an updated version that solved this and other user interface issues.)

When children required some assistance, researchers modeled gameplay to help children who were unsure of how to begin a game; pointed out game elements they did not understand, such as the white highlighted line in the Big Gig App; showed children how to use aspects of the device, such as a computer mouse, camera, or track pad; and reminded children throughout gameplay about a certain game mechanics with which they were having difficulty (e.g.,

clicking the mouse, waving hand over the camera). On a few occasions, parents provided support, usually in terms of gameplay and technology use. For example, one mother helped her child by instructing her in Spanish which numbers to press when playing the Big Gig App: Counting by Ones activity, while another mother helped her child use the track pad to play the *Magical Shape Hunt* game when the child kept trying to touch the screen.

In some instances, children had difficulty with the equipment required to engage with the media. Approximately 39% of children had trouble using a mouse or track pad correctly. Also, some children found the *Magical Shape Hunt* challenging—likely due to its novel use of the camera built into the Chromebook, requiring children's hand movements to be within the camera's range of view—something that is not necessarily intuitive to a preschooler who is unfamiliar with such equipment.

There were a small number of technical difficulties (9.8% of sessions) during gameplay (e.g., slow Internet, disconnected wireless mouse, etc.) that required researchers to intervene. These predominantly occurred during online gameplay with *Chicken Dance* (20%) and *Magical Shape Hunt* (25.4%) and were related to a lapse in the wireless Internet connection.

Discussion

This CPB-PBS *Ready To Learn* Content Study suggests that public media resources, and the transmedia strategy that has been the focus of Ready to Learn these past four years, have the potential to provide children with measurable benefits in the skill domains they seek to target. Assessment data, including statistically significant gains on one item and positive, non-significant gains on three items as noted above, indicate that that direct engagement with *PEG+CAT* transmedia resources shows promise for enhancing children's mathematics skills (identification and recognition of 3-D shapes). These results are consistent with prior research studies using a similar design (Rockman et al., 2010).

A large majority of study parents found *PEG+CAT* resources appealing, and characterized them as educational resources that can support mathematics learning for their preschoolers. Most parents (95%) reported that *PEG+CAT* videos and interactive games were good for young children, and there were few occasions (14% of sessions) when parents were concerned that their child was bored with a game. Finally, most children were able to engage with *PEG+CAT* video resources independently, and a majority were able and willing to use the *PEG+CAT* interactive games in a similar fashion.

We recommend that these findings be interpreted with consideration of several additional observations about children's performance on the assessments and behavior when using *PEG+CAT* resources.

First, research concerning children's development of mathematics concepts has documented particular learning trajectories, or the typical pathways of children's emergent mathematical understanding. In particular, learning about patterns is more challenging, and comes developmentally later than learning about shapes, suggesting that these two skills should be separated and sequenced. In these frameworks, understanding the abstract idea of "patterns" develops gradually over early childhood (Clarke, Cheeseman & Clarke, 2006; Starkey, Klein & Wakely, 2004), whereas a beginning understanding of shapes and the ability to distinguish between different shapes can be observed in very young children (Sarama & Clements, 2009). Further, geometric concepts, including shapes, have been described as the foundation for other mathematical thinking (Bronowski, 1947; Clements & Battista, 1992; Clements & Sarama, 2007), suggesting strong shape knowledge and acquisition needs to be in place before more complex concepts, such as patterns, can be understood. As such, our findings may represent a natural developmental trajectory of young children's mathematical learning.

Consistency and repetition are important for supporting children's learning.

The contextual nature of the presentation of concepts has been noted as key to children's cognitive development (Vygotsky, 1987). Research shows children's learning from media can deepen through successive interactions with specific concepts and skills (Crawley, Anderson, Wilder, Williams, & Santomero, 1999; Stevens and Penuel, 2010). Children in the study did not have the opportunity to repeat experiences they found engaging and enjoyable as they may have done in a naturalistic setting. At the same time, children were repeatedly exposed to the same shapes across episodes and games, and the context for such exposure was the same—all episodes and games took place in the same setting. Further, the shapes were all defined multiple times with various examples, and as Sarama and Clements argue (2009), "shape words and names help organize and direct attention to the relevant features of objects" (209). Thus, the link between the naming of the shape and the presentation of the shape likely enhanced children's learning.

The notable exception to this pattern in our findings was children's inability to identify a sphere, despite repeated exposure and verbal associations with objects. One possible explanation for this is that in the 2-D representation of videos and games, was not able to represent a 3-D sphere without making it look like a 2-D circle, such that children may have confused the two shapes.

The way patterns were represented, explained, and reinforced may have been insufficiently clear and consistent. While children were provided with multiple opportunities to engage with patterns (i.e., watching a video and playing an app game), the available representations of the concept of patterns and specific pattern content may been less supportive of learning. Settings varied across episodes and between the episodes and games, and "pattern" was only defined once in the Beethoven episode and very briefly in the Big Gig Patterns game. Given that the development of children's understanding of patterns is more gradual than it is for shapes (see above), it may be that this level of defining did not provide enough scaffolding for children to completely understand the conceptual idea of a pattern (Vygotsky, 1978). Further, the patterns children were exposed to in the episodes (AAB, AAAB) were more advanced than the traditional AB pattern, and also different from episode to episode. Whereas the same shapes were consistently presented, this lack of consistency suggests this presentation of patterns may have been too taxing on young children's cognitive load (Sweller, Ayres, & Kalyuga, 2011). Similarly, in the *Chicken Dance* game, there is no mention of the word "pattern," such that the game is not contextualized as a pattern but as helping the chickens complete their dance. Without a verbal cue or connection to the idea of "patterns," children were not primed to think of the game as a pattern activity. Further, children received no feedback on their pattern completion, except the response from Peg: "That wasn't the dance step that was supposed to come next, so, um try again?", suggesting there was not sufficient scaffolding in place to help children refine their thinking as they attempted to provide the correct answer (Vygotsky, 1978).

Limitations and Constraints

The sample of children for this exploratory, descriptive study was small, consisting of families living in urban neighborhoods, where there is a higher concentration of low-income households and children who speak a language other than English at home. While this sample is appropriate to the goals of the *PEG+CAT* study and broadly representative of the audience served by the Ready To Learn Initiative, the sample is not nationally representative of the population of preschool children and their families. Moreover, because the sample consisted of families who volunteered to participate in this study, selection bias (i.e., the participation of families where parents are favorably disposed toward media-rich forms of learning) cannot be ruled out. Given these limitations, the findings apply specifically to the children and families who participated in this study and do not support inferences about children in general.

The study experience was unmediated in that children interacted with resources independently, and without cooperation or instruction from parents, teachers, or researchers (unless guidance was requested to deal with technical or usability issues that arose). The resources that children engaged with were carefully selected for their focus on patterns and shapes and the presence of particular educational strategies. They were also presented in a sequence that researchers felt would provide the strongest possible benefit.

Study conditions may have influenced children's behavior. Children and parents who participated in the study found themselves in a new and very unfamiliar environment: the offices of education researchers. This environment and the interactions with researchers who politely asked children to participate in study activities may have influenced children's behavior. This effect may have been reinforced by the fact that families typically worked with, and received considerable individualized attention from, the same researcher over the course of the five-week experience, building rapport and a cordial relationship that made the experience more fun, but also may have created expectations on the part of the families about what was expected and how they should conduct themselves. Thus, children's behavior and parents' reflections may differ from what they would have been in more natural environments in which they interact with digital media.

A customized approach to assessment was required. First, measures of the early mathematics skills targeted by *PEG+CAT* remain in short supply. Second, the scope and depth of the intervention itself were very limited, requiring an assessment that was similarly focused. Specifically, there are no standardized preschool mathematics measures with valid subtests for the particular skills (counting, patterns, shapes, etc.) targeted by the study experience. Assessments are generally designed to track learning as it emerges over longer periods of time and multiple learning experiences. The REMA was selected for this study because it was judged to be the best possible standard measure available, and has been shown to be valid and reliable with children from lower-income households. However, it

measures a broader set of skills than *PEG+CAT* resources covered, does not have sub-skill scales, and is designed to detect changes in learning over longer periods of time than those this study sought to examine. Similarly, the PCIS assessment was developed according to the highest research standards, but as with any curriculum-aligned assessment, it has limited psychometric data compared to established, standard measures.

Data provided by parents through surveys was not triangulated with independent data collection activities such as observations in family homes. While researchers have no reason to mistrust the integrity of parent responses, but cannot exclude the possibility that parents may have sought to provide responses they felt researchers would prefer.

The single-condition design means that all claims this research can support are more suggestive than definitive. Without a like comparison group of children who did not engage in study activities, it is not possible to exclude the possibility that differences in children's performance resulted from chance experiences that took place outside the study.

Future Research

This study's findings point the way for research on transmedia and early learning, including our own Ready To Learn *PEG+CAT* Home Study (2014/2015).

Early learning mathematics assessments

The creation and validation of assessments that include subscales for individual skills (like patters and shapes) continues to be an important priority for the field. To date, no assessment instruments have been created that do this, or have been made valid and reliable for children living in under-resourced communities or for whom English is a second language. Similarly, there is a need for micro-genetic assessments that can capture emergent and partial knowledge, as opposed to the more typical approach to assessment that assumes a much longer period of engagement and rehearsal of new knowledge between pre- and post-test.

The study transmedia experiences in the naturalistic settings

While broad patterns of domestic media use and technology engagement have been documented through recent survey research (Rideout, 2014) much less is known about how contemporary families, siblings, and young children on their own engage with particular resources, or the degree to which children and parents may benefit from such engagements. New research, that takes place outside the learning laboratory conditions used in this study, could contribute new and important knowledge to the field by adding to the existing research on children's home television experiences (Crawley et al, 1999; Anderson et al, 2000).

The study of emerging learning technologies that are being broadly adopted

Many studies have documented how children and families watch television. New research is needed to describe how children engage with touch-screen technologies like tablets and smart phones. In particular, new research on the time, manner, and social arrangements for such engagement can help developers to better understand the placement and function of these media in the context of home and school learning. In turn, this knowledge could inform public media's efforts to build stronger home-school connections to better support early learning and development among children who may struggle with the skills needed to experience success in school settings.

