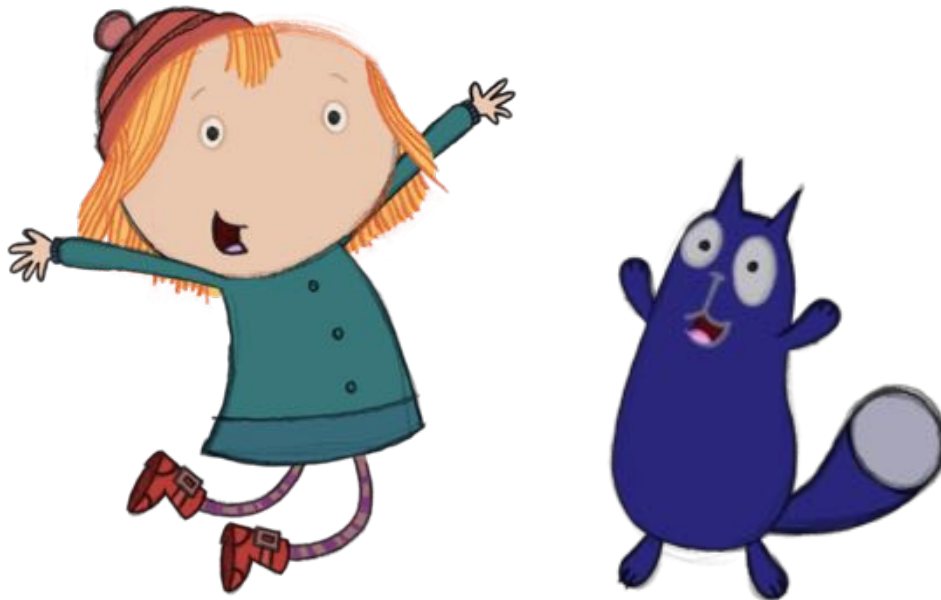

Peg + Cat Early Learning of Math Through Media Summative Evaluation Findings

Rockman et al

Research & Evaluation



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Executive Summary

Project Overview

The Peg + Cat Early Learning of Math Through Media (ELM2) project was a three-year project, funded by the National Science Foundation (NSF) Advancing Informal Science Learning (AISL) program. Peg + Cat is an award-winning PBS television series, produced by The Fred Rogers Company, in which a girl, Peg, and her companion, Cat, solve everyday problems using mathematics concepts. The Peg + Cat ELM2 project team developed several resources, based on the show's core messages. These resources included additional episodes of the Peg + Cat television series, online games, and mobile apps, a set of professional development (PD) mathematics modules for early childhood educators, classroom-based family engagement activities for teachers to implement with parents and children, and a variety of math-based take-home materials for families. Project resources were disseminated across two program years: Program Year 1 (2014-2015) and Program Year 2 (2015-2016).

The main goals that the Peg + Cat ELM2 project sought to address were to:

- **Goal 1:** Deepen the field's understanding of how to advance early learning in mathematics
- **Goal 2:** Produce a broadcast series and web and mobile games that kids love and that get kids excited about math
- **Goal 3:** Help children develop math content knowledge, skills, and problem-solving/reasoning abilities
- **Goal 4:** Help children develop a positive and persistent attitude towards mathematics
- **Goal 5:** Increase preschool teachers' knowledge of math content and pedagogy, as well as their confidence
- **Goal 6:** Increase parents' interest, engagement, and confidence in exploring mathematics with their children

Rockman et al (REA), the external evaluators for the project, utilized a mixed-methods approach to explore the following questions:

- **EQ1:** To what extent does this project meet its objectives and deliverables?
- **EQ2a:** What are the key teacher-reported program elements that support or hinder the transfer of knowledge to pedagogy?
- **EQ2b:** How did teachers use the project resources and strategies?
- **EQ3a:** What are the key parent-reported program elements that support or hinder parents' a.) interest, engagement, and confidence in exploring mathematics with their children, and b.) the development of knowledge of math as accessible and important for their children, and c.) development of strategies to support children's mathematics learning and engagement?

-
- **EQ3b:** How did parents use project resources and strategies?
 - **EQ4:** Does teachers' participation in and outcomes from the project's professional development, and children's involvement with program resources and activities impact children's interest in, and positive and persistent attitudes towards mathematics?

To answer the questions above, REA a.) conducted observations of PD, classroom routines and activities, and family engagement activities, b.) administered parent, teacher, and end-of-year project team member interviews, and c.) collected teacher post-surveys, parent pre-post surveys, and family forms to track project resource use.

Key Findings

Key findings from the Peg + Cat ELM2 project are organized by evaluation question.

EQ1: To what extent does this project meet its objectives and deliverables?

Goal 1: Deepen the field's understanding of how to advance early learning in mathematics

- Administrative buy-in is a key contributor to successful PD for early childhood educators. When administrators experience PD alongside teachers, both groups see more value in the PD.
- Changes in teacher practices take time. Thus, more school district-like PD, like ELM2 PD, may be needed to support teachers' transfer of knowledge to pedagogy.
- Deep learning occurs when children have multiple opportunities to explore math concepts and activities. Thus, effective math instruction for early learners should include intentional exposure to math throughout the school day in a variety of contexts, as well as provide families with ideas and strategies to connect what children are doing in school to their everyday lives.
- Transmedia¹ resources, such as television programming, online games, songs, and hands-on activities, can be leveraged to support teachers' and families' math exploration and interest. Such materials provide approachable language and simple ways for teachers and parents to talk about and do math with children. Transmedia holds children's attention, and helps get families and teachers excited about math.

Transmedia resources provide approachable language and simple ways for teachers and parents to talk about and do math with children.

¹ For the Peg + Cat ELM2 project, "transmedia" was defined as Peg + Cat broadcast and digital media, and hands-on family engagement materials.

Goal 2: Produce a broadcast series and web and mobile games that kids love and that get kids excited about math

- The Peg + Cat television series, online games, and mobile apps are popular with children.

Peg + Cat Television Series

- Since its October 2013 premiere, the Peg + Cat television series has consistently ranked as one of the most popular programs on television for preschoolers and among mothers with young children.
- In terms of viewership on streaming video, Peg + Cat broke PBS KIDS' record for most video streams for a new show in its first month of airing.

Peg + Cat Website & Online Games

- Since its October 2013 premiere, the Peg + Cat website has had high web traffic, including over 244 million page views and over 21 million users.
- Over half of Peg + Cat website users are return visitors.
- Since October 2013, Peg + Cat online games have had over 10 million page views.
- The Peg + Cat online games are highly engaging, with players spending an average of 3 minutes and 30 seconds per game session.

Peg + Cat Mobile Apps

- Since its launch date on October 3, 2013, *The Big Gig* has been downloaded 70,457 times, with an additional 60,939 updates downloaded.
- During end-of-year interviews, participating parents and teachers reported that Peg + Cat media helped children get excited about math concepts and activities.

Goal 3: Help children develop math content knowledge, skills, and problem-solving/reasoning abilities

- All Head Start classrooms in the Allegheny Intermediate Unit (AIU) participated in the Peg + Cat ELM2 project. According to the Head Start 2015 and 2016 Annual Reports from the AIU, the majority of all children at the AIU Head Start improved their math skills from the beginning of the program year to the end of the program year in both years that the Peg + Cat ELM2 project was taking place.
- Parents' perceptions of their children's understanding of mathematics did not change significantly in either program year.
- During end-of-year interviews, participating parents and teachers reported seeing changes in children's understanding of specific math skills and increased math vocabulary use across both program years.

Goal 4: Help children develop a positive and persistent attitude towards mathematics

Children's Interest in Mathematics

Children's interest in mathematics, as reported by their parents, increased in both program years.

- In both program years, parents reported significantly higher agreement with the statement, "My child likes math," at the end of year, compared to the beginning of each year.
- During interviews, parents and teachers reported that they saw evidence of children's increased interest in math through their willingness to initiate math-related activities and engage in math talk.

Children's Persistence in Mathematics

- Parents' perceptions of their children's persistence in mathematics did not change significantly in either program year.
 - However, when only the responses of parents who thought that their children did not keep trying when faced with a difficult math problem at the beginning of each program year were compared, these parents were significantly more likely by the end of Program Year 1 to indicate that their children had increased their persistent behavior. There were no significant differences in children's persistence in this subgroup in Program Year 2.
- During end-of-year interviews, participating parents and teachers reported that they observed children keep trying when faced with a difficult math problem.

Goal 5: Increase preschool teachers' knowledge of math content and pedagogy, as well as their confidence

Teachers' Knowledge of Math Content & Pedagogy

- 82% of teachers who were surveyed (n=55) increased or maintained their level of pedagogical content knowledge from the beginning of the program year to the end of the program year.
 - This result is noteworthy, given that most teachers came into the Peg + Cat ELM2 PD with relatively high levels of pedagogical content knowledge beforehand.

Teachers who participated in Peg + Cat ELM2 professional development increased or maintained their level of pedagogical content knowledge, despite entering the project with relatively high levels already.

Teachers' Confidence in Math Instruction

- 51% of participating teachers (n=45) reported an increase in their general confidence level towards teaching mathematics by the end of both program years.

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- After two program years, participating teachers were significantly more likely to indicate that they felt prepared to specifically teach about numbers, geometry, and data.
 - During end-of-year interviews, participating teachers reported that their confidence in talking about and doing math activities with children and families had increased.

Goal 6: Increase parents' interest, engagement, and confidence in exploring mathematics with their children

Parents' Interest in Math

- In general, parents' self-reported interest in mathematics did not significantly change from pre-to-post in either program year.

Parents' Engagement with Math

- In both program years, parents reported talking with their children about math significantly more often by the end of the year compared to the beginning of the year.

Parents reported talking with their children about math significantly more by the end of each program year, compared to the beginning of each year.

- In both program years, parents also reported participating significantly more often in Head Start activities involving math by the end of the program year compared to their level of participation at the beginning of that program year.
- A significantly higher percentage of parents reported doing math-related activities with their children by the end of the second program year, compared to the beginning of that program year (Note: This question was not asked in the first program year).

Parents' Confidence in Math

- Parents were fairly comfortable with their own math abilities, on average, at both the beginning and end of the year. In general, parents' self-reported confidence in their own math abilities did not significantly change in the first program year. In the second program year, parents' confidence significantly decreased from pre to post, but still remained relatively high.
- Parents were fairly comfortable exploring math with their children, on average, at both the beginning and end of the year. In general, parents' self-reported confidence in exploring math with their children did not significantly change in the first program year. In the second program year, parents' confidence significantly decreased from pre to post, but still remained relatively high.

EQ2a: What are the key teacher-reported program elements that support or hinder the transfer of knowledge to pedagogy?

Contributors to Teachers' Pedagogical Content Knowledge

- Teachers reported that the top three aspects of the PD that they felt had made the most difference in their classrooms were hands-on activities around specific math concepts, discussions of specific math concepts, and information on and brainstorming about activities in the classroom.
- Teachers shared that the training they received around family engagement resources and strategies helped them feel more comfortable engaging young children and their families around math.
- Teachers internalized messages from the PD regarding characteristics of effective family engagement. These strategies included:
 - Letting children take the lead during the FEA interaction
 - Utilizing everyday materials to connect to what children are already doing at home
 - Modeling math vocabulary and ways to elicit children's thinking for parents
 - Going over a math concept or activity with the children in the classroom before the FEA
 - Making families feel welcome by greeting them and thanking them for attending
- Teachers felt that the Peg + Cat transmedia resources made math more exciting for them personally.
- Teachers thought that the information about children's learning trajectories in mathematical skills development and child interviewing techniques prepared them to assess children's mathematical thinking.