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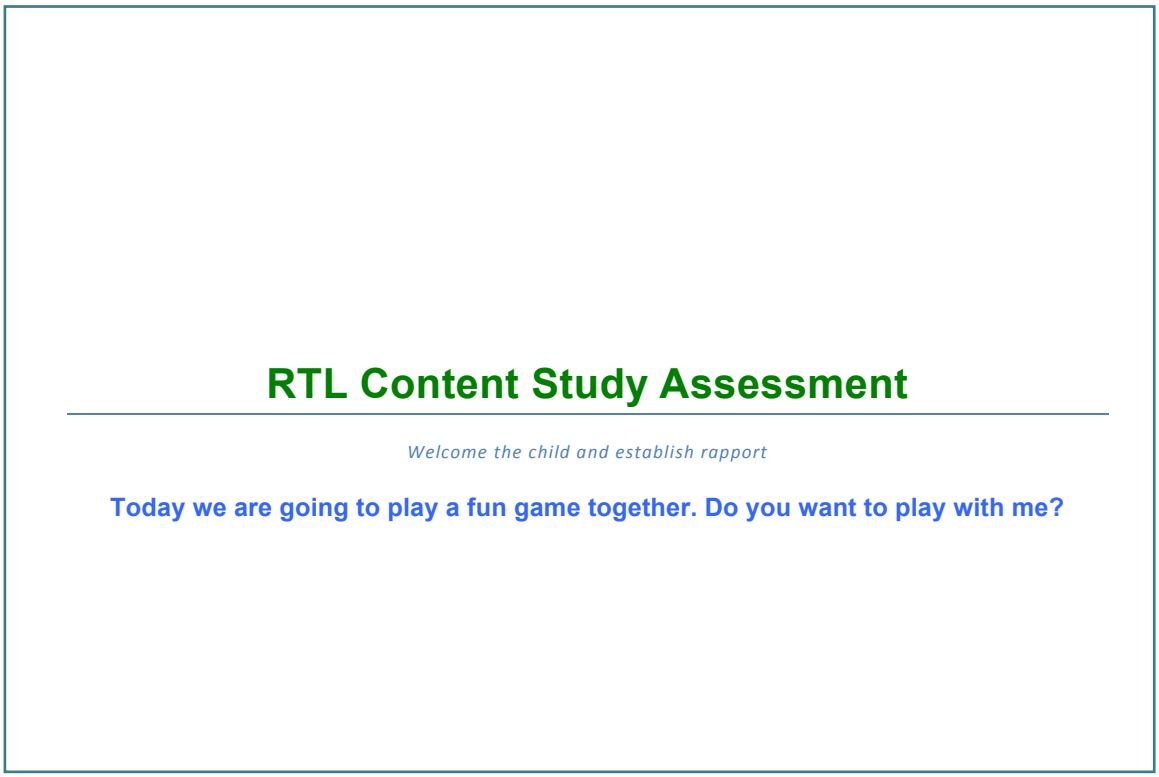
Appendices

Appendix A: Flip Book



Session 2: Item 1

Manipulatives:

- 6 short sausages
- 6 long sausages

Ramone has some sausages; some are short and some are long. Peg wants him to make a pattern with the sausages.

Help Ramone make a pattern here (*point to space in front of the child*) **with these sausages** (*place the sausage images on the table in front of the child in a random order*).

Note: Any pattern produced is correct.

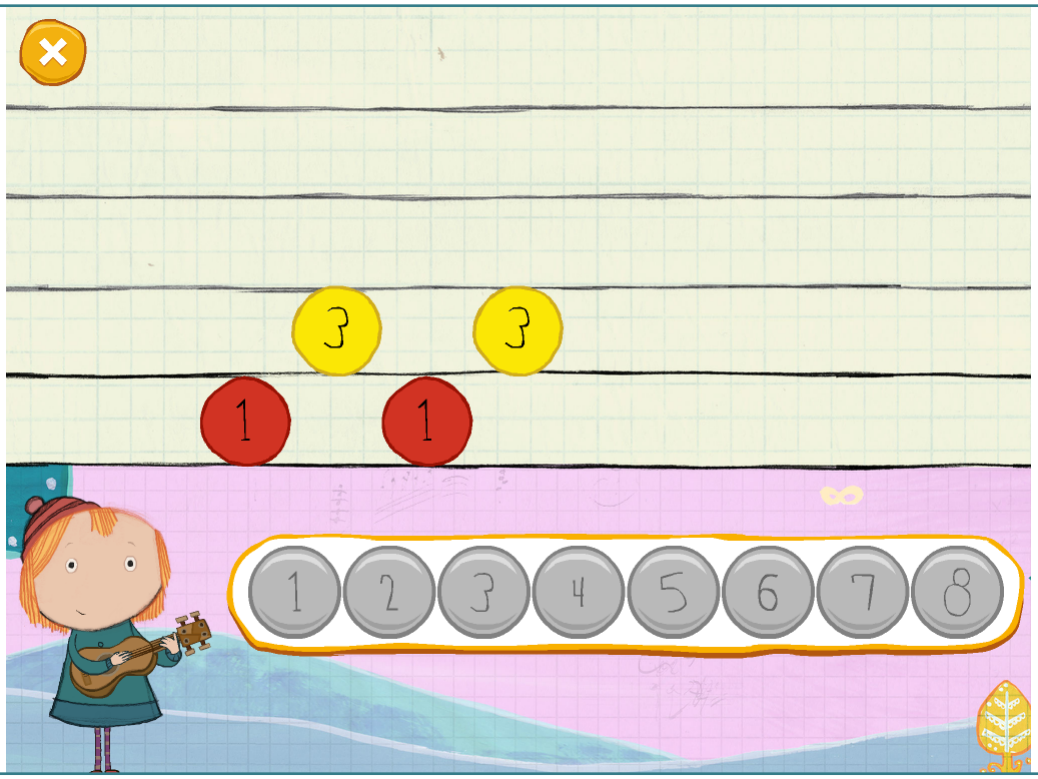
Session 2: Item 2.

Manipulatives:

- 6 short feathers
- 6 long feathers

Peg made a pattern with feathers: short, short, short, *long*, short, short, short, *long*
(*point to feathers on the flipbook as you read the pattern*).

Make the *same* pattern here *(point to space in front of the child)* **using these feathers**
(*place the feather images on the table in front of the child in a random order*).



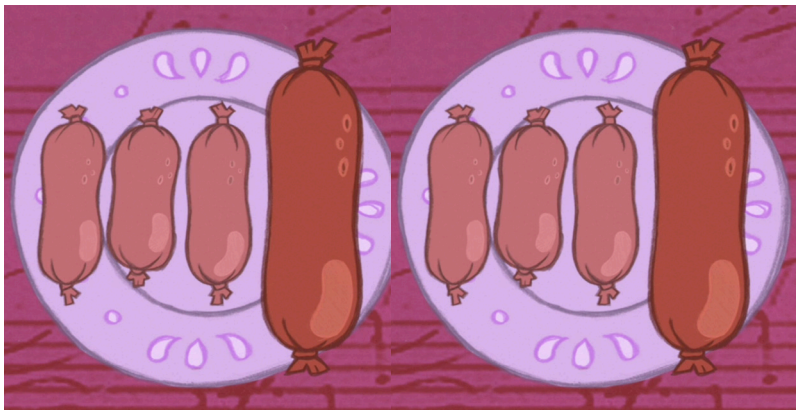
Session 2: Item 3.

No manipulatives

Peg made a pattern using these numbers (*slide finger from child's left to right across the 1, 3, 1, 3 pattern in the flipbook*).

What number comes next *(slide fingers from left to right across the grey numbers*)?

Note: child may point to the number "1" within the pattern, within the greyed out numbers, or verbalize for correct answer.



Session 2: Item 4.

Manipulatives
- 6 short sausages
- 6 long sausages

Ramone made a pattern with sausages: short, short, short, *long*, short, short, short, *long* (*point to sausages in the flipbook as you read the pattern*).

Make the same pattern here (*point to space in front of the child*) **using these sausages** (*place the sausage images on the table in front of the child in a random order*).

Session 2: Item 5.

Manipulatives:
- 4 Lemons
- 4 Limes

I'm making a pattern (*from the child's left to right, place a lemon, lime, lemon, lime pattern on the table while you say* **yellow, *green*, yellow, *green***).

Now you keep going *(place remaining limes in front of child).*

If child only puts one fruit, say: **Keep going.**

Note: child only needs to add 1 unit for correct answer.

Session 2: Item 6.

No manipulatives

I'm going to make a pattern using my hands on the table. Let's look and listen. (*Using both hands on the table slowly demonstrate: tap, tap, tap, clap; tap, tap, tap, clap; while at the same time saying the pattern:* **tap, tap, tap, *clap*; tap, tap, tap, *clap*.**

Make the *same* pattern using *your* hands.

If child only completes tap, tap, tap, clap say: **Keep going.**

Note: child can verbalize the pattern without the motion for correct answer

Session 2: Item 7.

Manipulatives:

- 8 short guitars
- 2 long guitars

I'm going to try and make a short, short, short, *long* pattern using these guitars and I want you to help me make sure I make it right (*from the child's left to right, place guitars on the table between you and the child: short, short, short, long, short, short, short, short*).

I think I made a mistake...can you help me fix it *(place the remaining guitars in front of the child)?* **Show me what I should change to make it right.**

Session 2: Item 8.

Manipulatives:

- 6 number “1” cards (2 for pattern 4 for child)
- 8 number “4” cards (4 for pattern 4 for child)
- 4 of each: "2", "3" and "5" card

I have these cards with numbers on them (*lay out all of the number cards on the table between you and the child*). **I'm going to make a pattern using some of them** (*make the following ABB pattern from the child's left to right so they can see: 1, 4, 4, 1, 4, 4*).

Make the same kind of pattern here *(point to space below pattern)* **using these numbers** (*Point to the remaining number cards*).

Session 3 Assessment

Session 3: Item 1.

Manipulatives:

- 5 small dinosaur footprints
- 5 large dinosaur footprints

Peg and the dinosaurs like to make patterns in the mud with their footprints (*point to Peg and Dinosaurs in the flipbook*).

Here are some dinosaur footprints (*place footprints in random assortment in front of child*)**; some are big and some are small.**

Help Peg and the dinosaurs make a pattern here (*point to space in front of the child*) **with the footprints.**

Session 3: Item 2.

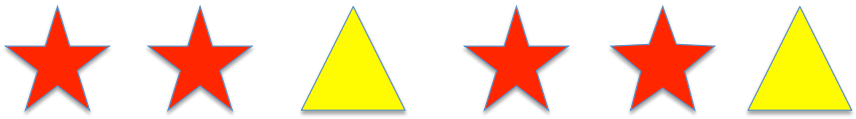
Manipulatives:

- 4 purple blocks
- 4 orange blocks

Let's make a pattern (*from child's left to right, place: purple block, orange block, purple block, orange block*).

Show me what comes next (*point to the space right next to the last block while you provide the blocks*).

If child only puts one block, say: **Keep going.**



Session 3: Item 3.

Manipulatives:

- Play dough
- Shape stamps: star and triangle

Look, I have these shape stamps. When we stamp in the play dough, we want to make soft stamps. Watch how I make soft stamps (*model how to make a soft stamp by gently pressing the stamp into the play dough).*

Peg made a pattern (*from the child's left to right, slide your fingers through the pattern in the flipbook*).

Make the *same* pattern on the play dough (*place rolled out strip of play dough in front of child*) **using these shape stamps** (*place stamps randomly in front of child*).

Note: shapes can be in any direction (e.g. upside down) for correct answer.

Session 3: Item 4.

No manipulatives

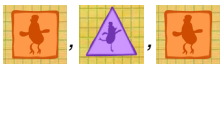
I'm going to make a pattern using my hands. Watch me: (*demonstrate with your hands fist, fist, open palm onto table; fist, fist, open palm onto table*).

Now it's your turn. Make the *same* pattern using *your* hands.

Session 3: Item 5.

Manipulatives:

- 4 orange squares
- 4 purple triangles
- 1 red diamond, 1 green circle, 1 blue upside down triangle

Let's make a pattern like Peg (*from the child's left to right place:* ).

Which shape comes next? (*Point to the space right next to the last shape while you provide the rest of the shapes in the order below*).

Session 3: Item 6.

Manipulatives:

- 1 Dinosaur

Peg and the dinosaurs like to make patterns in the mud with their footprints (*point to Peg and Dinosaurs in the flipbook*). **The pattern they made is:** (*from child's left to right, use dinosaur to demonstrate action and say* **step, step, *bounce*; step, step, *bounce*.**

Using this dinosaur (*give the child the dinosaur*), **show me the pattern they made.**

Note: If the pattern is not visibly clear, say: **oops, I missed that, please show me again?**

Session 3: Item 7.

Manipulatives:

- 5 small dinosaur footprints
- 5 large dinosaur footprints

Peg and the dinosaurs made a pattern in the mud with their footprints (*from child's left to right, slide your fingers through the pattern in the flipbook*).

Here are some dinosaur footprints (*place footprints in random assortment in front of child*); **some are big and some are small.**

Make the same pattern here (*point to the space in front of the child*) **using the footprints.**

Session 3: Item 8.

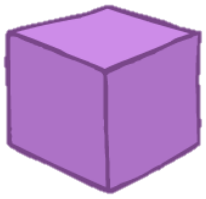
Manipulatives:

- 3 orange squares
- 4 purple triangles
- 1 red diamond, 1 green circle, 1 blue upside down triangle

I'm going to make a pattern like Peg (*from child's left to right place:*  ,  ,  ,  , *BLANK* , 

I forgot to put one shape. Which shape goes *here*? *(Point to blank space while you provide the rest of the shapes in the order below).*

Session 4 Assessment



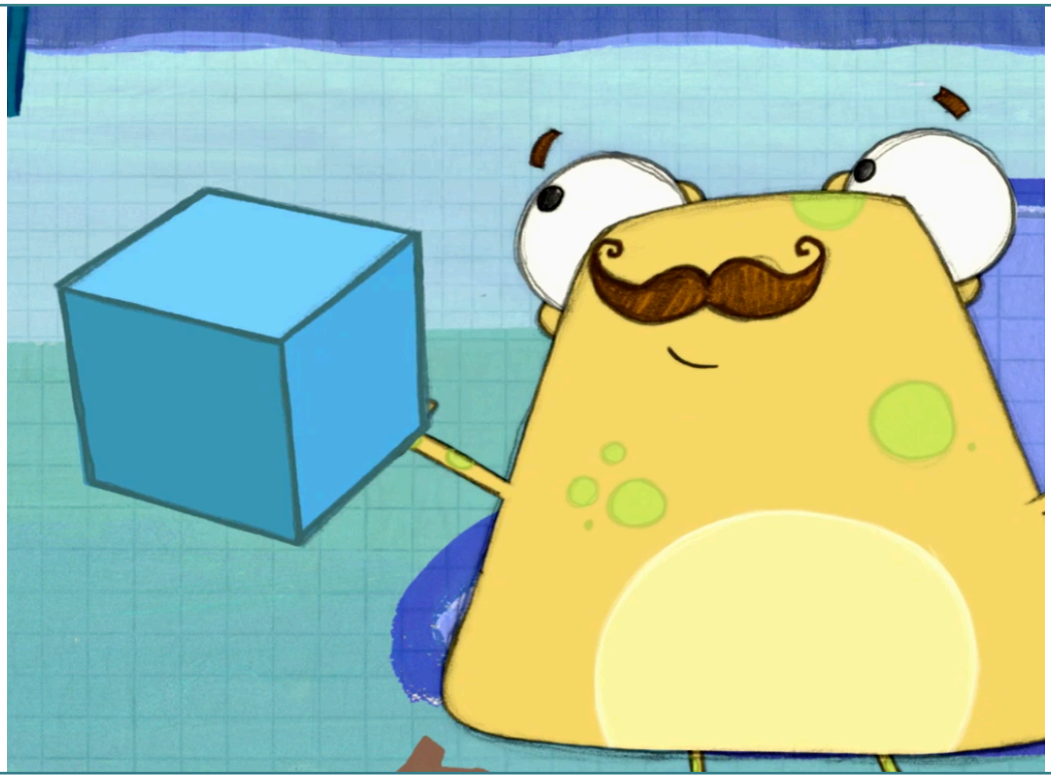
Session 4: Item 1.
No manipulatives

Look at these shapes *(point to top of page in the flipbook).* **Point to the shape that has squares on the top and bottom.**

Session 4: Item 2.
No manipulatives

The mermaid needs help finding one of her jewels (*run finger through shapes).*

Point to the jewel that is a solid shape that looks like a box with six square sides.



Session 4: Item 3.
No manipulatives

What shape (*point to blue cube in the flipbook*) **is the toad holding?**

Session 4: Item 4.
No manipulatives

The mermaid needs help finding another jewel (*run finger through shapes*).

Point to the jewel that looks like a tube with circles on the ends.

Session 4: Item 5.
Manipulatives:

- Basket of 3D shapes: Cube, sphere, cylinder, pyramid

Here is a basket of shapes (*provide child basket of shapes*).

Find the cylinder.

Session 4: Item 6.
No manipulatives

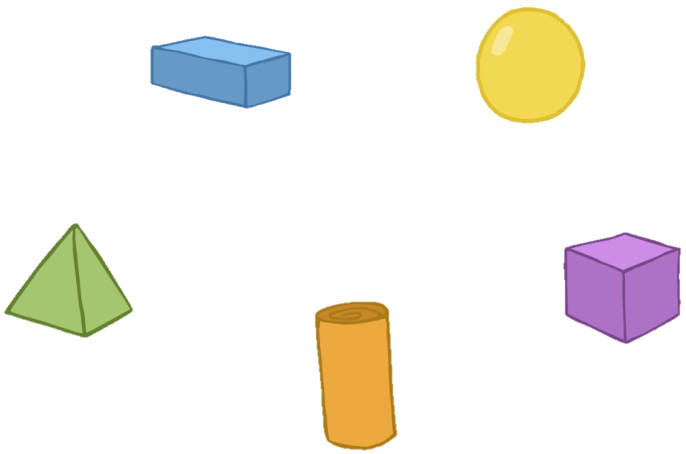
What shape (*point to pyramid on the child's left in the flipbook*) **is the mermaid holding?**

Session 4: Item 7.
Manipulatives:

- Basket of 3D shapes: cube, sphere, cylinder, pyramid

Here is a basket of shapes (*provide child basket of shapes*).

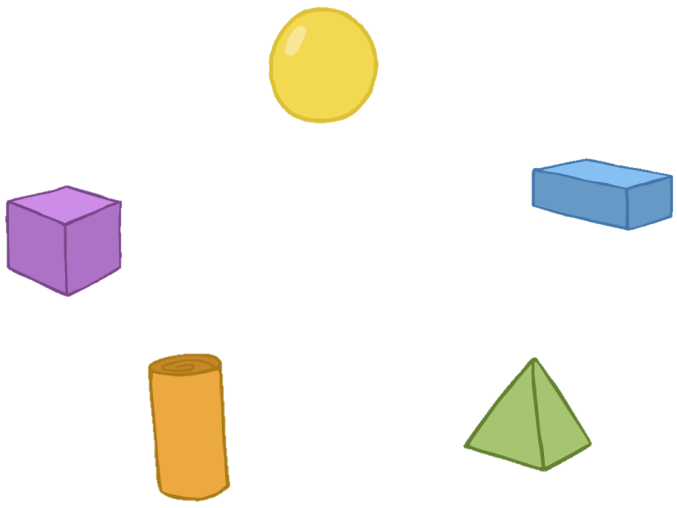
Find the cube.



Session 4: Item 8.
No manipulatives

Look at these shapes (*run finger through the shapes in the flipbook*).

Point to the sphere.

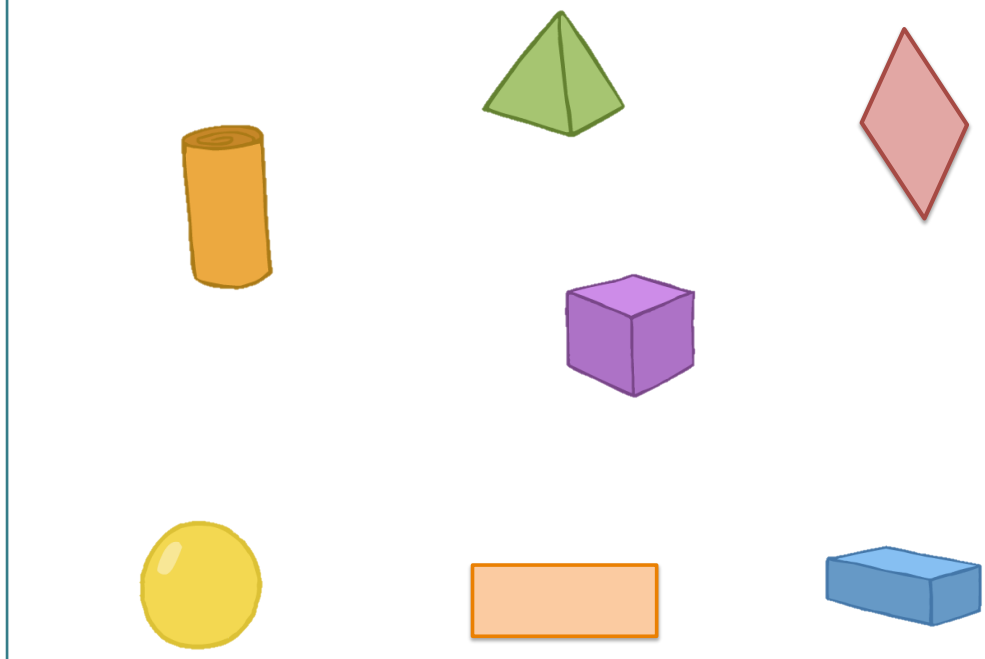


Session 4: Item 9.
No manipulatives

Look at these shapes (*run finger through the shapes in the flipbook*).

Point to the cylinder.

Session 5 Assessment



Session 5: Items 1a – 1d
No manipulatives

Let's play a game. Look at these shapes (*run finger through shapes in the flipbook*). **I'll tell you what shape I am looking for and you can help me find it by pointing to it.**

1a. **I'm looking for a flat shape that has four sides of equal length. Please point to it.**

1b. **Now I'm looking for a shape that is round like a ball. Show me where that one is.**

1c. **Now I'm looking for a shape with six flat sides that are all the same size. Where is that one?**

1d. **Can you find a solid shape that has a rectangle on every side? Show me.**

For scoring: Each question (1a – 1d) is scored separately as correct or incorrect

Session 5: Items 2a – 2d

Manipulatives:

- 3D shapes: sphere, cone, rectangular prism, cylinder

I'm going to show you some shapes and I need you to help me figure out what each of them is (*place a sphere, a cone, a rectangular prism and a cylinder on the table*).