Predictors of Teachers' Confidence in Their Math Instruction

- Teachers' use of project resources significantly predicted teachers' confidence in their mathematics instruction at the end of the program, controlling for their confidence in their mathematics instruction beforehand.
 - Further analyses revealed that teachers' use of PD resources made a unique contribution to the variance in their confidence.

Teachers use of Peg + Cat ELM2 professional development resources significantly predicted their confidence in their mathematics instruction.

EQ2b: How did teachers use the project resources and strategies?

Teachers' Use of Classroom Activities

- End-of-year surveys indicated that the largest number of teachers reported utilizing books and graphing activities in Program Year 1, and books, shape scavenger hunts, and block play in Program Year 2.
- In both program years, teachers reported using the resources and activities covered in the PD most often to reinforce a math concept or during Centers/Small Group activities. In Program Year 1, teachers also reported using these resources quite often during Circle Time.
- During end-of-year interviews, participating teachers noted that the most frequent changes to their classroom were their attendance procedures and materials, the presence of a number line calendar, and the inclusion of more math resources overall.

Teachers' Use of Family Engagement Activities (FEAs)

- Teachers in Program Year 1 indicated that they did approximately 6 Peg + Cat FEAs per year, whereas teachers in Program Year 2 indicated that they did approximately 8 Peg + Cat FEAs per year.
 - In Program Year 1, the largest number of teachers reported doing the Counting Collage FEA, while in Program Year 2 the largest number of teachers reported doing the Dice & Action Game FEA. They reported that the Dice & Action Game was well-received by families, whereas the Counting Collage was not.

Teachers adapted activities and ideas from the professional development into Family Engagement Activities within their own classrooms.

- Teachers reported spending more time planning for FEAs by the end of each program year ($M=3.81$), compared to the beginning of those program years ($M=3.23$).
- Teachers adapted activities and ideas that they were exposed to in the PD into FEAs within their own classrooms.

Teachers' Use of Transmedia Resources

- Most participating teachers utilized the Peg + Cat ELM2 transmedia resources in their classrooms.
 - Teachers in Program Year 1 indicated that they used approximately 7 Peg + Cat transmedia resources per year, whereas teachers in Program Year 2 indicated that they used approximately 5 Peg + Cat transmedia resources per year.
 - In the first program year, the greatest number of participating teachers reported using the Lending Box materials and the Take-Home Activity Sheets. In the second program

year, the greatest number of teachers reported using the Peg + Cat video clips and episodes in their classrooms.

Teachers' Use of Pedagogical Strategies

- Teachers utilized several strategies that they were exposed to during the PD, including ways to encourage children to keep trying when faced with a difficult problem, modeling math talk for parents, and incorporating questioning techniques to elicit children's mathematical thinking.

EQ3a: What are the key parent-reported program elements that support or hinder parents' a.) interest, engagement, and confidence in exploring mathematics with their children, and b.) the development of knowledge of math as accessible and important for their children, and c.) development of strategies to support children's mathematics learning and engagement?

Predictors of Parents' Math Interest

- Teacher confidence, combined with teachers' and parents' use of project resources, helped predict parents' interest in math in both program years.
- Parents were provided with a list of Peg + Cat media resources, and asked to indicate whether each resource had increased their interest in mathematics. In Program Year 1, the highest percentage of parents indicated that going on the Peg + Cat website had made them more interested in mathematics. In Program Year 2, the highest percentage of parents indicated that playing with Peg + Cat apps on a tablet or mobile device had made them more interested in mathematics.

Predictors of Parents' Engagement in Math With Their Children

Analyses showed that parents' use of project resources in Program Year 2 predicted how often parents talked to their children about math AND how often they engaged in math-related activities together.

- Teacher confidence, combined with teachers' and parents' use of project resources, helped predict the frequency with which parents talked about math with their children in both program years.
- In Program Year 2, further analyses revealed that parents' use of project resources made a unique contribution to the variance in how often parents talked with their children about math at the end of the program year, after controlling for parents' prior amount of mathematics talk. There were no unique contributors in Program Year 1.

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- Parents were provided with a list of Peg + Cat media resources, and asked to indicate whether each resource had helped them talk about math with their children. In both program years, the highest percentage of parents indicated that watching Peg + Cat on television helped them find ways to talk about math with their children.
 - Teacher confidence, combined with teachers' and parents' use of project resources, helped predict the frequency that parents reported engaging in math-related activities with their children in Program Year 2. This analysis was not available for Program Year 1 data.
 - In Program Year 2, further analyses revealed that parents' use of project resources made a unique contribution to the variance in how often parents engaged in math-related activities with their children at the end of the program year, after controlling for parents' prior engagement in math-related activities with their children.

Predictors of Parents' Confidence in Math

- Teacher confidence, combined with teachers' and parents' use of project resources, helped predict the frequency with which parents talked about math with their children in both program years.
 - In Program Year 1, further analyses revealed that when controlling for parents' prior confidence in their own math abilities, parents' use of project resources made a unique contribution to the variance in parents' confidence in exploring mathematics with their children. In Program Year 2, no unique contributors were identified, after controlling for parents' prior confidence in their own math abilities.

Analyses showed that parents' use of project resources in Program Year 1 predicted parents' confidence in exploring mathematics with their children.

Predictors of Parents' Beliefs About Math

- In Program Year 2, analyses showed that teachers' confidence, combined with teachers' and parents' use of project resources, helped predict parents' beliefs that math should be accessible at home and at school overall. Analyses did not reveal an adequate model for predicting parents' beliefs in math accessibility at the end of Program Year 1.
 - There were no unique contributors to parents' beliefs about math accessibility at the end of Program Year 2.
- In both program years, analyses did not reveal any significant predictors of parents' beliefs about the importance of mathematics.

EQ3b: How did parents use project resources and strategies?

Parents' Use of Family Engagement Activities (FEAs)

- A total of 1780 parents attended 221 FEAs across 46 classrooms in Program Year 1, and a total of 2733 parents attended 351 FEAs across 48 classrooms in Program Year 2.
- The average number of parents attending an FEA in Program Year 1 was 8.31 parents per FEA, and 7.8 parents per FEA in Program Year 2.

Parents' Use of Transmedia Resources

- At the end of each program year, a significantly higher percentage of parents reported that they had engaged with their child around one of the Peg + Cat transmedia resources that had already been available to them at the beginning of the program year.
- When the Peg + Cat ELM2 project resources were used at home, many parents tended to report using them with their children.

When the Peg + Cat ELM2 project resources were used at home, many parents reported using them with their children.

EQ4: Does teachers' participation in and outcomes from the project's professional development and children's involvement with program resources and activities impact children's interest in and positive and persistent attitudes towards mathematics?

Predictors of Children's Interest in Math

- Teachers' confidence in math, and parents' and teachers' use of project resources, predicted children's interest in math (as reported by parents) at the end of both program years, when controlling for children's prior interest in math.
 - In Program Year 1, parents' use of project resources made a unique contribution to the variance in children's interest in math at the end of the program year, when controlling for children's prior interest in math.
 - In Program Year 2, no unique contributors were identified, after controlling for children's prior interest in math.

Analyses showed that parents' use of project resources in Program Year 1 predicted their children's parent-reported interest in math.

Predictors of Children's Persistence in Math

- Teachers' confidence in math, and parents' and teachers' use of project resources, predicted children's persistence in math (as reported by parents) at the end of both program years, after controlling for children's prior persistence in math.
 - In Program Year 1, no unique contributors were identified, after controlling for children's prior persistence in math.

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- In Program Year 2, parents' use of project resources made a unique contribution to the variance in children's persistence in math at the end of the program year, after controlling for children's prior persistence in math.

Analyses showed that parents' use of project resources in Program Year 2 predicted their children's parent-reported persistence in math.

Impacts of Peg + Cat Transmedia Resources on Children

- In general, parents reported that their children utilized technology to explore mathematics significantly more often at the end of both program years, compared to the beginning of each year.

Parents reported that their children used technology to explore math significantly more often by the end of each program year, compared to the beginning of each program year.

- Parents were provided with a list of Peg + Cat media resources, and asked to indicate whether each resource had increased their children's interest in mathematics. In Program Year 1, the highest percentage of parents indicated that watching Peg + Cat on television and doing a Peg + Cat FEA had made their children more interested in mathematics. In Program Year 2, the highest percentage of parents indicated that using the Lending Box had made their children more interested in mathematics.
- Parents were provided with a list of Peg + Cat media resources, and asked to indicate whether each resource had helped their children better understand mathematics. In Program Year 1, the highest percentage of parents indicated that Watching Peg + Cat on television had helped their children better understand math. In Program 2, the highest percentage of parents indicated that using Peg + Cat apps helped their children better understand math.

Conclusion

The Peg + Cat ELM2 project sought to combine robust media-integrated teacher training in both math content and facilitation of classroom and family engagement activities with transmedia resources that parents and children could utilize at home. This cohesive approach resulted in increases in teachers' confidence in and knowledge about their mathematics instruction, parents' engagement in activities and conversations with their children around math, and children's positive and persistent attitudes towards math, as reported by their parents. Taken together, these findings suggest that the Peg + Cat ELM2 project positively impacted teachers, parents, and children.

But what features of the project contributed to teacher, parent, and child outcomes? Teacher outcomes were mediated by their use of project resources. Most parent and all child outcomes were mediated by teacher confidence, teachers' use of project resources, and parents' use of transmedia resources. Parents' use of transmedia resources was often a unique contributor to outcomes, such as the frequency that parents talked about math or engaged in math-related activities with their children, parents' confidence in their own math abilities, and children's interest in and persistence towards mathematics. Thus project resources, particularly transmedia resources, had an important impact on teachers, parents, and children.

Finally, the Peg + Cat ELM2 project generated some lessons learned regarding the ways that transmedia can support mathematics exploration. Transmedia appears to work best when it is leveraged across multiple settings. For teachers, this meant encountering Peg + Cat video clips, songs, online games, apps, and hands-on activities during PD, and then incorporating these resources into their classroom and family engagement activities. For parents, transmedia was introduced during family engagement activities in their children's classrooms and carried over to the home through the Lending Box and other Peg + Cat take-home resources. This resulted in children experiencing math through media in various contexts - within daily classroom routines, during scaffolded family engagement activities, and in everyday life at home. In this way, transmedia was a pervasive thread that gave teachers, parents, and children an approachable and fun way to experience math together.

Peg + Cat ELM2 Summative Evaluation Report

Project Overview

The Peg + Cat Early Learning of Math Through Media (ELM2) project was a three-year project, funded by the National Science Foundation's (NSF) Advancing Informal Science Learning (AISL) program. Peg + Cat is an award-winning PBS television series, produced by The Fred Rogers Company, in which a girl, Peg, and her companion, Cat, solve everyday problems using mathematics concepts (see Figure 1). The Peg + Cat ELM2 project leveraged the message of the show by asking whether Peg + Cat transmedia² could impact teachers', parents', and children's interest, engagement, and confidence around exploring mathematics. The main goals that the project sought to address were to:

- **Goal 1:** Deepen the field's understanding of how to advance early learning in mathematics
- **Goal 2:** Produce a broadcast series and web and mobile games that kids love and that get kids excited about math
- **Goal 3:** Help children develop math content knowledge, skills, and problem-solving/reasoning abilities
- **Goal 4:** Help children develop a positive and persistent attitude towards mathematics
- **Goal 5:** Increase preschool teachers' knowledge of math content and pedagogy, as well as their confidence
- **Goal 6:** Increase parents' interest, engagement, and confidence in exploring mathematics with their children

Figure 1: Animation still from the Peg + Cat television series



² For the Peg + Cat ELM2 project, “transmedia” was defined as Peg + Cat broadcast and digital media, and hands-on family engagement materials.