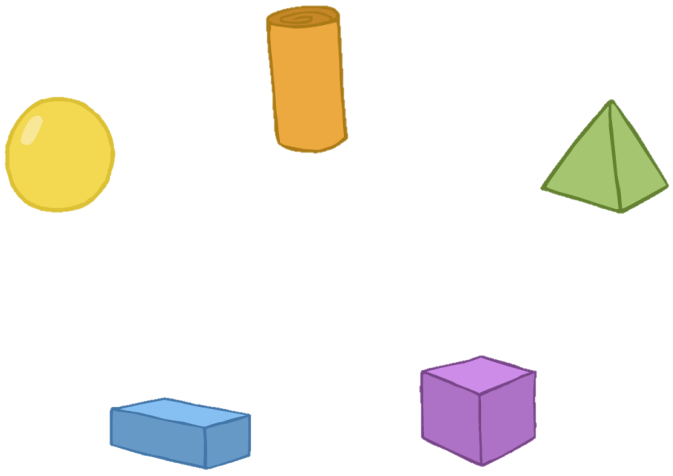
2a. **Which one is the sphere?**

2b. **Which is the cone?**

2c. **Which is the rectangular prism?**

2d. **Which is the cylinder?**

For scoring: Each question (2a – 2d) is scored separately as correct or incorrect



Session 5: Items 3a – 3b
No manipulatives

Look at all of these shapes (*run finger through shapes in flipbook).* **Ramone needs your help finding specific shapes. I'll point to the shape, and you say its name. Ready?**

3a. (*point to the rectangular prism in the flipbook*)

3b. (*point to the pyramid in the flipbook*)

For scoring: Each question (3a – 3b) is scored separately as correct or incorrect

Session 5: Items 4a
No manipulatives

Note: this Prompt is for the next 3 items – 4a – 4c

I'm going to show you pictures of Peg and her friends and I want you to tell me what shape each of them is near.

4a. **Here is the mermaid** (*show the child a picture of the mermaid looking at the sphere in the flipbook*).

What shape is she looking at?

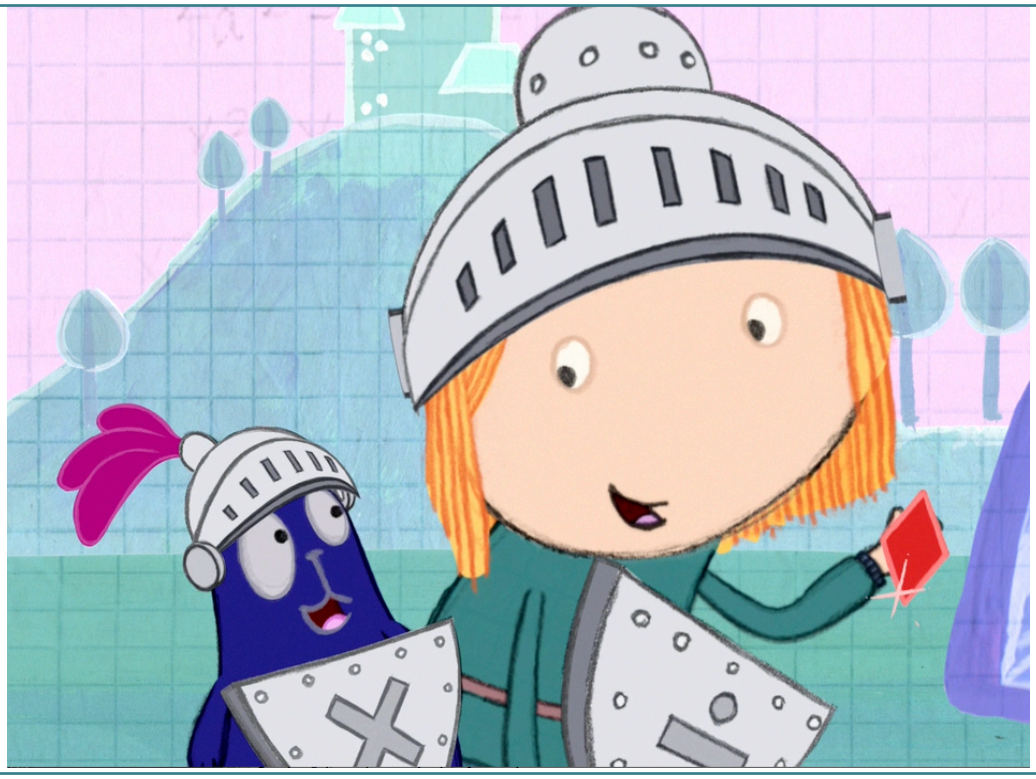
Flip to next page

Session 5: Items 4b

4b. **Here is the toad** (*show the child a picture of the toad holding a cube in the flipbook*).

What shape is he holding?

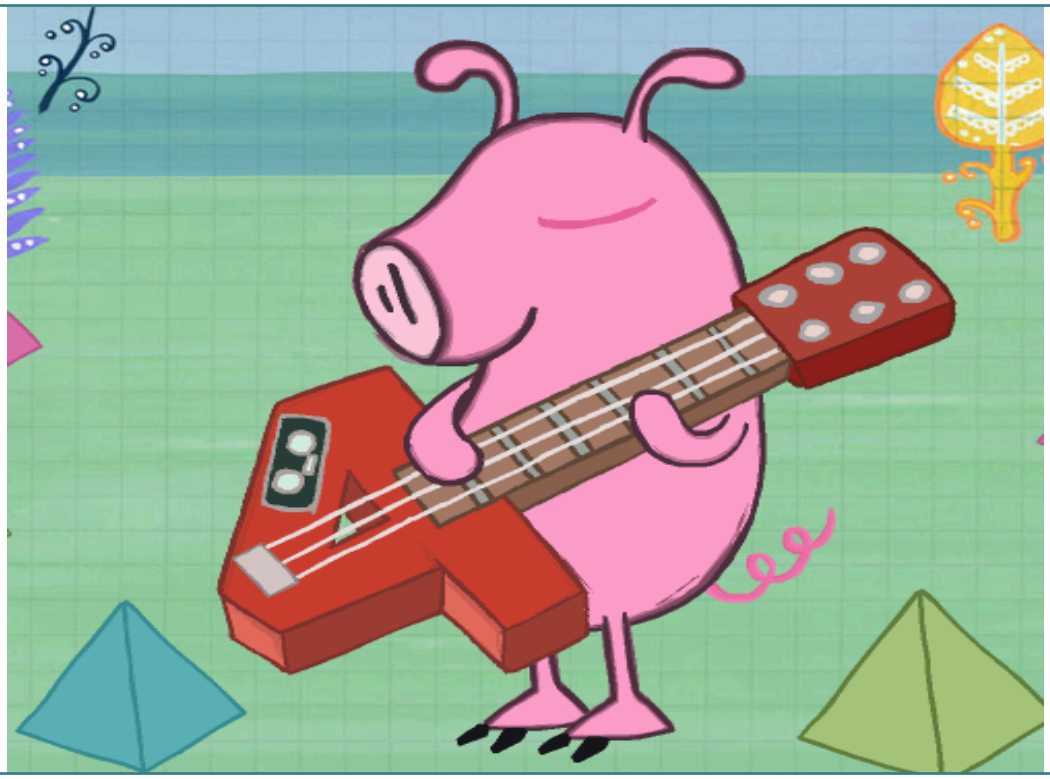
Flip to next page



Session 5: Items 4c

4c. **And here is Peg** (*show the child a picture of Peg holding a rhombus in the flipbook*).

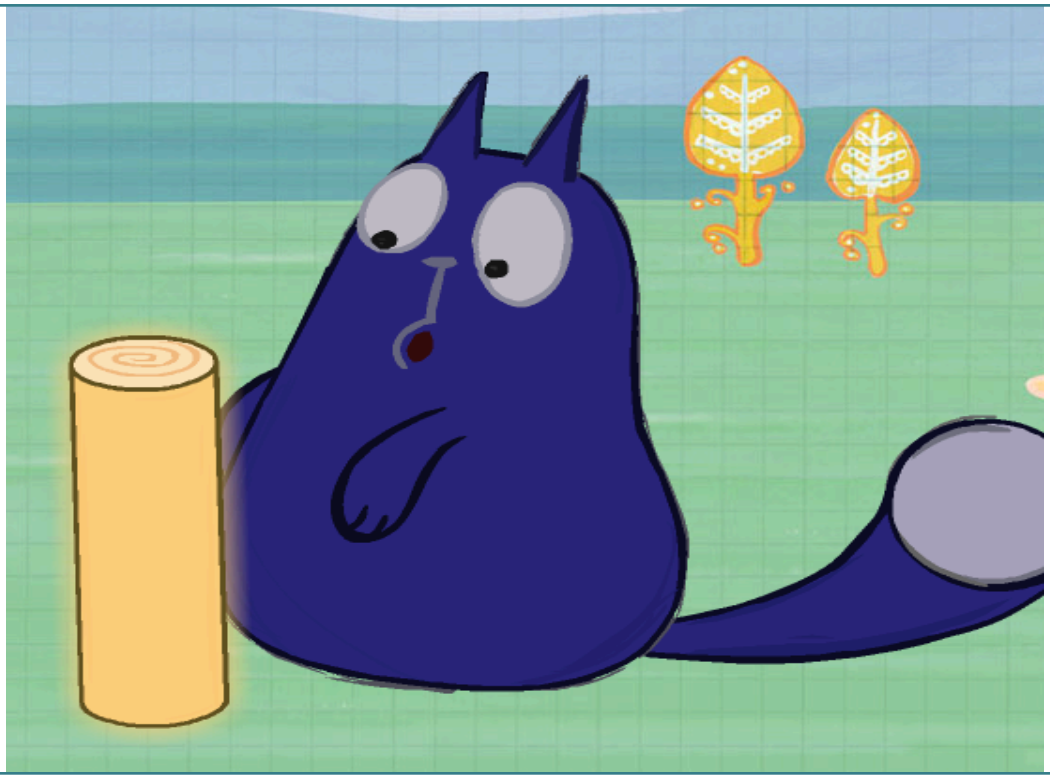
What shape is she holding?



Session 5: Items 5
No manipulatives

Pig is standing near some shapes (*point to picture of Pig with pyramids in the flipbook*).

Tell me, what shape is this? (*point to the BLUE pyramid)*



Session 5: Items 6
No manipulatives

Cat is holding a shape (*point to picture of Cat holding a cylinder in the flipbook*).

Tell me, what shape is this? (*point to the cylinder*)

Appendix B: Observation Protocol

Observation date:	Observer:
Child ID:	Child Name:
Study Session #:	Peg + Cat Video Episode:

Video Observation:

Start time: ☐☐ : ☐☐ End time: ☐☐ : ☐☐

1. What behaviors did you observe while the child was watching the video? [*Mark all that apply.*]

a. Child was sitting still	☐
b. Child was moving around (e.g., standing up, moving around the table, etc.)	☐
c. Child was attending to the screen	☐
d. Child was turning away from the screen	☐
e. Child was laughing at jokes/funny moments in the video	☐
f. Child was attempting to "interact" with the characters by answering questions they asked or talking to them	☐
g. Child was singing along with characters	☐
h. Child was asking questions or making comments about the video	☐
i. Child asked to watch the video again	☐
j. Child appeared reluctant to watch the video	☐
k. Child asked to stop watching	☐
l. Other (Please describe):	☐

2. Based on your observations, do you think the child was engaged while watching the video? *[Mark one].*

Yes. Please explain.	☐
No. Please explain.	☐

3. If child was distracted or appeared disengaged, what do you think was the cause? [*Mark all that apply.]*

a. Technical problem (e.g. technology malfunction like video freezing/ not playing)	☐
b. Child wanted attention of parent/family more than wanting to watch the show	☐
c. Parent/family interrupted or engaged with child	☐
d. Other (Please describe):	☐

4. If the child made any comments or asked any questions during the video, please record them (and any parent/researcher responses) here.

Follow-up prompts for child:
Ask the child the following questions at the conclusion of the video. Please note their responses in the text boxes.

1. Tell me about the video. What did you notice?

2. What was the problem that Peg had?

3. How did Peg and Cat solve the problem?

Observation date:	Observer:
Child ID:	Child Name
Study Session #	Peg + Cat Game

Game Observation:

Start time: ☐☐ : ☐☐ End time: ☐☐ : ☐☐

1. What behaviors did you observe in the child while playing the game? *[Mark all that apply.]*

a. Child was sitting still	☐
b. Child was moving around (e.g., standing up, moving around the table, etc.)	☐
c. Child was attending to the screen	☐
d. Child was turning away from the screen	☐
e. Child was attempting to "interact" with the characters by answering questions or talking	☐
f. Child wanted to play the game more than once	☐
g. Child clicked randomly while playing	☐
h. Child was able to play the game without guidance or support	☐
i. Child was asking questions/ making comments about the game	☐
j. Child was moving around and turning away from the screen	☐
k. Child appeared reluctant to play the game	☐
l. Child asked to stop playing	☐
m. Other (Please describe):	☐

2. Based on your observations, do you think the child was engaged while playing the game? *[Mark one].*

Yes. Please explain.	☐
No. Please explain.	☐

3. If child was distracted or appeared not to be engaged, what was the cause?

a. Technical problem (e.g. technology malfunction like video freezing/ not playing)	☐

b. Child wanted attention of parent/family more than wanting to watch the show	☐
c. Parent/family interrupted or engaged with child	☐
d. Other (Please describe):	☐

4. Did the child need support from researcher to begin playing?

Yes. Please describe.	☐
No.	☐

5. Did any technical problems occur during game play?

Yes. Please describe.	☐
No.	☐

Follow-up prompts for child:
Ask the child the following questions at the conclusion of the video. Please note their responses in the text boxes.

1. Tell me about the game. What did you notice?

2. What did you think of the game? [Probe for whether children liked or disliked the game, why, whether they had a part they liked best, and so on].

Appendix C: Parent Interview

Interview Topics for Content Study
When the opportunity arises, please ask parents any or all of the following questions.

Name of Interviewer:
Name of Parent:
Child ID:

We are really interested in learning more about how families use media at home and sharing what we learn with the producers who make videos and video games for children. Do you mind if I ask you some questions? Most of the questions are about the kinds of television shows or videos your child might watch or the video games your child might play. Does your child watch TV or videos or play video games at home? [*If the answer is no, the interview can end here.*]

1. Ok, tell me a little bit about the television shows your child watches.

    a. How about video games or computer games—could you tell me a little bit about the games your child plays?

    b. Are any of the shows CHILD watches or games s/he plays about learning **math**? *If yes:* Tell me about those shows/games. What is CHILD learning?

    c. Are there things you and CHILD do at home that are about **math**? [*If parent doesn't come up with anything, suggest counting together.*]

    d. Are there other things you think CHILD is learning when s/he watches TV or plays video games? Of the shows CHILD watches and the games s/he plays, which do you think are the most educational? [*Probe for specific show/game connections to learning—e.g., what does s/he learn from Sesame Street?]*

2. We are really interested in learning more about how children use media at home—for example, do kids mostly watch TV or play video games on their own? Or is it sometimes with other kids (like brothers or sisters) or adults, like parents or babysitters? [*Probe for when CHILD uses media, how often, with whom/frequency—we want an idea of how much is on their own, how much is with parents, how much is with siblings, etc.*]

    a. What do you usually do during the time your child is watching a show or using technology?

    b. What kinds of help does CHILD need when using technology? [*Probe on:* Does CHILD ever have technical problems, like needing help getting to the right webpage or restarting the computer? Who provides assistance to CHILD when required?]

c. Do you ever have the chance to watch television or videos or play games with CHILD? Tell me about a time when you watched TV or played video games with CHILD. [Probe on a story – get some rich examples about a time when the parent and child watched television/ videos or played games together.]

d. When you are watching TV or videos or playing games with CHILD, do you get the chance to ask CHILD questions? [*If yes*: What kinds of questions?]

e. Does CHILD ask you questions while s/he is watching TV or playing games with technology? What kinds of questions?

f. What do you like about watching TV or videos or playing video games together with CHILD?

Thank you for answering these questions!

Appendix D: Parent Survey (English-language version)

Peg + Cat Study
Family Technology Survey

INTRODUCTION

Thank you for helping us to learn more about how families with young children use technology. The information we are asking about will help researchers and program developers to make television shows and games that are fun and can help young children learn. Participating in this survey is voluntary. Please tell us about your use of technology and your child's use of technology when he or she is at home, and answer some background questions about your family. If you have more than one child, please answer the questions thinking about the child who is participating in this study.

Child ID: _____ _____ _____

TECHNOLOGY AT HOME

1. Please look over the list of devices in the left hand column. Do you have any in your household? *(Mark all that apply.)*

	I have this device in my household
a. Television set	☐
b. Cable or satellite TV	☐
c. Paid video subscription (such as Hulu, Netflix, Amazon Prime)	☐
d. DVD or VHS player	☐
e. Laptop or desktop computer	☐
f. Smart phone (you can send email, watch videos, or access the Internet on it)	☐
g. Tablet (like an iPad, Galaxy Tab, Nexus 7, Microsoft Surface, or Kindle Fire)	☐
h. Basic e-reader (like a Nook or Kindle)	☐
i. Digital educational toys (like a LeapPad or VTech tablet)	☐
j. iPod Touch or other type of video iPod	☐
k. Video game player that hooks up to your TV (like an Xbox, PlayStation, or Wii)	☐
l. Handheld video game player (like a GameBoy, Nintendo DS or PSP)	☐
m. Other (Please specify): _____	☐

2. Please tell us what kind of Internet access you have at home (if any). *(Mark only one).*

a. I don't have Internet access at home	☐
b. Dial-up telephone access (through a modem)	☐
c. High-speed (such as broadband, cable modem or DSL)	☐
d. I have Internet access at home, but only on a cell phone	☐
e. I have Internet access at home, but I don't know what kind	☐
f. I don't know if I have Internet access at home	☐

YOUR CHILD'S USE OF TECHNOLOGY

3. How often does your child do each of the following activities at home?

	Never	1 to 2 times a month	1 to 2 times a week	3 to 4 times a week	Every day
a. Watch TV	☐	☐	☐	☐	☐
b. Watch DVDs or videotapes	☐	☐	☐	☐	☐
c. Watch online videos	☐	☐	☐	☐	☐
d. Read or look at e-books (on an e-reader or other device)	☐	☐	☐	☐	☐
e. Play video games on a console or handheld video game player (such as Xbox, PlayStation, or Nintendo DS)	☐	☐	☐	☐	☐
f. Play games on a computer (laptop or desktop)	☐	☐	☐	☐	☐
g. Play games on mobile devices (such as cell phone, iPod, or iPad)	☐	☐	☐	☐	☐
h. Use apps other than games on mobile devices	☐	☐	☐	☐	☐

4. How often does your child do each of the following activities?

	Never	1 to 2 times a month	1 to 2 times a week	3 to 4 times a week	Every day
a. Watch educational television shows or DVDs	☐	☐	☐	☐	☐
b. Watch educational videos online on a computer or mobile device	☐	☐	☐	☐	☐
c. Play educational games on a video game player, computer, or mobile device	☐	☐	☐	☐	☐

5. During the week (Monday-Friday), about how much time does your child spend using technology (watching TV, using the computer, playing video games, etc.) each day? *(Mark only one).*

a. Less than half an hour a day	☐
b. Half an hour to 1 hour a day	☐
c. 1-2 hours a day	☐
d. 2-3 hours a day	☐
e. 3-4 hours a day	☐
f. More than 4 hours a day	☐

6. Do you monitor or limit your child's technology use? *(Mark only one).*

☐ a. No STOP ***SKIP TO QUESTION 7.*** ☐ b. Yes

6a. If you marked "yes" for Question 6 above, please tell us HOW you monitor or limit your child's technology use. *(Mark all that apply).*

a. I limit my child's **total time** with technology.	☐
b. I schedule **particular times of day** my child can or cannot watch/play.	☐
c. I limit the **content** (particular shows/games) my child can watch/play.	☐
d. I limit which **devices** my child can use.	☐
e. I set limits by **observing** my child's use of technology.	☐
f. I set limits based on child's **behavior** (e.g., allow technology use for good behavior).	☐
g. Other: _____	☐

6b. If you marked "yes" for Question 6 above, please tell us WHY you monitor or limit your child's technology use. *(Mark all that apply).*

a. I'm concerned about **age-inappropriate** content.	☐
b. I want my child to have **time for other activities,** like outdoor play or time with friends.	☐
c. I'm concerned about **overuse** of technology.	☐
d. I'm concerned about technology '**addiction**'.	☐
e. I'm concerned about **physical activity** levels, my child's **vision**, or other health concerns	☐
f. Other: _____	☐

MATH LEARNING AT HOME

7. Which of the following math skills, if any, do you help your child learn or practice at home or outside of school? *(Mark all that apply.)*

a. Counting (for example, counting out loud by saying "1, 2, 3" or counting objects such as cookies or the fingers on their hands)	☐
b. Identifying written numbers (for example, the number "1" on the page of a book, or on a sign at the market)	☐
c. Recognizing or drawing shapes (for example, recognizing or drawing circles, triangles, squares)	☐
d. Recognizing or creating patterns (for example, laying out snack—cracker, grape, cracker, grape—or colored blocks—red, red, blue, red, red, blue—in a pattern)	☐
e. Addition (for example, knowing how many crackers you have when you add one to the pile)	☐
f. Subtraction (for example, knowing how many berries are left after eating some)	☐
g. Measurement (for example, measuring size with hands or rulers, measuring water with cups, or measuring ingredients for a recipe)	☐
h. Other (Please specify): _____	☐