The Peg + Cat ELM2 project team developed several resources to carry out its core objectives. First, The Fred Rogers Company produced 40 televised episodes of Peg + Cat, as well as several online games and mobile apps. Second, project partners, The Math & Science Collaborative, developed and facilitated PD sessions for early childhood educators and administrators from the Allegheny Intermediate Unit (AIU) Head Start. Third, the Fred Rogers Company developed a set of transmedia resources to reach Head Start parents and children, including seven math-related Family Engagement Activities (i.e. 15-30 minute activities that AIU Head Start teachers set up monthly for parents and children to do together during pickup or drop-off times), and a variety of math-focused take-home materials (see Tables 2-4). Finally, The University of Pittsburgh’s Collaborative for Evaluation and Assessment Capacity (CEAC) conducted research on the PD’s impact on teachers’ knowledge, confidence, and pedagogy, while Rockman et al (REA), the project’s external evaluators, focused on parent and child, as well as overall project, outcomes.

Peg + Cat ELM2 Professional Development

Peg + Cat ELM2 PD sessions were conducted over the course of two program years. Program Year 1 took place from 2014-2015, while Program Year 2 took place from 2015-2016. There were two cohorts of AIU Head Start teachers and administrators who took part each year (57 teachers and 10 administrators in Program Year 1; 56 teachers and 7 administrators in Program Year 2). These cohorts comprised all of the AIU Head Start classrooms. Each year, one cohort had 8 consecutive full days of PD in the summer followed by 4 intermittent half-days during the school year, and one cohort had 8 full days and 4 half days of PD spaced out across the school year. However, there were no differences in the content delivery or activities that each cohort experienced. Thus, they are considered to be one cohesive group by the project team. If participants remained across both program years, they received 20 total days of PD.

Figure 2: Photographs from Peg + Cat ELM2 PD, Program Year 1



Figure 3: Photographs from Peg + Cat ELM2 PD, Program Year 2



In Program Year 1, the PD content focused on big ideas in pre-number, number concepts, and operations (see Table 1). In Program Year 2, the PD content focused on big ideas in spatial relations, geometry, and measurement. In both program years, the PD also conveyed the overarching messages that math is everywhere, all people can learn mathematics, that math is important, and that math begins early in life and should be supported and encouraged.

Table 1: Peg + Cat ELM2 Professional Development Topics By Program Year

Program Year 1	Program Year 2
Classifying & Sorting	Positional Words
Counting Principles	Block Play
Routines	Shape Attributes
Subtizing	Composing/Decomposing Shapes
Patterns	Social-Emotional Learning
Representations	Patterns
Fiveness	Measurement
Joining & Separating	Weight/Volume
Graphing	
Growth Mindset	
Child Interviewing	
Addition/Subtraction	

Each year, the 8 full days of PD were structured to include PowerPoint presentations to define and provide examples for key mathematics concepts, or to highlight pertinent findings from research in mathematics skills development in early childhood. These presentations were interspersed with small and large group discussions on how to apply these principles in preschool classrooms, and how to assess young children’s mathematics’ learning trajectories.

In addition, facilitators led a variety of hands-on activities throughout the day to either help teachers understand the foundations of a specific math concept or to give them ideas for resources they could use or activities that they could do in their own classrooms. Videos of teachers modeling pedagogical strategies for supporting children’s mathematical thinking and engagement were often shown as exemplars, and examples of children’s work were discussed. Video clips, songs, and other Peg + Cat media were utilized throughout the day to introduce mathematical concepts and to keep teachers engaged.

At the end of each day of PD, a representative from The Fred Rogers Company talked with the teachers about strategies to support family engagement around mathematics, and shared example activities that teachers could use with parents and children in their classrooms. In Program Year 1, The Fred Rogers Company shared eight math-related Family Engagement Activities (FEAs) for teachers to incorporate into their classrooms (see Table 2). In Program Year 2, Head Start teachers were provided with a template to come up with their own math-related FEAs for classroom use.

Table 2: Peg + Cat ELM2 Family Engagement Activities From Program Year 1

FEA Name	FEA Description
Counting Collage	Families made their own picture using 1 Peg, 1 Cat, 2 pieces of string, and 3 chickens.
Bedtime Routines	Families cut out images of activities that they did before bedtime, and placed the activities into a booklet or paper strip in order (1st, 2nd, etc.).
Sorting Socks & Silverware	Families grouped socks, silverware, and other everyday objects by different attributes such as color, size, shape, etc.
Dice & Action Game	Families drew a card with an action pictured on it, then rolled a die to see how many times they needed to do that action.
Patterns	Families made repeating patterns using movement, sound, color, size, shape, object type, etc.
54321 Calm Down Strategy	Families used stickers of Peg + Cat characters, and placed the numbers 1-5 backwards on a piece of paper. They then reviewed counting backwards from five as a strategy to calm down when children became frustrated.
Now How Many? Add One More	Families take a handful of objects, and then count how many they have in their hands. One more object is added, and families try to determine the quantity that they have now.
Five Fingers/Tracing Your Hand	Families traced their hands and then wrote the numbers 1-5 above each finger. They then practiced different ways to make 5 with their hands.

Figure 4: Photographs from Five Fingers/Tracing Your Hand FEA



The remaining four half days of the PD were reserved for teachers to share out what they had been doing and what resources they were incorporating in their classrooms, and for the facilitators to share additional reflections on and resources for the math concepts that had been covered that year.

After two program years of PD were completed, the project team revised and compressed the PD sessions, based on feedback from the research and evaluation teams, into three modules: A foundational content module on number sense and two extension modules (one on shapes and spatial relationships, the other on measurement, data, and patterns). The foundational module requires 6 days of PD, while each extension module will take 3 days of PD (12 total days of PD).

Peg + Cat ELM2 Transmedia Resources

The Fred Rogers Company designed a set of math and Peg + Cat-related resources for teachers to utilize in their classrooms, and for families to take home. In Program Year 1, these materials included a Lending Box, Activity Sheets, and a set of Trading Cards (see Table 3). In Program Year 2, new items were added to the Lending Box, and families were provided with a tote bag that included a Measuring Tape, Shape Cards, and the Peg + Cat Out-on-a-Limb DVD and Family Activity Guide (see Table 4). Teachers also received a large floormat for their classrooms, and families received an identical placemat to take home in Program Year 2.

Table 3: Peg + Cat ELM2 Resources in Program Year 1

Program Year 1 Resources			
LENDING BOX ITEMS			
Timer	Calculator	Dice & Action Game	
			
Dominoes	Jumbo Playing Cards	Peg + Cat Music CD	
			
Five Creatures Book	Anno's Counting Book	Peg + Cat Chickens on the Loose DVD	
			
Activity Sheets			
			
Trading Cards			
			

Table 4: Peg + Cat ELM2 Resources in Program Year 2

Program Year 2 Resources	
<p>LENDING BOX ITEMS All of the Program Year 1 items plus:</p>	
<p>Measuring Tape</p> 	<p>Shape Cards</p> 
<p>Peg Rocks! DVD</p> 	<p>Placemat</p> 
<p>Pirates Ahoy! DVD</p> 	<p>Out on a Limb DVD & Family Activity Guide</p> 
	<p>Floormat</p> 

Evaluation Methodology

Rockman et al (REA), the external evaluators for the Peg + Cat ELM2 project, utilized a mixed-methods approach to collect data from teachers and families that included observations, interviews, pre-post surveys, and forms to track project resource use. A detailed breakdown of the sample size obtained via each method can be found in Appendix A.

In both program years, a member of the evaluation team attended all PD sessions for both cohorts, and took observation notes and photographs of the activities and discussions that occurred. All participating Head Start teachers were assigned a number based on whether they attended summer or school year PD. These numbers were used to track and link all subsequent datasets.

PD facilitators asked teachers to fill out a daily reflection (i.e. to list one or two things that they had learned about that day's topic, and to identify any questions they still had). After the 8 main days of PD, teachers were asked to fill out a feedback form, highlighting what they had found most and least helpful about the elements of the PD and indicating how they planned to use what they had learned in their own classrooms. REA used the daily reflections and feedback form to provide formative feedback to the project team to improve the subsequent year's PD and the development of the final PD modules.

During each program year, REA conducted a subset of classroom observations of participating Head Start teachers. Here, a member of the evaluation team took notes and photographs of the math-related activities, resources, and conversations that teachers incorporated into their classrooms. In addition, REA conducted a subset of observations of math-related FEAs to find out how teachers were adapting math content and activities for families, and to see the extent to which families engaged with these activities. After each FEA, observed teachers were contacted for a short telephone interview to reflect on what worked well and what did not work as well during their FEAs. This information was used to improve the subsequent year's approach to FEAs and in the development of the final family engagement components of the PD modules. All teachers were also asked to submit their participant sign-in sheets for any math-related FEAs with the title of the activity and the number of participants who attended.

In addition, REA added questions to a teacher post-survey administered by CEAC, the project's internal research team, regarding how often and in what context teachers used Peg + Cat ELM2 resources and activities. At the end of each program year, REA interviewed a subset of participating teachers by phone, regarding whether the PD had impacted their pedagogy, what strategies they felt they had learned from the PD, and how they used Peg + Cat ELM2 resources and activities in their classrooms and during family engagement.

Parents with a child who was enrolled in a participating Head Start classroom were asked to take a pre-survey at the beginning of each program year (Spring/Fall 2014 or Fall 2015), and a post-survey at the end of those years (Spring 2015 or Spring 2016). Paper versions of the survey were distributed to parents during pick up or drop off of their children, or adult family members took the surveys online.

A subset of Head Start parents were also interviewed by phone at the end of each program year. Interviewees were asked about their use of and opinions about various project resources. They also answered questions regarding how they felt that these materials supported their children's math interest, engagement, and persistence, and what role they felt they had played with their children while using these materials.

During each program year, parents were asked to fill out a series of forms, indicating how they had used various project resources and strategies. Families completed a Lending Box Checkout Form whenever they borrowed one of the Lending Box materials for use at home, and teachers submitted these forms to the evaluation team at the end of each month.

REA used quantitative analyses to examine potential changes in parent and parent-reported child outcomes towards math over time, as well as to look at possible predictors of programmatic impacts on families. In addition, qualitative techniques were used to identify common themes and lessons learned from the Peg + Cat ELM2 project. Findings from analyses of the Peg + Cat ELM2 project's multiple data sources can be found below.

Findings

EQ1: To what extent does this project meet its objectives and deliverables?

Goal 1: Deepen the field's understanding of how to advance early learning in mathematics

One of the main lessons learned from the Peg + Cat ELM2 project with relevance to early childhood mathematics programs is that administrative support is a key contributor to successful PD. Teachers at the AIU Head Start had been asking program administrators for more district-like PD, and the leadership saw the Peg + Cat ELM2 project's in-depth 20-day PD experience as a means for providing their teachers with a quality PD opportunity. In addition, Head Start administrators made the commitment to experience the Peg + Cat ELM2 PD alongside their teachers. The inclusion of administrators in PD sessions led to more buy-in from both teachers and administrators alike as they recognized the importance and value of intentional mathematics instruction for early learners. One project team member elaborated, *"It sends a message, 'This is valued. We're investing in you. We value you as a learner and we want you to be able to do your very best.'" In turn, increased administrator involvement resulted in deeper teacher participation: "I observe a direct correlation between teacher engagement and more open reflection when leadership is also involved in that. When they take an active role and actually contribute to the discussions, it just seems to spread. It seems to be more contagious."* Furthermore, both administrators and teachers were able to align their expectations around the kinds of strategies and resources that support early learners' exploration of mathematics and commit to incorporating them into Head Start classrooms. One administrator shared, *"I will be more aware of intentional math teaching and opportunities the teachers are providing, while observing."*

Administrative support is a key contributor to successful PD.

Since administrator buy-in is a large part of what made the Peg + Cat ELM2 PD a success, the final PD modules that were developed recommend including a planning year for program administrators to figure out how the Peg + Cat ELM2 PD sessions fit in with their existing PD offerings and strategic vision. For Head Start and other early childhood programs across the country, who are being asked to think broadly around five-year strategic goals, the Peg + Cat ELM2 PD is well-situated to meet their needs.

Peg + Cat ELM2 PD is well-situated to meet the needs of Head Start and other early childhood programs.

A second lesson learned with implications for the field is that changing teachers' classroom practices requires an investment in time for PD, but that timing must be realistic to the early childhood context. The PD provided during the Peg + Cat ELM2 project consisted of 20 days over a two-year period (8 full days and 4 half days per year). Evaluation feedback from teachers and administrators indicated that the amount of time provided in the Peg + Cat ELM2 PD was not necessary to fully comprehend the content, activities, and strategies for supporting children's exploration of math. The project team also felt that the amount of PD provided during Peg + Cat ELM2 was not realistic for other early childhood programs to implement given other constraints on their time. Therefore, in order to provide a sustainable model for other early childhood programs, the final PD modules disseminated as part of the Peg + Cat ELM2 project were reduced to 12 days total (a 6-day foundational content module and two 3-day extension modules). The nature of the final modules recognizes that there are core concepts that need to be covered in a math-specific PD experience, while allowing early childhood programs the flexibility to select whether to extend their educators' PD to include other important concepts and activities in subsequent years. The PD days can also occur consecutively or spaced out over time to fit in with program timelines and teachers' availability.

Deep learning occurs when children have multiple opportunities to explore math concepts and activities.

A third takeaway related to early learning in mathematics is that deep learning occurs when children have multiple opportunities to explore math concepts and activities. In practice, this means that impactful teachers introduce math concepts in different contexts throughout the day instead of limiting math exposure to a scheduled time or setting. Here, a teacher might intentionally ask for help sorting markers by color at an art table, encourage children who are playing with animals to figure out different ways to sort them, or ask the children to sort themselves in

different ways while waiting in line to go outside. Intentional instruction does not necessarily mean coming up with all new activities and classroom resources around a particular math topic, but rather leveraging the materials and daily routines with which teachers and young

children in their classroom already engage. For example, teachers who experienced the Peg + Cat ELM2 PD incorporated math in their attendance procedures, while reading books to their class, and even during handwashing before mealtimes (see Figure 5).

Figure 5: Photographs from Peg + Cat ELM2 Classroom Observations



FROM LEFT TO RIGHT: A COMPARISON OF THE TOTAL NUMBER OF CHILDREN IN ATTENDANCE ON MONDAY VS. TUESDAY USING UNIFIX CUBES TO REPRESENT EACH CHILD; A REPRESENTATION OF NUMBERS USING DOTS AND NUMERALS TO SHOW THE ORDER OF STEPS IN HANDWASHING; AND A TEACHER READING A STORY ABOUT A SNOW FAMILY AND ASKING THE CHILDREN TO MAKE DIFFERENT SNOWMAN PATTERNS.

In addition, the Peg + Cat ELM2 project provided several opportunities for parents and children to engage around math together through FEAs in the classroom or take-home materials and activities for families to explore math together at home. Bringing families into their children’s experiences with math served two purposes: It expanded who children could explore mathematics concepts with and where children could engage with math. In the Peg + Cat ELM2 project, math is not just something that children do at school, but rather it is positioned as something that is applicable to and a part of children’s everyday lives.

A fourth project takeaway with implications for the field is that media resources can effectively be leveraged to support teachers’, parents’, and children’s exploration of mathematics. It was not a project objective to have these audiences increase their screen time at home or in the classroom to explore math. Rather, the goal was to use a nested mediation model to first introduce math concepts and strategies to teachers, and then have the teachers

Media can be leveraged to support teachers’, parents’, and children’s exploration of mathematics.

reach out to parents and families. Thus, Peg + Cat transmedia resources were first introduced to teachers to grab their attention, highlight a math concept or strategy, and to sustain their interest with the PD.

Many participating teachers did incorporate Peg + Cat characters and transmedia resources into their classroom activities and routines, and during family engagement time. Teachers felt that the transmedia resources held children's interest and presented new math ideas in relatable ways using age-appropriate language. In addition, take home transmedia resources were provided to families to help bridge what children were experiencing in the classroom to the ways that they could explore math concepts and activities at home. Parents also appreciated that these materials provided them with simple ways to talk about and do math with their children. In this way, the project's transmedia resources played an important role by providing multiple opportunities for children and families to encounter mathematics.

Goal 2: Produce a broadcast series and web and mobile games that kids love and that get kids excited about math

Peg + Cat Broadcast Series

As part of the Peg + Cat ELM2 project, 37 episodes of Peg + Cat were developed and aired on PBS (example episodes can be viewed at <http://pbskids.org/peg/videos>). One metric of determining whether children love the broadcast series is to look at how the show is ranked by young children and their parents. Since its October 2013 premiere, the show has consistently ranked as one of the most popular programs on television for preschoolers and among mothers with young children. Peg + Cat often ranks among the top 5 programs with children, ages 2-5 on PBS, and among the top 15 programs on all networks. As of August 2016, Peg + Cat had a Nielsen rating of 1.47, among kids ages 2-5. The show had a Nielsen rating of 1.0, among Ladies of the Household with children under 3.

Another metric that indicates whether Peg + Cat is a show that children love is the number of viewers the show has. In terms of viewership on streaming video, Peg + Cat broke PBS KIDS' record for most video streams for a new show in its first month of airing. Peg + Cat has averaged over 14.3 million video streams per month across all PBS KIDS video platforms since its launch, with a total of 630,377,936 video streams.

A third metric of whether children loved the show and whether it helped get them excited about math is parents' and teachers' self-report. Head Start parents and teachers who participated in the Peg + Cat ELM2 project found the media to be enjoyable, and easy for children to understand. During end-of-year interviews, a few parents and teachers described how episodes from the show supported their children's understanding of and engagement with math:

"I just feel like its age appropriate, so it's like they understand but they also make kids talk back to the TV. 'Oh, I'm four, how neat.' Because that is what my son will say, so watching the video or watching the TV is like answering the questions, and he's trying to figure out the answers too. So that's how it supports him - it makes him think, it keeps their attention and it gives different ways to practice learning." - Head Start Parent

"I think a lot of parents, we have good intentions. But how do you approach a child? And the Peg and Cat series to me kind of breaks that off, so you can have that with them. It's showing you how to do it, and to get your child's attention, enthusiasm into learning the math and the words." - Head Start Parent

"They loved seeing a female character that was doing a lot of math. She has a problem. She uses her friend to help solve it." - Head Start Teacher

Taken together, the metrics above indicate that the Peg + Cat television series was well-liked by children, and supported their positive attitudes towards mathematics.

Peg + Cat Website & Online Games

As part of the Peg + Cat ELM2 project, five online games were developed (see <http://pbskids.org/peg/games>):

- *Pizza Place*: Players prepare pizzas for characters by counting toppings and dividing each pizza with the correct number of toppings for up to four customers.
- *Chicken Blastoff*: Players choose a spaceship of the proper size and shape for different groups of passengers.
- *Magical Shape Hunt*: Players identify and collect specific geometric shapes from the shapes that are floating down the Mermaid character's river.
- *Very Hungry Pirates*: Players follow maps using directional words and counting skills to find where X marks the spot.
- *Star Swiper*: Players use counting skills to return the correct number of celestial objects into the sky to equal ten objects.

To determine whether children liked the Peg + Cat website, the number of page views, number of website users, and time spent playing the online games were examined. Since its October 2013 premiere, the Peg + Cat website has had high web traffic, including over 244 million page views and over 21 million users (see Figure 6). An additional indicator of continued engagement with the website is that 56.4% of users are return visitors.

Since October 2013, Peg + Cat online games have had over 10 million page views. The games are highly engaging, with players spending an average of 3 minutes and 30 seconds per game session.

Figure 6: Peg + Cat Website Analytics from October 2013-January 2017



As before, parents' and teachers' self-report via end-of-year interviews was also examined to see whether they felt like the online games supported children's interest in mathematics. These interviews indicated that teachers and parents did think that the games engaged children with mathematics concepts:

"It's something that like, you see. It's like actually brought to life, but that you can also – it's hands-on and is really like, engaging, and it's fun." - Head Start Parent

"I just did this same "Highlight Zone" game! It was great! The kids were talking about attributes of shape. They were sorting. They were counting. It was just so much math!" - Head Start Teacher

Peg + Cat Mobile Apps

As part of the Peg + Cat ELM2 project, a mobile App called *The Big Gig*, was created (<http://pbskids.org/apps/peg--cat-big-gig.html>). *The Big Gig* is an open-ended app in which players select a character and an instrument, then follow a numbered sequence of notes to create songs from the Peg + Cat series. Players can also compose and record their own music in the app's "Sound Check" section. The main metric that indicates whether children liked *The Big Gig* is the number of times that the app has been downloaded. Since its launch date on October 3, 2013, *The Big Gig* has been downloaded 70,457 times, with an additional 60,939 updates downloaded. These numbers indicate that the app was popular with children.

In sum, the Peg + Cat television series, online games, and mobile apps appear to be popular with children. In addition, parents and teachers shared that these media helped children get excited about math concepts and activities. Here, one teacher summarizes how the Peg + Cat media, in general, promoted children's positive attitudes towards mathematics:

Parents and teachers reported that Peg + Cat broadcast and digital media helped children get excited about math.

“The parents loved it because the kids were excited about it, and the fact that the kids already knew the music and they were like, ‘Oh, they’re starting to watch this at home now,’ and, ‘She plays these apps all the time, and she really loves it. It’s so amazing how much she can count now,’ or ‘How much she’s sorting,’ or ‘How much she’s doing this or that.’ The parents were excited because they were seeing it work. It was successful with the kids, and I don’t think you can get much more rewarding than that, to see them grow and learn.” - Head Start Teacher

Goal 3: Help children develop math content knowledge, skills, and problem-solving/reasoning abilities

Children’s Understanding of Mathematics

Measuring changes in children’s understanding of specific mathematics concepts directly (i.e. gathering pre-post data from participating children) was not a specified goal of the Peg + Cat ELM2 project. Therefore, potential changes in children’s general understanding of mathematics were examined via general comparative assessments of children’s skills and parents’ self-report at the beginning and end of each program year.