8. Please indicate whether you agree or disagree with the following statements.

	Strongly Disagree	Disagree	Agree	Strongly Agree
a. Young children (ages 3-5) learn math mainly at school, not at home	☐	☐	☐	☐
b. I can help my child learn math as well as other skills like reading and writing.	☐	☐	☐	☐
c. I am confident in my ability to help my child learn and talk about mathematics.	☐	☐	☐	☐
d. Young children (ages 3-5) generally like math and are interested in it.	☐	☐	☐	☐
e. Math is too difficult for young children (ages 3-5) to understand.	☐	☐	☐	☐
f. I like helping my child learn about math.	☐	☐	☐	☐
g. Math can be taught anytime throughout the day.	☐	☐	☐	☐
h. Part of my role is to teach math to my children.	☐	☐	☐	☐

BACKGROUND

9. Please indicate the highest level of education the child's mother completed. *(Mark only one).*

- a. No formal schooling ☐
- b. 8th grade or less ☐
- c. 9th grade ☐
- d. 10th grade ☐
- e. 11th grade ☐
- f. High School Diploma or GED ☐
- g. Some college or technical school classes (no diploma) ☐
- h. Associate's Degree (AA, AS) or Technical Degree ☐
- i. Bachelor's Degree (BA, BS) ☐
- j. Graduate or Professional Degree ☐
- k. Don't know ☐

10. Please indicate the highest level of education the child's father completed. *(Mark only one).*

- a. No formal schooling ☐
- b. 8th grade or less ☐
- c. 9th grade ☐
- d. 10th grade ☐
- e. 11th grade ☐
- f. High School Diploma or GED ☐
- g. Some college or technical school classes (no diploma) ☐
- h. Associate's Degree (AA, AS) or Technical Degree ☐
- i. Bachelor's Degree (BA, BS) ☐
- j. Graduate or Professional Degree ☐
- k. Don't know ☐

11. What languages do you speak at home? *(Mark all that apply).*

- a. English ☐
- b. Spanish ☐
- c. Chinese (Mandarin, Cantonese, or other) ☐
- d. French ☐
- e. Vietnamese ☐
- f. Other (Please describe): ☐

_____

12. Please indicate your race or ethnicity. *(Mark all that apply).*

- a. White (Non-Hispanic) ☐
- b. Hispanic or Latino ☐
- c. Black or African-American ☐
- d. Asian ☐
- e. Native Hawaiian or Other Pacific Islander ☐
- f. American Indian or Alaska Native ☐
- g. Other (Please specify): ☐

_____

13. What is your relationship to the child listed on this survey? *(Mark only one).*

- a. Mother ☐
- b. Father ☐
- c. Grandmother ☐
- d. Grandfather ☐
- e. Guardian ☐
- f. Other (Please specify): ☐

_____

14. Are you male or female? *(Mark only one).*

☐ a. Male ☐ b. Female

THANK YOU VERY MUCH FOR TAKING THE TIME TO COMPLETE THIS SURVEY!

Appendix E: Parent Survey (Spanish-language version)

Estudio Peg + Cat
Encuesta sobre Tecnología en la Familia

INTRODUCCIÓN

Gracias por ayudarnos a aprender más sobre cómo las familias con niños pequeños utilizan la tecnología. La información que solicitamos ayudará a los investigadores y desarrolladores de programas a producir programas de televisión y juegos que sean divertidos y que ayuden a los niños pequeños a aprender. La participación en esta encuesta es voluntaria. Por favor, cuéntenos sobre su uso de la tecnología y el uso de la tecnología de su hijo cuando está en casa, y conteste a algunas preguntas sobre su familia. Si usted tiene más de un hijo, por favor conteste las preguntas pensando en el niño que está participando en este estudio.

Identificación del Niño(a):

_____ _____ _____

TECNOLOGÍA EN SU CASA

1. Por favor, revise la lista de dispositivos en la columna de la izquierda. ¿Tienes alguno de ellos en su hogar? *(Por favor, marque todas las que correspondan.)*

	Tengo éste en casa
a. Televisión	☐
b. TV por cable o satélite	☐
c. Vídeo de subscripción pagada (como Hulu, Netflix, Amazon Prime)	☐
d. Reproductor de DVD o VHS	☐
e. Computadora portátil o de escritorio	☐
f. Teléfono inteligente (puede enviar correos, ver videos, o acceder al internet)	☐
g. Tableta (como iPad, Galaxy Tab, Nexus 7, Microsoft Surface, o Kindle Fire)	☐
h. Lector electrónico básico (como Nook o Kindle)	☐
i. Juguetes educativos digitales (como LeapPad o tableta VTech)	☐
j. iPod Touch u otro tipo de reproductor de video iPod	☐
k. Dispositivo de juegos conectado a TV (como Xbox, PlayStation, o Wii)	☐
l. Dispositivo de juegos portátil (como Game Boy, Nintendo DS o PSP)	☐
m. Otro *(Por favor explique)*: _____	☐

2. ¿Qué tipo de acceso a Internet tiene en su casa? (si tiene). *(Marque solo una respuesta.)*

a. No tengo acceso a Internet en casa	☐
b. Acceso a internet por línea de teléfono (a través de un módem)	☐
c. Internet de alta velocidad (como banda ancha, módem de cable o DSL)	☐
d. Tengo acceso a Internet en casa, pero solo en teléfono celular	☐
e. Tengo acceso a Internet en casa, pero no sé de qué tipo	☐
f. No sé si tengo acceso a Internet en casa	☐

USO DE LA TECNOLOGÍA POR SU HIJO

3. ¿Con qué frecuencia su hijo(a) hace las siguientes actividades en casa?

	Nunca	Una o dos veces por mes	Una o dos veces por semana	Tres o cuatro veces por semana	Todos los días
a. Ver televisión	☐	☐	☐	☐	☐
b. Ver DVDs o cintas de video	☐	☐	☐	☐	☐
c. Ver videos online	☐	☐	☐	☐	☐
d. Leer o ver libros electrónicos (en un lector de libros electrónicos u otro dispositivo)	☐	☐	☐	☐	☐
e. Jugar juegos de video en una consola o en dispositivo manual para juegos de video (como Xbox, PlayStation, or Nintendo DS)	☐	☐	☐	☐	☐
f. Jugar juegos en la computadora (portátil o de escritorio)	☐	☐	☐	☐	☐
g. Jugar juegos en dispositivos móviles (como teléfono celular, iPod, o iPad)	☐	☐	☐	☐	☐
h. Usar aplicaciones distintas de juegos en dispositivos móviles	☐	☐	☐	☐	☐

4. ¿Con que frecuencia su hijo hace cada una de las siguientes actividades?

	Nunca	Una o dos veces por mes	Una o dos veces por semana	Tres o cuatro veces por semana	Todos los días
a. Ve programas educacionales en la televisión o DVDs	☐	☐	☐	☐	☐
b. Ve videos educacionales en línea, en computadora o en dispositivo móvil	☐	☐	☐	☐	☐
c. Juega juegos educativos en un dispositivo de juegos de video, en computadora, o en un dispositivo móvil	☐	☐	☐	☐	☐

5. ¿Durante la semana (lunes a viernes), ¿cuánto tiempo del día pasa su hijo usando la tecnología (viendo televisión, usando la computadora, jugando juegos de video, etc.)? *(Marque solo una respuesta.)*

- a. Menos de media hora al día ☐
- b. Media hora a 1 hora al día ☐
- c. 1-2 horas del día ☐
- d. 2-3 horas del día ☐
- e. 3-4 horas del día ☐
- f. Más de 4 horas del día ☐

6. ¿Monitorea o limita el uso de tecnología de su hijo? (*Marque solo una respuesta.)*

☐ a. No  ***Si responde NO, por favor vaya a la pregunta 7.*** ☐ b. Yes

6a. Si marcó "sí " en la pregunta 6, por favor díganos CÓMO controla o limita el uso de la tecnología de su hijo. Por favor, marque todas las respuestas que correspondan.
(Marque todas las respuestas que correspondan.)

- a. Limito el **tiempo total** que mi hijo usa la tecnología. ☐
- b. Programo **momentos concretos del día** en que mi hijo puede o no ver/jugar. ☐
- c. Limito **el contenido** (solo algunos programas/juegos) que mi hijo puede ver/jugar. ☐
- d. Limito los **dispositivos** que mi hijo puede usar. ☐
- e. Pongo límites **observando** el uso que mi hijo hace de la tecnología. ☐
- f. Pongo límites basados en el **comportamiento** del niño (por ejemplo, permitir el uso de tecnología por buen comportamiento). ☐
- g. Otro *(Por favor explique)*: _____ ☐

6b. Si marcó "sí " en la pregunta 6, por favor díganos POR QUÉ controla o limita el uso de la tecnología de su hijo. *(Marque todas las respuestas que correspondan.)*

- a. Estoy preocupado por **contenido inapropiado** para la edad. ☐
- b. Quiero que mi hijo tenga **tiempo para otras actividades,** como jugar al aire libre o pasar tiempo con sus amigos. ☐
- c. Estoy preocupado por el **uso excesivo** de la tecnología. ☐
- d. Estoy preocupado por la "**adicción**" a la tecnología. ☐
- e. Estoy preocupado por los niveles de **actividad física**, la **visión**, u otros problemas de salud de mi hijo. ☐
- f. Otro *(Por favor explique)*: _____ ☐

APRENDIZAJE DE MATEMÁTICAS EN EL HOGAR

7. De las siguientes habilidades matemáticas, ¿con cuáles le ayuda a su hijo a aprender o practicar en casa o fuera de la escuela? *(Marque todas las respuestas que correspondan.)*

a. Contando (por ejemplo, contar en voz alta diciendo: "1, 2, 3" o contar objetos como galletas o los dedos de la mano)	☐
b. Identificando números escritos (por ejemplo, reconocer el número “1” en la página de un libro, o en un letrero de la tienda)	☐
c. Reconociendo formas o dibujos de formas (por ejemplo, reconociendo o dibujando círculos, triángulos, cuadrados)	☐
d. Reconociendo o creando patrones (por ejemplo, reconociendo un aperitivo—galleta, uva, galleta, uva—o bloques de colores—rojo, rojo, azul, rojo, rojo, azul—en un patrón)	☐
e. Sumando (por ejemplo, sabiendo cuantas galletas habrá si se agrega una más a una pila)	☐
f. Restando (por ejemplo, sabiendo cuantas frutillas quedan después de comerse algunas)	☐
g. Midiendo (por ejemplo, midiendo tamaño con las manos o reglas, midiendo agua con tazas, o midiendo los ingredientes para una receta)	☐
h. Otro *(Por favor explique)*: _____	☐