In the overall Head Start program, teachers assess children three times throughout the program year using the Teaching Strategies GOLD assessment system. The GOLD assessment is aligned with the Head Start Early Learning Outcomes Framework and the State Early Learning Guidelines. According to the Early Head Start and Head Start 2015 and 2016 Annual Reports from the Allegheny Intermediate Unit, the majority of all children at the AIU Head Start improved their math skills from the beginning of the program year to the end of the program year in both years that the Peg + Cat ELM2 project was taking place (see Table 5). It is unknown what other factors contributed to this increase, thus no causal link can be made between participation in the Peg + Cat ELM2 project and children’s math skills. However, since all AIU Head Start teachers participated in the PD over the two years of the Peg + Cat ELM2 project in which these increases occurred, the trends seen in this external data are promising.

Table 5: Percentage of Children Achieving Math Skill Competency, Based on GOLD Assessment

Program Year	% Below Expectations		% Meeting Expectations		% Exceeding Expectations	
	Fall	Spring	Fall	Spring	Fall	Spring
2014-2015	51%	13%	45%	61%	5%	26%
2015-2016	50%	14%	45%	62%	5%	24%

* Total for some areas may be greater than 100% due to rounding.

In contrast, according to parents who were surveyed, their children’s general understanding of mathematics did not significantly change from pre-to-post in either program year (see Table 6). In other words, parents tended to disagree that their children struggle with understanding math concepts at both the beginning and end of each program year. This may be due to parents’ own perceptions of what constitutes math competency. In fact, some teachers reported that one of the challenges that they had in their classrooms was convincing parents that math understanding for early learners goes beyond being able to count out loud from 1 to 10.

Table 6: Changes in Children’s Understanding of Mathematics, As Reported By Parents

Program Year	Pre**	Post**	Significance Level	Number of Respondents
2014-2015	2.41	2.37	0.606	126
2015-2016	2.21	2.22	0.894	92

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

** Responses to the statement, “My child struggles with understanding math concepts,” on a scale from 1 to 4, with 1 being “Strongly Disagree” and 4 being “Strongly Agree.”

Regardless, when only the responses of parents who did think that their children struggled with math at the beginning of each program year were compared (i.e. those who “Agreed” or “Strongly Agreed” with the statement), these parents were significantly more likely to disagree with the statement by the end of both program years (see Table 7). In other words, they thought that their children understood math more by the end of both program years than they had at the beginning of these program years.

Table 7: Changes in Struggling Children’s Understanding of Mathematics, As Reported By Parents

Program Year	Pre**	Post**	Significance Level	Number of Respondents
2014-2015	3.17	2.70	.004*	53
2015-2016	3.15	2.67	.000*	27

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

** Responses to the statement, “My child struggles with understanding math concepts,” on a scale from 1 to 4, with 1 being “Strongly Disagree” and 4 being “Strongly Agree.”

During interviews at the end of each program year, a subset of parents did indicate that their children’s understanding of math had increased. Here, two parents explain how they felt that the Peg + Cat ELM2 program supported their children’s development:

“Honestly, like, the program is great. I remember at the beginning of the year how little she actually, you know, understood compared to the end of the year, all the things that she had learned and the ways that she progressed. So, it gave her like a lot of tips and tricks throughout the year.” - Head Start Parent

“I’m excited, because I enjoy watching her...She’s like a sponge. She wants more, and just saying, ‘because,’ is not a sufficient answer. She wants to know why, how, and what follows through.” - Head Start Parent

Specifically, parent interviewees felt that the program had increased their children’s counting skills. Here, one parent describes how her son became better at subitizing: *“He’s been better with his numbers and putting numbers together and recognizing just by looking at like, five dots, that that’s – that that adds up to five without having to sit there and count through each one.”*

Similarly, participating teachers saw evidence in their classrooms that children were increasing their mathematical understanding over the course of the year, especially around their counting skills. The following examples from both program years demonstrate the kinds of mathematics understanding that teachers observed children engaging in within their classrooms:

Understanding of Counting

“From the beginning of the year till now, I have four kids that did the program last year to this year, and I could see a huge growth from when they started till now...Two of them can count through 130, counting by twos, counting by fives, knowing simple addition. They can do up to ten. Subitizing is really quick. It’s just a lot of those concepts.” - Head Start Teacher

Understanding of Patterns

“We worked on it every day to the point where a lot of kids really understood the concept of patterns and were able to recognize patterns in their clothes, in my clothes or in my jewelry. Just to think outside of just initial patterns or they tried to make their own patterns at choice time.” - Head Start Teacher

Understanding of Shapes

“Like they know all the attributes of the shape, the pentagram, hexagon. It’s just amazing at how much they are able to do because of the information I have gotten through this PD.” - Head Start Teacher

Another indicator of increased understanding, according to participating teachers, was that children in their classrooms incorporated more mathematics vocabulary into their activities as the year progressed:

“They’re always using math terms. ‘This is greater. This is less than. I’m bigger. I’m smaller. Let’s see how many we have.’” - Head Start Teacher

“When we were doing 3D shape interpretation, they would tell each other to pass the cylinder. It became part of their normal lexicon. I don’t think that they understood that they were becoming more aware of math. It just became part of the classroom culture.”
- Head Start Teacher

“They’re incorporating the math vocabulary way more into their everyday play. Before, they would just say things were big or small, or they didn’t have the vocabulary for tall or short, and I’m even seeing them using comparison words so much more now than at the beginning of the year.” - Head Start Teacher

Although most parents did not see a general change in their children’s mathematics understanding, this may be due to the way that the initial statement on the pre-post survey was worded. The question, *“My child struggles with understanding math concepts,”* may have been viewed as being about their children’s ability to come to understand a math concept, rather than their current mathematics content knowledge and skills. In other words, parents began each program year believing that their children had the ability to understand math concepts, and ended the year with the same belief. Yet parents who thought that their children struggled with math at the beginning of each program year did indicate a significant shift in their children’s mathematical understanding. Furthermore, since both parents and teachers noticed that children were developing specific mathematics skills and vocabulary, and taking into account changes in the percentage of children who met or exceeded competency on the GOLD assessment of their math skills, it appears that some children’s math content knowledge, skills, and problem-solving abilities did increase.

Goal 4: Help children develop a positive and persistent attitude towards math

Children’s Interest in Mathematics

To measure potential changes in children’s interest in mathematics, evaluators examined parents’ level of agreement with the statement, *“My child likes math,”* on a survey given at the beginning and end of each program year. In both program years, parents reported significantly higher agreement with the statement at the end of year, compared to the beginning of each year (see Table 8).

Children’s interest in mathematics, as reported by their parents, increased in both program years.

Table 8: Changes in Children’s Interest in Mathematics, As Reported By Parents

Program Year	Pre**	Post**	Significance Level	Number of Respondents
2014-2015	3.16	3.32	.005*	128
2015-2016	3.17	3.31	.009*	93

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

** Responses to the statement, “My child likes math,” on a scale from 1 to 4, with 1 being “Strongly Disagree” and 4 being “Strongly Agree.”

During interviews, parents were also asked to share any evidence that they had seen or heard that indicated to them that their child had increased his or her interest in math. Parents shared that they tended to see their children’s interest reflected through increased initiation of math-related activities and conversations:

“She counts everything. We’ve counted telephone poles on the way to school, garbage cans, dumpsters, pools, flower beds, cars, vans...It’s really got her into it.” - Head Start Parent

“Yesterday, when I was cooking dinner he was peeking in from outside playing. Don’t you know, he was counting the potatoes I was cutting!” - Head Start Parent

“That he actually wants to do the little activities, or learn about it more. Before, he wouldn’t. He talks about it a lot – like a lot! - What he does in school. He’ll come home and talk about it, and like tell me different things that he’s done.” - Head Start Parent

“I’ve seen a big difference that she’s interested. Just like her body language and her telling you, ‘Hey, Mommy, look at this! Look what I can do. I can add this. I can subtract this. I can do this.’” - Head Start Parent

During interviews, teachers indicated that they also saw evidence in their classrooms that children’s interest in mathematics increased over the course of the program year. Like parents, teachers tended to see this interest play out in the initiation of math activities and increased math talk:

“They will actually now do things on their own mathematically, and they will bring it to my attention. They’ll say, ‘Look, I did this pattern. Come look, come see,’ and you know, ‘I’ve made another castle...’ They’ll make their own or their own kind of way of doing it, and they’ll explain it to me. ‘Well, this is less, so that’s why I put this here, and this is more, so I had to put that on top.’ So they’re definitely taking what they’ve learned and applying it in their own way, and on their own.” - Head Start Teacher

Children’s Persistence in Mathematics

To measure potential changes in children’s persistence in mathematics, evaluators examined the frequency with which parents reported that their children keep trying when faced with a difficult problem. There were no significant changes in terms of children’s persistence in either program year (see Table 9). However, in Program Year 1, parents were significantly more likely to report that their children tried to figure out problems on their own at the end of the year, compared to the beginning, $t(127) = -2.611, p=.010$.

Table 9: Changes in Children’s Persistence in Mathematics, As Reported By Parents

Program Year	Pre**	Post**	Significance Level	Number of Respondents
2014-2015	2.66	2.83	0.062	127
2015-2016	2.61	2.65	0.691	98

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

** Responses to the statement, “When my child (ages 3-5) encounters a problem he/she can’t solve, he/she keeps trying until he/she figures it out” on a scale from 1 to 4, with 1 being “Not At All” and 4 being “Almost Every Time.”

Interestingly, parents who indicated that their children did not keep trying “at all” at the beginning of each program year, tended to report that their children had increased their persistent behavior by the end of those years. However, the sample size was too low to run statistical tests to explore this trend.

In general, parent interviewees felt that their children kept trying when faced with a difficult problem:

“She’ll keep plugging along until she gets it right. She doesn’t get discouraged. We won’t discourage her, just keep encouraging her, and when she gets it right, then it’s a big, ‘Yay! You did it! Great job! You figured it out!’ And it’s something we talk about. Some problems are hard, but you got to keep trying. As long as you keep trying, you’re going to get it, and that’s what the teachers have taught us to do - At least me, with my child - is to keep it upbeat, you know? Keep encouraging.” - Head Start Parent

“He wants to count more. He wants to figure out everything, and that’s something he hasn’t done before.” - Head Start Parent

“When he gets frustrated, he’ll recount or he’ll ask me, ‘Well, why is it only this many?’, and I’ll help him out.” - Head Start Parent

Teachers’ own observations, as related via end-of-year interviews, supported parents’ assertions that their children kept trying:

"We are really big on persistence and telling them that it's not about getting the right answer. It's about trying your best and trying to figure out the right answer. Our kids were so resilient this year. They helped each other out. There was a sense of camaraderie with our students."
- Head Start Teacher

"We showed them how to measure, and then we showed them the different tools of measuring... If they were doing it wrong, we'd say, 'Okay. Start over. This is where you start.' And they keep trying. They wouldn't give up." - Head Start Teacher

Taken together, results from parent pre-post surveys, and parent and teacher end-of-year interviews suggest that the Peg + Cat ELM2 project helped children develop positive and persistent attitudes towards mathematics.

Goal 5: Increase preschool teachers' knowledge of math content and pedagogy, as well as their confidence

The Peg + Cat ELM2 project changed teachers' knowledge of math content and pedagogy by increasing their understanding of ways to incorporate math into their classrooms and ways to assess children's development of mathematical skills. Furthermore, the project increased their confidence in teaching math in the classroom, and in facilitating math activities with families.