8. Por favor indique qué tanto está usted de acuerdo o en desacuerdo con lo siguiente.

	Muy en desacuerdo	En desacuerdo	De acuerdo	Muy de acuerdo
a. Los niños pequeños (edades 3-5) aprenden matemáticas sobre todo en la escuela, no en casa.	☐	☐	☐	☐
b. Yo puedo ayudar a mi hijo a aprender matemáticas así como otras habilidades como lectura y escritura.	☐	☐	☐	☐
c. Tengo capacidad para ayudar a mi hijo a aprender y hablar de las matemáticas.	☐	☐	☐	☐
d. A los niños pequeños (edades 3-5) en general les gustan e interesan las matemáticas.	☐	☐	☐	☐
e. Las matemáticas son muy difíciles para que niños pequeños (edades 3-5) las entiendan.	☐	☐	☐	☐
f. Me gusta ayudar a mi hijo para que aprenda matemáticas.	☐	☐	☐	☐
g. Las matemáticas pueden enseñarse en cualquier momento del día.	☐	☐	☐	☐
h. Parte de mi función es enseñar matemáticas a mis hijos.	☐	☐	☐	☐

INFORMACIÓN SOBRE SUS ANTECEDENTES

9. Por favor indique el nivel más alto de educación que terminó la madre del niño. *(Marque solo una respuesta.)*

- a. Sin educación formal ☐
- b. Grado 8º o menos ☐
- c. Grado 9º ☐
- d. Grado 10º ☐
- e. Grado 11º ☐
- f. Diploma de preparatoria (High School) o GED ☐
- g. Algunas clases de la universidad o escuela técnica (sin diploma) ☐
- h. Grado Técnico Asociado (AA, AS) o Grado Técnico ☐
- i. Licenciatura (BA, BS) ☐
- j. Postgrado o grado profesional ☐
- k. No lo sé ☐

10. Por favor indique el nivel más alto de educación que terminó el padre del niño. *(Marque solo una respuesta.)*

- a. Sin educación formal ☐
- b. Grado 8º o menos ☐
- c. Grado 9º ☐
- d. Grado 10º ☐
- e. Grado 11º ☐
- f. Diploma de preparatoria (High School) o GED ☐
- g. Algunas clases de la universidad o escuela técnica (sin diploma) ☐
- h. Grado Técnico Asociado (AA, AS) o Grado Técnico ☐
- i. Licenciatura (BA, BS) ☐
- j. Postgrado o grado profesional ☐
- k. No lo sé ☐

11. ¿Qué idioma(s) habla usted en casa? *(Marque todas las respuestas que correspondan.)*

- a. Inglés ☐
- b. Español ☐
- c. Chino (mandarín, cantonés u otro) ☐
- d. Francés ☐
- e. Vietnamita ☐
- f. Otro *(Por favor describa)*: ☐

_____

12. Por favor indique su raza u origen étnico. *(Marque todas las respuestas que correspondan.)*

- a. Blanco (No Hispano) ☐
- b. Hispano o Latino ☐
- c. Negro o afro-americano ☐
- d. Asiático ☐
- e. Hawaiano o de las Islas del Pacífico ☐
- f. Indio Americano o Nativo de Alaska ☐
- g. Otro *(Por favor especificar)*: ☐

_____

13. ¿Cuál es su relación con el niño que se nombra en esta encuesta? *(Marque solo una respuesta.)*

- a. Madre ☐
- b. Padre ☐
- c. Abuela ☐
- d. Abuelo ☐
- e. Tutor ☐
- f. Otro *(Por favor describa)*: ☐

_____

14. ¿Es usted hombre o mujer? *(Mark only one).*

☐ a. Hombre ☐ b. Mujer

¡GRACIAS POR PARTICIPAR EN ESTA ENCUESTA Y POR CONTRIBUIR CON LO QUE CONOCEMOS DE LOS NIÑOS Y LA TECNOLOGÍA!

Appendix F: Checklist and Reflection (English-language version)

Child ID:	Child Name:	Parent Name:
Date:	Session #	

Please observe while your child watches the video. Check one box for each of the questions below.

Name of Video:	Yes	No
a. Have you seen this video before?	☐	☐
b. Do you think your child is enjoying this video?	☐	☐
c. Do you think your child is bored with this video?	☐	☐
d. Do you think this video is trying to teach anything?	☐	☐
e. Do you think this video is trying to teach math?	☐	☐
f. Do you think this video is trying to teach children how to solve problems?	☐	☐
g. Do you think this video is trying to teach children vocabulary or new words?	☐	☐
h. Do you think your child understands what the characters are saying/ talking about?	☐	☐
i. Does your child seem confused by this video?	☐	☐
j. Do you think this is a good video for young children?	☐	☐

Other comments:

Please observe while your child plays the game and check one box for each of the questions below.

Name of the Game:	Yes	No
a. Have you seen this game before?	☐	☐
b. Do you think your child is enjoying this game?	☐	☐
c. Do you think your child is bored with this game?	☐	☐
d. Do you think this game is trying to teach anything?	☐	☐
e. Do you think this game is trying to teach math?	☐	☐
f. Do you think this game is trying to teach children how to solve problems?	☐	☐
g. Do you think this game is trying to teach children vocabulary or new words?	☐	☐
h. Does your child seem confused by this game?	☐	☐
i. Do you think your child needs help from an adult when playing this game?	☐	☐
j. Do you think this is a good game for young children?	☐	☐

Other comments:

We are interested in learning more about your reactions to the video and game, so we can share that feedback with the developers. Please respond to the following questions, providing as much detail as possible.

1. What did you think about the video and the game? Please describe what caught your attention as you were watching.

2. Was there something in the video or game that you did not understand or did not like? Please explain.

3. Do you think your child would like to watch this video or play this game? Please explain.

4. Do you think you would watch this video or play this game with your child? Why or why not?

5. Have you had the opportunity to work with your child at home on activities related to the Peg + Cat videos and games? Please describe.

6. Has your child asked to watch Peg + Cat or play the Peg + Cat video games at home?

7. Have you observed any change in your child's behavior at home related to the Peg + Cat videos and games? For example, does your child act like Peg or Cat at home?

Appendix G: Checklist and Reflection (Spanish-language version)

ID del niño:	Nombre del niño:	Nombre del Padre/Madre:
Fecha:	Sesión Número:	

Por favor observe mientras su hijo ve el video. Marque un solo cuadro para cada pregunta.

Nombre del video:	Sí	No
a. ¿Ha visto usted este video antes?	☐	☐
b. ¿Cree usted que su hijo está disfrutando este video?	☐	☐
c. ¿Cree usted que su hijo se aburre con este video?	☐	☐
d. ¿Cree usted que este video está tratando de enseñar algo?	☐	☐
e. ¿Cree que este video está tratando de enseñar matemáticas?	☐	☐
f. ¿Cree usted que este video está tratando de enseñar a los niños cómo resolver problemas?	☐	☐
g. ¿Cree usted que este video está tratando de enseñar a los niños vocabulario o palabras nuevas?	☐	☐
h. ¿Cree usted que tu hijo entiende lo que los personajes del video están diciendo o de lo que están hablando?	☐	☐
i. ¿Parece su niño confundido con este video?	☐	☐
j. ¿Cree usted que este es un buen video para niños pequeños?	☐	☐

Otros comentarios:

Por favor observe, mientras que su hijo juega el juego y marque un solo cuadro para cada pregunta.

Nombre del juego:	Sí	No
a. ¿Ha visto usted este juego antes?	☐	☐
b. ¿Cree usted que su hijo está disfrutando este juego?	☐	☐
c. ¿Cree usted que tu hijo se aburre con este juego?	☐	☐
d. d. ¿Cree usted que este juego está tratando de enseñar algo?	☐	☐
e. ¿Cree que este juego está tratando de enseñar matemáticas?	☐	☐
f. ¿Cree que este juego está tratando de enseñar a los niños cómo resolver problemas?	☐	☐
g. ¿Cree que este juego está tratando de enseñar a los niños vocabulario o palabras nuevas?	☐	☐

h. ¿Parece su niño confundido por este juego?	☐	☐
i. ¿Cree usted que su hijo necesita ayuda de un adulto cuando juega este juego?	☐	☐
j. ¿Cree usted que este es un buen juego para niños pequeños?	☐	☐

Otros comentarios:

Estamos interesados en entender más sus reacciones ante el video y el juego, para poder retroalimentar con esa información a quienes los desarrollaron. Por favor responda a las siguientes preguntas, proporcionando tantos detalles como sea posible.

1. ¿Qué piensa sobre el video y el juego? Por favor describa lo que le llamó la atención, mientras estaba observando.

2. ¿Hubo algo en el video o juego que usted no entendió o que no le gustó? Por favor, explique.

3. ¿Cree usted que a su hijo le gustaría ver este video o jugar a este juego? Por favor, explique.

4. ¿Cree usted que le gustaría ver este video o jugar a este juego con su hijo? ¿Por qué si o por qué no?

5. ¿Ha tenido la oportunidad de trabajar con su hijo en casa en actividades relacionadas con los vídeos y juegos *Peg + Cat*? Por favor describa.

6. ¿Le ha pedido su hijo ver el video *Peg + Cat* o jugar los videojuegos de *Peg + Cat* en casa?

7. ¿Ha observado algún cambio en el comportamiento de su hijo en casa, relacionado con los videos y juegos de *Peg + Cat*? Por ejemplo, ¿Actúa su hijo como *Peg* o *Cat* en su casa?