The research team from CEAC administered pre-post surveys measuring teacher confidence and classroom resource use to teachers at the beginning and end of each program year. A pedagogical content knowledge assessment was administered to teachers at the beginning of the first program year (Fall 2014) and at the end of the second program year (Spring 2016), for those who remained in the program across both years (n=55).

Teachers who participated in Peg + Cat ELM2 PD increased or maintained their level of pedagogical content knowledge, despite entering the project with relatively high levels already.

Teacher Knowledge of Math Content & Pedagogy

According to pre-post survey results, teachers who participated in the Peg + Cat ELM2 PD significantly improved their pedagogical content knowledge, $t(54)=3.642$, $p=.001$. Specifically, 82% (n=55) of participating teachers increased or maintained their self-reported level of knowledge from the beginning of the program year to the end of the program year. This result is noteworthy, given that most teachers came into the program with relatively high levels of pedagogical content knowledge beforehand, and almost all participating teachers had a Bachelor's degree in education.

During end-of-year interviews in both program years, Head Start teachers shared that their participation in the Peg + Cat ELM2 PD had changed the way that they incorporated math into classroom conversations and activities:

“Oh, my gosh! What hasn’t changed? Certainly my talk has changed. The way that I interact with them and get them thinking more about math. Certainly more resources than last year, you know, that I’ve implemented with math, from Peg + Cat. But just other resources that I can’t get in my classroom for math, getting them to think along the lines of more about sorting and just numbers in general has certainly changed dramatically compared to last year because of Peg + Cat.” - Head Start Teacher

Teachers also shared that the PD helped them gain a better understanding of the learning trajectories that young children go through when learning mathematics concepts, and the kinds of things that they could do as teachers to both assess and build upon children’s conceptual development:

“So I’m now looking for, you know, who’s sorting by one attribute, who’s sorting by two attributes, who’s sorting by three attributes. I just feel like I have more knowledge on what to look for rather than just saying, ‘Oh friends, let’s sort today,’ and then we sort and I kind of just keep an eye on all my kids to see what they’re doing, but I just feel like I’m more involved and more – I have more knowledge of sorting.” - Head Start Teacher

“I guess it gave me a better understanding of what order kids typically begin to learn things so, if they were at a certain skill level how to help them reach the next skill level. I feel like I got a better understanding of – like I never thought of it in terms did they like, remember 7 when they count 7, things like that. So I’ve been able to understand that a little better and help them achieve the goals.” - Head Start Teacher

“If someone’s having a hard time understanding, I just ask more questions. You know, they had the answer that’s not quite correct. I say, ‘How did you get this answer? How did you find that there was five?’ But there’s really six. ‘How did you do that?’ Just asking more questions rather than saying, ‘No, you’re wrong. That’s not the right answer.’ Just to have them figure it out for themselves by just asking more questions.” - Head Start Teacher

Teacher Confidence

Teachers’ self-reported confidence in their ability to facilitate mathematics activities in their classroom significantly increased from pre-to-post survey, $t(44)=2.06$, $p=.045$. Over half of participating teachers (51.1%) reported an increase in their general confidence level towards teaching mathematics. In terms of their perceived preparedness to teach specific content, teachers also experienced significant increases in

Head Start teachers had more confidence in their ability to teach math by the end of the Peg + Cat ELM2 program, compared to the beginning.

confidence. Here, teachers were significantly more likely after two program years to indicate that they felt prepared to teach about number (48.9%, n=47), geometry (71.4%, n=42), and data (63.3%, n=49).

Teachers reported that they modeled how to engage children in math for families more often by the end of the Peg + Cat ELM2 program, compared to the beginning.

Teachers also became more comfortable modeling for families how to engage their children in math. They reported doing so more often by the end of the program (M=3.77), compared to the beginning (M=3.32)³. During end-of-year interviews, teachers also shared that they had specifically increased their confidence in talking about and doing math activities with children and families:

"I know these concepts. I know what I'm looking for, just to help parents. 'Cause I know it embarrasses some parents just that, 'I don't think I'm good at math. I had a bad experience.' When you have a teacher that is really confident and can help you in math, that's awesome."
- Head Start Teacher

"I think it made me more comfortable because I'm not a very strong – I wouldn't consider myself very strong in math. So it made me a little bit more comfortable to talk with parents and use math language appropriately because I think before the training I didn't even know what like subitizing was or the difference between sorting and classifying. So it made me more confident to talk to parents." - Head Start Teacher

"I feel so much more confident and better as a teacher that I was already doing more math, knowing what I'm doing, and knowing what I'm doing is really making a difference. And that's my own social-emotional growth, and that's beyond the education of the children, but really the education of myself that's such a self-motivator." - Head Start Teacher

In sum, both teacher pre-post surveys and end-of year interviews indicated that teachers' pedagogical content knowledge and confidence in facilitating math activities for children and their families increased as a result of the Peg + Cat ELM2 PD.

Goal 6: Increase parents' interest, engagement, and confidence in exploring mathematics with their children

Parents in both program years (2014-2015 & 2015-2016) were asked to take a pre-survey at the beginning of the year and a post-survey at the end of the program year. The survey contained Likert scale questions regarding parents' opinions of their own interest, engagement, and

³ On a scale from 1 to 5, with 1 being "None," and 5 being a "Considerable Amount."

confidence in exploring mathematics with their children. Analyses indicated that while parents' interest in and confidence around mathematics did not increase after participation in the Peg + Cat ELM2 project, parents' level of engagement with their children around mathematics did significantly increase in both program years.

Parent Interest

In general, parents' self-reported interest in mathematics did not significantly change from pre-to-post in either program year (see Table 10). They tended to strongly disagree with the statement, "Math is boring," at both the beginning and end of each program year. During end-of-year interviews with a subset of parents, a few individuals indicated that the experience had increased their interest in mathematics: "I hated math, and it became fun. I enjoyed doing these things with her. Again, I'm learning, while she's learning." However, the majority of parents indicated changes in their children's, rather than their own, mathematics' interest.

Table 10: Changes in Parents' Self-Reported Interest in Mathematics

Program Year	Pre**	Post**	Significance Level	Number of Respondents
2014-2015	1.71	1.67	0.525	126
2015-2016	1.64	1.72	0.225	92

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

** Responses to the statement, "Math is boring," on a scale from 1 to 4, with 1 being "Strongly Disagree" and 4 being "Strongly Agree."

Parents who were less interested in math beforehand tended to report an increase in their math interest by the end of each program year. However, the sample size was too small for this trend to be examined via statistics.

Parent Engagement

Overall, parents' reported increased engagement with their children around math.

In both program years, parents reported talking with their children about math significantly more often by the end of the year compared to the beginning of that program year (see Table 11). Here, parents shifted from talking about math with their children once a week, on average, to several days a week.

Parents reported talking with their children about math significantly more by the end of each program year, compared to the beginning of each year.

Table 11: Changes in Parents' Self-Reported Frequency of Math Conversations With Their Children

Program Year	Pre**	Post**	Significance Level	Number of Respondents
2014-2015	5.56	6.11	.000*	131
2015-2016	6.11	6.38	.019*	102

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

** Responses to the question, "Approximately how often do you talk to your child about math?" on a scale from 1 to 7, where 1 = Never, 2 = Once a year, 3 = 2-3 times a year, 4 = Once a month, 5 = Once a week, 6 = Several days a week, and 7 = Every day.

When asked during interviews what kinds of math conversations they had with their children at home, parents tended to talk about counting and how it related to everyday life:

"We talked about numbers and looking for numbers everywhere, like outside or inside, street signs, or just like everyday things. We talked about sorting. We talked about shapes and colors. We talked about making learning fun. So like, making up songs, or different games, things like that." - Head Start Parent

"It's just like everyday things, and I mean just counting all day, counting how many steps you come up or go down. 'What channel is this?' They have to read the number. 'Oh, what time is it? Read me the numbers, and I'll explain it to you,' and 'How many forks do we need?' and 'How many chicken nuggets do you want for lunch? I mean everything is math. 'All right. You have this many and that many. Now how many do you have?'" - Head Start Parent

"We talk about math every day. We do math every day, like you got to count how many fingers and thumbs you got, and the gloves you wear." - Head Start Parent

In both program years, parents also reported participating significantly more often in Head Start activities involving math by the end of the program year compared to their level of participation at the beginning of that program year (see Table 12). Here, parents shifted from attending such activities 2-3 times a year, on average, to approximately once a month.

In Program Year 2, parents reported doing math-related activities with their children significantly more by the end of the year, compared to the beginning of the year.

In Program Year 2, parents were also asked to indicate whether they participated in a variety of specific math-related activities at home with their children. A significantly higher percentage of parents reported doing math-related activities, such as counting objects, sorting items, finding numbers or shapes, talking about measuring, or using math-related words, with their children by the end of the second program year, compared

to the beginning of that program year (see Figure 7). There was no pre-post comparison available for this question in the first program year.

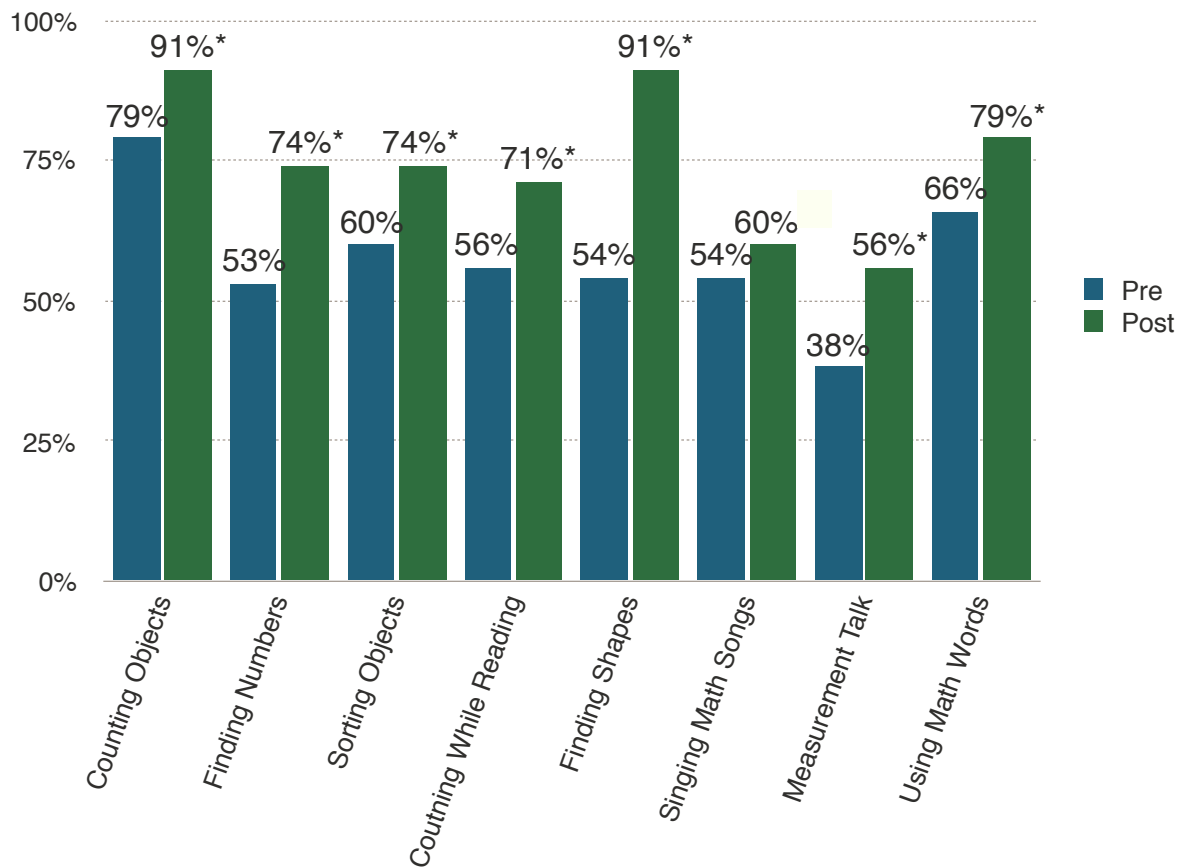
Table 12: Changes in Parents’ Self-Reported Frequency of Participation in Math-Related Head Start Activities With Their Children

Program Year	Pre**	Post**	Significance Level	Number of Respondents
2014-2015	3.01	4.49	.000*	126
2015-2016	3.36	4.77	.000*	102

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

** Responses to the question, “Approximately how often do you participate in activities at Head Start involving math?” on a scale from 1 to 7, where 1 = Never, 2 = Once a year, 3 = 2-3 times a year, 4 = Once a month, 5 = Once a week, 6 = Several days a week, and 7 = Every day.

Figure 7: Changes in Parents’ Self-Reported Frequency of Participation in Math-Related Activities At Home With Their Children



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

Parent Confidence

Parents' self-reported confidence in mathematics did not significantly change in the first program year (see Table 13). Their confidence started out high and remained high. However, in the second program year, parents' agreement with the statements, "I am comfortable with my own math abilities," and "I am comfortable exploring math with my child," significantly decreased from pre-to-post. One possible explanation for this shift may be that parents in Program Year 2 over-estimated their level of comfort at the beginning of the year or underestimated their comfort level at the end of the program year. Regardless, parents were still relatively comfortable in their own math abilities and in exploring mathematics with their children across both program years.

Table 13: Changes in Parents' Self-Reported Confidence Towards Math

Statement	Program Year	Pre**	Post**	Significance Level	Number of Respondents
"I am comfortable with my own math abilities."	2014-2015	3.24	3.34	0.085	127
	2015-2016	3.27	3.03	.021*	99
"I am comfortable exploring math with my child."	2014-2015	3.46	3.48	0.663	123
	2015-2016	3.50	3.18	.003*	99

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

** Responses on a scale from 1 to 4, with 1 being "Strongly Disagree" and 4 being "Strongly Agree."

Interestingly, parents who weren't very comfortable with their own math abilities or in exploring mathematics with their children beforehand tended to report increased confidence by the end of each program year. The sample sizes were too small to run statistical tests to explore this trend, but qualitative information from teachers during end-of-year interviews suggested that they felt parents in their classroom had increased their confidence in exploring math with their children as a result of the Peg + Cat ELM2 project:

"With a lot of the families we work with, school makes them uncomfortable. Education makes them uncomfortable because they feel that they're not equipped to help their child. You have to make them feel at ease, and word it in a way that they feel empowered to do this, that they can help their child. That's the biggest benefit." - Head Start Teacher

Additional Project Goals

In addition to the main project goals listed above, the Peg + Cat ELM2 PD was designed to address the following key messages:

- Math is everywhere!
- All people can learn mathematics.
- Math is important.
- Math learning begins early in life - and should be both supported and encouraged.

The following analyses explore how the PD messaging impacted both teachers and parents.

How PD Messaging Impacted Teachers

One of the biggest takeaways for teachers from the PD was how math could be incorporated into everyday activities:

“For my own self as a teacher, that’s probably one of the biggest things I took away from Peg + Cat was just that math really is all around. Yes, you normally think like language and literacy, of course those are all around because you’re speaking and you’re listening and all of those things, and maybe math sometimes gets forgotten or just not at the forefront, but it’s truly everywhere and you can incorporate it in so many different ways.” - Head Start Teacher

During end-of-year interviews, teachers shared some examples of how they tried to relate mathematics to children’s everyday lives. Some connected mathematical concepts to classroom routines, while others linked to thematic curriculum:

“Well, we really talk about daily things. We say, ‘Today is –’ We talk about the calendar, today’s date. We count how many days in the month. We might say, ‘Okay, today is Wednesday. How many days till Friday?’ Or ‘How many days until your birthday? How many steps we take up the stairs?’ We’ll have them count their food in front of them. So if it’s meatballs, ‘How many meatballs?’ So we really kind of just keep doing daily things, and we also ask them, ‘Okay, how many friends in our classroom are wearing shorts? How many are wearing shirts?’” - Head Start Teacher

*“We do things that are rooted in everyday situations. So it’s always – the math is usually always related to a theme. For example, when we were doing butterflies and caterpillars...I punched holes in leaves. So they would tell me how many holes the caterpillar had eaten through the leaf. So I try and always tie it back to make it meaningful for what we are learning about in the classroom so it’s not just – the math isn’t a standalone subject.”
- Head Start Teacher*

*“When we would go for walks, like around our neighborhood during school, we would count how many vehicles we would pass or how many buildings, what buildings were taller, what buildings were shorter, all the different shapes that we could find as we were walking. You could definitely tell that it was relating to what they were seeing in their lives.”
- Head Start Teacher*

One of teachers’ biggest takeaways from the Peg + Cat ELM2 PD was the message that “math is everywhere.”

“We would talk about measuring a lot. We would say, ‘How do you measure at home? What would your mother do to measure?’ We’d make them think about, ‘When my mom makes cookies or if I’m going to set the table, how many of each thing do I need? How many plates and things?’ It made them think about, ‘We set the table at school and we set the table at home. A lot of kids would actually start setting the table at home when they learned how to do that, learned how to count how many family members.” - Head Start Teacher

Teachers also saw the ways in which various Peg + Cat ELM2 transmedia resources supported connections between mathematics concepts and children’s everyday lives:

“[The placemat’s] just a constant reminder of - there’s math in everyday life and that it doesn’t have to be...Math can be a whole encompassing thing. It’s not just counting. It’s not just shapes. It’s a whole bunch of different areas that make up our everyday life and that it’s easy to engage a child in it. You don’t have to overcomplicate it.” - Head Start Teacher

“[The Shape Cards] helped a lot of the kids who were struggling with shapes pick up on different shapes. Once they saw them on the cards, they were able to see the shapes throughout the room or wherever we go for a walk.” - Head Start Teacher

In fact, teachers tried to relay these messages to parents by letting them know that they were already doing math at home and may not have realized it, or that there were simple ways that they could incorporate math into everyday activities:

“Then your parents are more open to discuss things with you that they may be struggling with, ways that you can help, even if it is like sorting. Like the one parent that, ‘Well, just do dishes. Let them help you with the dishes, and you can incorporate math there. I mean, you’re counting how many plates you washed, how many cups that you washed, how many more do you have to go.’” - Head Start Teacher

Thus, teachers seemed to be internalizing the messaging from the PD, and applying it within their own classrooms and in their interactions with children and their families.

How PD Messaging Impacted Parents

As with Head Start teachers, participating parents indicated that the Peg + Cat ELM2 project showed them that math is everywhere:

“There’s math every day, in everything that we do. We just incorporate it, and I try to do it with him all the time.” - Head Start Parent

“I used to think, oh, algebra, calculus, all that I never used again in my life. But math actually it’s all around you. There’s three trees together. There’s six flowers. That’s – you can use it all the time.” - Head Start Parent

Parents also began realizing that they did not need to invent new math activities because many of the everyday activities that they were already doing contained math:

“For me, that was a huge eye-opener to where I could kind of – You know, we could still do math and they really love it. It don’t have to be as complicated as we try to make it.”

- Head Start Parent

“He’s more aware of how much things are numbers. I’m more aware too because like we mentioned earlier, like I didn’t really think all these things that I was doing had math in it.”

- Head Start Parent

In addition, teachers noticed that some parents were becoming more aware of their children’s capabilities, and letting their children take the lead. One teacher shared a conversation that she had with a mother and her son during an FEA during which children sorted plastic bears by size and color:

“She said to me, ‘If I had known playing these simple games like this would’ve helped, I’d have done it a long time ago.’ ...Her little boy was playing with the bears, and she said, ‘Well, when I went to separate them and put the yellows and the blues...the child itself started to say, ‘Well, no. This one doesn’t fit because it’s a big one.’ ...I didn’t realize how something so simple, you know, opens the door.”

Parents’ beliefs about whether children should be exposed to math at school and at home were less affected by PD messaging. In Program Year 1 (2014-2015), parents did not significantly change their beliefs about math exposure by the end of the program year (see Table 14). They started out with a positive view towards math exposure, and sustained those beliefs over time. However, in Program Year 2 (2015-2016), parents beliefs about math exposure significantly decreased by the end of the year. Regardless of this shift, by the end of the second program year, parents still had relatively positive views towards math exposure.

Table 14: Changes in Parents’ Beliefs About Math Exposure At Home and At School

Program Year	Pre**	Post**	Significance Level	Number of Respondents
2014-2015	3.19	3.15	0.331	127
2015-2016	3.45	3.19	.004*	102

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

** Responses on a scale from 1 to 4, with 1 being “Strongly Disagree” and 4 being “Strongly Agree.”

Parents’ beliefs about the importance of math were slightly affected by the PD messaging. In Program Year 1 (2014-2015), parents significantly increased their level of agreement with statements regarding the importance of mathematics for children (see Table 15). There were no significant changes in parents’ beliefs about the importance of mathematics for their

children in Program Year 2 - Their views were positive to begin with, and remained high. Yet over the two years of the project, participating Head Start teachers did notice a change in parents' beliefs about the importance of mathematics. On their own pre-post survey, a higher percentage of teachers disagreed with the statement, "Head Start families don't see math as important," by the end of the second program year (76%, n=38), compared to the beginning of the first program year (59.7%, n=46).

Table 15: Changes in Parents' Beliefs About the Importance of Mathematics

Program Year	Pre**	Post**	Significance Level	Number of Respondents
2014-2015	3.72	3.85	.000*	130
2015-2016	3.86	3.88	0.729	100

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

** Responses on a scale from 1 to 4, with 1 being "Not At All Important" and 4 being "Somewhat Important."

During end-of-year interviews, a few parents shared how they passed along the message that, "Math is important," to their children:

"Whatever the activity was. Or if she – make sure she understood what it was, why we were doing this, how it worked. Like the measuring thing. Simply, you could go around my house and measure anything. Anybody and everything has a measurement, even going to the doctors with me and having them show her her height, and then coming home with the measuring stick and showing her how much that was on the measuring stick." - Head Start Parent

"We talk about like what we're doing, why we're doing it, what this means to you. Like why are you going to count? Because you're going to get a job and you're going to get a paycheck and you're going to go to the bank and you're going to have to count your money."
- Head Start Parent

In sum, parents accepted the message that, "Math is everywhere," and somewhat received the message that, "Math is important." However, they already had fairly positive, firmly held beliefs about math exposure at home and at school.

EQ2A: What are the key teacher-reported program elements that support or hinder the transfer of knowledge to pedagogy?

Impacts on Teachers' Transfer of Knowledge to Pedagogy

At the end of both program years, teachers were asked to rate the aspects of the PD that they felt had been most helpful in terms of supporting mathematics learning within their own classrooms. While teachers found all aspects of the PD to be at least somewhat helpful, the

hands-on activities around specific math concepts were most highly rated, and the daily written reflections were least highly rated, on average (see Table 16).