Appendix H: Score Sheet

RTL Content Assessment Study: Session 2 - Sets 2 and 3 Pretest

Child Name _____

Child ID _____

Assesor _____

Date _____

Item	Prompt	Correct Response	Score		Notes
S2.1	Help Ramone make a pattern here with these sausages	2 repeating units	correct / incorrect	NR	
S2.2	Make the *same* pattern here using these feathers	short short short *long* x 2	correct / incorrect	NR	
S2.3	What number comes next?	1 verbally or 1 pointing	correct / incorrect	NR	NA
S2.4	Make the *same* pattern here	short short short *long* x 2	correct / incorrect	NR	
S2.5	Now you keep going.	add lemon lime x1	correct / incorrect	NR	
S2.6	Make the *same* pattern using *your* hands.	tap, tap, tap, *clap* x 2	correct / incorrect	NR	
S2.7	Show me what I should change to make it right.	indicate last short should be long	correct / incorrect	NR	
S2.8	Make the same kind of pattern here using these numbers	any ABB x2	correct / incorrect	NR	
S3.1	Help Peg and the dinosaurs make a pattern here with the footprints.	2 repeating units	correct / incorrect	NR	
S3.2	Show me what comes next	add 1 unit (purple block, orange block)	correct / incorrect	NR	
S3.3	Make the *same* pattern on the playdough using these shape stamps	star, star, triangle x 2	correct / incorrect	NR	
S3.4	Now it's your turn. Make the *same* pattern using *your* hands.	fist, fist, open palm x 2	correct / incorrect	NR	
S3.5	Which shape comes next?	orange square	correct / incorrect	NR	
S3.6	Using this dinosaur show me the pattern they made.	step, step, bounce x 2	correct / incorrect	NR	
S3.7	Make the same pattern here using the footprints.	small, small, large x 2	correct / incorrect	NR	
S3.8	I forgot to put one shape. Which shape goes here?	orange square	correct / incorrect	NR	

Appendix I: PCIS Item Results

Table I1. Session 2 Results PCIS Items

Item	Target Skill	Description	Correct Response	N	Pretest		Posttest		Change Pre to Post	
					% Correct	n	% Correct	n	% Correct	n
1	Pattern Creation	The child is asked to create a pattern using dinosaur footprints from The *PEG+CAT* video, *The Dinosaur Problem*.	2 repeating units	58	29.31%	17	31.03%	18	1.72%	1
2	Pattern Extension	The assessor creates an ABAB pattern with purple and orange blocks, then asks the child to extend the pattern using the blocks	add 1 unit (purple block, orange block)	58	84.48%	49	79.31%	46	-5.17%	-3
3	Pattern Duplication	The assessor shows the child an image of an AABAAB pattern of red stars and yellow triangles, then asks child to duplicate the pattern in play dough using	star, star, triangle x 2	58	53.45%	31	56.90%	33	3.45%	2
4	Pattern Duplication	The assessor demonstrates the pattern with their hands: fist, fist, open palm onto table; fist, fist, open palm onto table, then asks the child to duplicate the same pattern.	fist, fist, open palm x 2	58	58.62%	34	62.07%	36	3.45%	2
5	Pattern Completion	Using the *Chicken Dance* images from The *PEG+CAT* Online Game, *Chicken Dance,* the assessor makes an ABAB pattern, then asks the child to pick from all the *Chicken Dance* images to complete the pattern.	orange square	58	56.90%	33	63.79%	37	6.90%	4
6	Pattern Duplication	Using a plastic toy dinosaur, the assessor demonstrates an AAB pattern (step, step, bounce), and then asks the child to duplicate the pattern using the dinosaur.	step, step, bounce x 2	58	70.69%	41	79.31%	46	8.62%	5
7	Pattern Duplication	The assessor shows child an image of the dinosaur footprint pattern step, step, bounce, then the child is asked to create the same pattern using dinosaur footprints from *PEG+CAT* video, *The Dinosaur Problem*.	small, small, large x 2	58	36.21%	21	32.76%	19	-3.45%	-2
8	Pattern Completion	Using the *Chicken Dance* images from The *PEG+CAT* Online Game, *Chicken Dance*, assessor makes an ABAB_B pattern, then asks the child to pick from all the *Chicken Dance* images to insert the correct piece of the pattern.	orange square	58	65.52%	38	63.79%	37	-1.72%	-1

Table I2. Session 3 Results PCIS Items

Item	Target Skill	Description	Correct Response	N	Pretest		Posttest		Change Pre to Post	
					% Correct	n	% Correct	n	% Correct	n
1	Pattern Creation	The child is asked to create a pattern using sausages from The *PEG+CAT* video, *The Beethoven Problem*.	2 repeating units	59	47.46%	28	47.46%	28	0.00%	0
2	Pattern Duplication	Using images of feathers in lengths of short and long, the assessor makes an AAAB pattern, and then asks the child to duplicate the pattern using the feathers.	short short short long x 2	59	42.37%	25	47.46%	28	5.08%	3
3	Pattern Completion	Using a screenshot from the *PEG+CAT* Game App, The Big Gig, the assessor slides their fingers across a 1, 3, 1, 3 pattern, then asks the child to tell them what number comes next.	1 verbally or 1 pointing	59	35.59%	21	54.24%	32	18.64%	11
4	Pattern Duplication	The assessor shows the child images of sausages arranged in an AAABAAAB pattern from The *PEG+CAT* video, *The Beethoven Problem*. The Child is then asked to duplicate the pattern using the sausages provided.	short short short long x 2	58	44.83%	26	50.00%	29	5.17%	3
5	Pattern Extension	The assessor creates an ABAB pattern with plastic lemons and limes, then asks the child to extend the pattern using the lemons and limes provided.	add lemon lime x1	58	72.41%	42	81.03%	47	8.62%	5
6	Pattern Duplication	The assessor demonstrates the pattern with their hands: tap, tap, clap; tap, tap, clap, then asks the child to duplicate the same pattern.	tap, tap, tap, clap x 2	58	36.21%	21	43.10%	25	6.90%	4
7	Pattern Recognition	The assessor tells child they are making an AAABAAAB pattern using images of guitars. The assessor them makes an AAAABAAAA pattern on the table, and tells the child to help them make sure they did it right, and to help them change it to make it right.	indicate last short guitar should be long	58	36.21%	21	43.10%	25	6.90%	4
8	Pattern Duplication	Using the numbered circles from the *PEG+CAT* Game App, The Big Gig, the assessor creates the pattern 1,4,4,1,4,4 (from the game), and then gives the child numbered circles 1-5 asking them to create the same kind of pattern using the numbers provided.	any ABB x2	57	50.88%	29	61.40%	35	10.53%	6

Table I3. Session 4 Results PCIS Items

Item	Target Skill	Description	Correct Response	N	Pretest		Posttest		Change Pre to Post	
					% Correct	n	% Correct	n	% Correct	n
1a-1d. Prompt		The assessor shows the child images of various 2D and 3D images from the *PEG+CAT* video, *The Sparkling Sphere*, then using definitions from the video, asks the child to point to the shape that fits the definition								
1a	Shape characteristics	I'm looking for a flat shape that has four sides of equal length.	Rhombus	57	19.30%	11	22.81%	13	3.51%	2
1b	Shape characteristics	Now I'm looking for a shape that is round like a ball.	Sphere	57	91.23%	52	91.23%	52	0.00%	0
1c	Shape characteristics	Now I'm looking for a shape with six flat sides that are all the same size.	Cube	57	21.05%	12	21.05%	12	0.00%	0
1d	Shape characteristics	Can you find a solid shape that has a rectangle on every side?	Rectangular Prism	57	29.82%	17	22.81%	13	-7.02%	-4
2a-2d. Prompt		For the items 2a-2d, the assessor places the following 3D shapes on the table: sphere, cone, rectangular prism and cylinder, then asks the child to point to or pick up the shape.								
2a	3D Shape recognition	Which one is the sphere?	Sphere	57	31.58%	18	29.82%	17	-1.75%	-1
2b	3D Shape recognition	Which is the cone?	Cone	57	71.93%	41	80.70%	46	8.77%	5
2c	3D Shape recognition	Which is the rectangular prism?	Rectangular Prism	57	63.16%	36	68.42%	39	5.26%	3
2d	3D Shape recognition	Which the cylinder? 3D items	Cylinder	57	54.39%	31	43.86%	25	-10.53%	-6
3a - 3b Prompt		The assessor shows the child images of various 2D and 3D shapes from the *PEG+CAT* video, *The Sparkling Sphere*, and asks the child to say the name of the shape.								
3a	3D Shape recognition	Rectangular prism	Rectangular prism	57	0.00%	0	5.26%	3	5.36%	3
3b	3D Shape recognition	Pyramid	Pyramid	57	8.77%	5	10.53%	6	1.75%	1

Table I3. Session 4 Results PCIS Items (Continued)

Item	Target Skill	Description	Correct Response	N	Pretest		Posttest		Change Pre to Post	
					% Correct	n	% Correct	n	% Correct	n
4a-4c. Prompt		The assessor shows the child various images of characters from the *PEG+CAT* video, *The Sparkling Sphere*, and asks the child to say the name of the shape the character is holding, or near.								
4a	3D Shape recognition	The assessor points to Mermaid looking at a sphere	Sphere	57	0.00%	0	1.75%	1	1.75%	1
4b	3D Shape recognition	The assessor points to Toad holding a cube	Cube	57	0.00%	0	7.02%	4	7.02%	4
4c	2D Shape recognition	The assessor points to Peg holding a rhombus	Rhombus	57	0.00%	0	8.77%	5	8.77%	5
5	3D Shape recognition	The assessor points to Pig near a pyramid	Pyramid	57	5.26%	3	10.53%	6	5.26%	3
6	3D Shape recognition	The assessor points to Cat holding a cylinder	Cylinder	57	0.00%	0	29.82%	17	29.82%	17

Table I4. Session 5 Results PCIS Items

Item	Target Skill	Description	Correct Response	N	Pretest		Posttest		Change Pre to Post	
					% Correct	n	% Correct	n	% Correct	n
1	Shape characteristics	The assessor shows the child images of a cube and a pyramid from The *PEG+CAT* video, *The Golden Pyramid Problem*, then, using the definition from the video, the assessor asks the child to "point to the shape that has a square on the top and bottom".	Cube	59	81.36%	48	88.14%	52	6.78%	4
2	Shape characteristics	The assessor shows the child an image of the Mermaid with various 3D shapes from The *PEG+CAT* video, *The Golden Pyramid Problem*, then, using the definition from the video, the assessor asks the child to "point to the jewel that is a solid shape that looks like a box with six square sides".	Cube	59	81.36%	48	93.22%	55	11.86%	7
3	3D Shape recognition	The assessor shows the child an image of Toad holding a cube from The *PEG+CAT* video, *The Golden Pyramid Problem*, then asks the child what shape Toad is holding.	Cube	59	3.39%	2	8.47%	5	5.08%	3
4	Shape characteristics	The assessor shows the child an image of the Mermaid with various 3D shapes from The *PEG+CAT* video, *The Golden Pyramid Problem*, then, using the definition from the video, the assessor asks the child to "point to the jewel that looks like a tube with circles on the ends".	Cylinder	59	33.90%	20	44.07%	26	10.17%	6
5	3D Shape recognition	The assessor places the following 3D shapes in a basket: sphere, cube, cylinder, and pyramid, then asks the child to point to or pick up the cylinder.	Cylinder	59	54.24%	32	67.80%	40	13.56%	8
6	3D Shape recognition	The assessor shows the child an image of Mermaid holding pyramids from The *PEG+CAT* video, *The Golden Pyramid Problem*, then asks the child what shape Mermaid is holding.	Pyramid	59	3.39%	2	15.25%	9	11.86%	7
7	3D Shape recognition	The assessor places the following 3D shapes in a basket: sphere, cube, cylinder, and pyramid, then asks the child to point to or pick up the cube.	Cube	59	38.98%	23	55.93%	33	16.95%	10
8	3D Shape recognition	The assessor shows the child images of various 2D and 3D images from the *PEG+CAT* video, *The Golden Pyramid Problem*, and asks the child to point to the sphere.	Sphere	59	16.95%	10	20.34%	12	3.39%	2
9	3D Shape recognition	The assessor shows the child images of various 2D and 3D images from the *PEG+CAT* video, *The Golden Pyramid Problem*, and asks the child to point to the cylinder.	Cylinder	59	38.98%	23	54.24%	32	15.25%	9

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