Table 16: Average Level of Helpfulness Head Start Teachers Ascribed to Aspects of the Professional Development*

	Program Year 1 (2014-2015); N=50	Program Year 2 (2015-2016); N=50
Hands-on activities around specific math concepts	3.44	3.46
Information on & brainstorming about activities for the classroom	3.32	3.42
Discussions of literature connections & specific children’s books	3.32	3.42
Discussions of specific math concepts	3.30	3.42
Family engagement information & activities	3.28	3.39
Discussions of representations	3.18	3.22
<i>Peg + Cat</i> video clips	3.14	3.42
Videos of teachers and children demonstrating specific math concepts	3.02	3.28
Videos and discussions on facilitating math interviews with children	3.00	3.16
Discussions of where children are at on the learning trajectory for a specific skill or math concept	2.88	3.02
Book chapters from <i>Big Ideas in Mathematics</i>	2.88	2.92
Discussions of Pennsylvania Standards	2.84	3.02
Daily written reflections	2.14	2.50

* Teachers rated helpfulness on a scale from 1 = Not At All Helpful to 4 = Very Helpful.

Teachers in both program years were also asked to identify the top three aspects of the PD that they felt had made the most difference in their classrooms. Teachers most often selected hands-on activities around specific math concepts, discussions of specific math concepts, and information on and brainstorming about activities in the classroom. Here, several teachers reflect on how these three aspects of the PD affected how they thought about engaging young children with mathematics:

Impacts of Hands-On Activities on Teachers

“Cooperating in hands-on activities around specific math concepts with fellow teachers and professionals encouraged me to think both inside and outside of the box on teaching any given concept. We were able to bounce different ideas and scenarios off of one another and propose an array of strategies and techniques for teaching/understanding that same concept in various ways.”

- Head Start Teacher

“This portion of the professional development made me give more thought to how to extend the activity and provide more opportunities for children to extend the activity with their ideas, conversation and just ‘doing.’ It also helped me to research and think of ways to extend the concept throughout the classroom.” - Head Start Teacher

Impacts of Discussing Specific Math Topics on Teachers

“The discussions of these specific math concepts has made me aware of how important and crucial they are to children’s mathematical development. By learning these skills (subitizing, patterns, sorting) at a deeper level, the children will have a better understanding of “future” math concepts that will be taught. I am more aware of how important a good foundation is for the children’s future math learning...I now fit ‘math’ into smaller parts of the day to make the time more meaningful.”

- Head Start Teacher

“The discussions that we had helped me think differently about math concepts. I think a lot more about just using the vocabulary for some of these concepts in everyday conversations with the kids. They gave me good ideas to try with my kids.” - Head Start Teacher

Impacts of Brainstorming Activities for the Classroom on Teachers

“It provided my colleagues and I with lesson plans and ideas to effectively and age appropriately provide math skills in our classrooms. I now know I can do more with our age group, not just numbers, shapes, and basic patterning.” - Head Start Teacher

“Hearing what other classrooms are doing and what they learn from the activities is helpful in planning activities for my classroom. [It] has given me a different perspective of how to address certain questions from children by hearing what others do and say.” - Head Start Teacher

Taken together, these results suggest that participating in hands-on math-related activities and brainstorming activities for the classroom helped teachers gather ideas for incorporating mathematics into their existing classroom routines, as well as generate new activities and classroom practices. In addition, by discussing math concepts with one another, experiencing activities as learners and not just as teachers, and brainstorming ideas, teachers were able to

Participating in hands-on math-related activities helped teachers brainstorm ideas for incorporating math into their existing classroom routines, as well as to generate new activities and practices.

move beyond rote skills to the development of deeper conceptual knowledge of mathematics and strategies for incorporating mathematics into the classroom.

Impacts of Peg + Cat Family Engagement Strategies on Teachers

On their post-surveys, teachers also ranked family engagement information and activities as a helpful aspect of the PD (see Table 16). Teachers liked that the FEAs increased children's interest in math topics and got parents to engage more with their children:

"It's just great for the parents to see that the child is excited to learn, is able to learn, and that they can learn in such a fun way with Peg + Cat." - Head Start Teacher

"Family engagement is really coming together now, where the parents are really talking, and I think Peg + Cat really brought that in." - Head Start Teacher

Several teachers noted that the family engagement resources from the PD had helped them think about and become more comfortable with engaging young children around mathematics:

"Having go-to activities to support math topics we were focusing on was a very useful way to incorporate Peg + Cat. The P + C math activities made me more confident in discussing math concepts with parents, and modeling how to support the concept." - Head Start Teacher

"The program helped me think of ways I can get children interested in math by relating to concepts of things they use everyday." - Head Start Teacher

Several features of effective family engagement were highlighted in the PD. These included developing hands-on, engaging, quick, fun, easy-to-do activities, differentiating the activities for different ability levels, incorporating everyday materials that connected to what families already do at home, doing the activity or going over the math concept with the children first before the FEA, modeling math vocabulary for parents, and encouraging parents to let their children lead the activity. Teachers picked up on these characteristics in subsequent interviews. For example, some teachers elaborated on the benefits of parents letting their children take the lead:

"It's wonderful to see the families because I think sometimes they don't give their kids enough credit. When we sit them down, sometimes they are amazed at how much their children can do. I've had parents try to do the activity for their kids, but we tell them, 'Take a step back. Watch what they can do,' and they're honestly blown away. They had no idea that their kid knew ordinal numbers or could put things in order from tallest to smallest. It's just very eye-opening for them. It's a good thing for both the parents and the kids." - Head Start Teacher

"Parents can see that the kids can actually do it on their own." - Head Start Teacher

Others shared how they utilized everyday materials during FEAs to connect math concepts to what children were already doing at home:

“By using things used in the home, so they don’t have to go out to purchase it, and letting them see that not only in the kitchen you can do math, but in the living room with the remote control, with the couches, loveseat. They can teach their children, ‘Which one is longer? Which one is shorter? How many sides in the wall? Count the corners.’” - Head Start Teacher

Teachers incorporated everyday materials during FEAs to connect math concepts to what families were already doing at home.

“Well, this activity was pretty cool because we were sorting clothes, which is something that they do see in the home almost every day. They’re like, ‘Oh, we can get them to sort our clothes at home.’ I’m like, ‘Yeah, and you didn’t know you were doing math.’ So I think they’re just really excited to see that they can take aspects from home, and at the same time help their child develop some skills in the math department, too.”

- Head Start Teacher

“The families were really struggling getting them to sleep, and I kept putting on the calendar like strategies for a bedtime routine and things like that, but they said that that really helped. We cut out the long strips and they have it hanging up and they said that that’s really benefited them at home.” - Head Start Teacher

In addition, teachers stressed the importance of modeling math vocabulary and ways of eliciting children’s thinking for parents:

“I think just even with them seeing us and how we ask and what we say, they picked up on it.”

- Head Start Teacher

“I think this year I finally understand the family engagement was really having the parents feel comfortable in the classroom, pay attention how you’re talking to the kids, modeling how you talk with them, that’s what they’re watching.” - Head Start Teacher

Teachers used mathematics terms and modeled how to talk about math with children for parents during FEAs.

“Families asking, ‘What shape is this? What are we doing right now? Next, we’re going to do this.’ I heard them saying a lot of the key words that I was using and reiterating them to their children.” - Head Start Teacher

“It’s neat for me to see how their language is changing with how they are talking to their kid. Like for a kid, if you say, ‘Let’s add it,’ kids aren’t going to know what it means to add. But when the parents hear me say, ‘How many do you have here?’ and ‘How many do you have here?’ and then ask ‘How many do you have all together?’ It’s neat to see that the parents will start to ask the children in the same way.” - Head Start Teacher

“I did the sorting ones with the socks that we had. I like to do it together and keep the language. ‘What do you notice that’s the same and different?’ and the parents are like, ‘You can do the black ones.’ I try to model with the kids, ‘How else can we do it? This one’s longer and this one’s shorter, and how can we do it?’ - Head Start Teacher

Teachers also found that going over a concept or activity with the children in the classroom before an FEA was helpful:

“I think working with the children beforehand helps a lot. I used to just kind of put the directions on the board and see if they can figure it out, and it wouldn’t go as smoothly as planned.” - Head Start Teacher

“I try to keep connected because a lot of times when you do one thing, that doesn’t mean the children grasp it. You have to kind of keep going back and going back.” - Head Start Teacher

Finally, teachers felt that they themselves needed to be engaged in the content and make parents feel comfortable and welcome in the space:

“I think that opening up that environment where it’s a safe zone to talk about it, ‘Where are your struggles? Where can I help you?’ It’s a great characteristic to have in the family engagement, and I think being prepared is certainly another. I think you, the teacher, being engaged in the activity is a huge part of it because if you’re going to check out, they’re going to check out.” - Head Start Teacher

“It was just nice seeing them work together, so any compliments you can give and thank them for coming, so that they can come back again.” - Head Start Teacher

In fact, during the PD, the facilitator encouraged teachers to greet families at the beginning of the FEA and thank them for coming at the end to let parents know that their time is valued, and that spending that time together with their child is important.

Thus, the PD helped teachers feel more comfortable engaging children and their families around math by providing them with strategies to facilitate effective Family Engagement Activities.

Impacts of Peg + Cat Transmedia Resources on Teachers

During end-of-year interviews, some teachers talked about the impact of the Peg + Cat transmedia resources. Most discussed how the transmedia made the math content covered in the PD more interesting to them personally:

“Peg + Cat has been really fun for the children and for the teachers. I know it’s made math more fun and alive for me. As a child, I always remember math being routine and rote and counting was just saying them over and over again, and shapes was the same thing. ‘That’s a square.’ But I like this. It meets them where they are. It makes it fun. It’s going to be math, but it’s going to be fun and you’re going to really learn something. The show does a great job. The resources are great. I like that we have the freedom to use the resources, but create our own thing for the children and their needs. It’s been such a real privilege.” - Head Start Teacher

How PD Prepared Teachers To Support Children’s Exploration of Math

During end-of-year interviews, teachers shared how the PD changed the ways that they talked to children about math, and the questioning strategies that they used to encourage children to explain their mathematical thinking. Teachers reported that most of their classroom conversations around math were around attendance, counting objects, the concept of more or less, and shapes in everyday objects. Here, one teacher describes the math-related conversations she had with children in her classroom:

“We talked a lot about how many, and more or less, and positional words were a lot of conversations we had with them. If we were sitting at lunch, we’d say, ‘How many meatballs do you have? Who has more meatballs?’ And then at snack two hours later, they were emptying out their animal crackers and saying, ‘I have more than her. How many do I have left now, Teacher? They were able to recognize that they were losing as they were eating them. So, that was constant conversation with them.” - Head Start Teacher

Teachers shared that they tried to elicit children’s mathematical thinking in a number of ways. These included letting children use their own words, asking open-ended questions, asking questions in different ways, using hands-on activities to explain concepts, incorporating more mathematics vocabulary, and modeling thinking out loud. Here, one teacher explains how she tried to facilitate children’s mathematical understanding:

“My conversations were always getting them to think. I wanted to build their learning instead of just answer simple yes or no questions. I wanted their learning to grow, so if I asked a math question it was usually, ‘Well, why do you think that?’ or, ‘How do you know?’ or kind of putting it back on them to really show that they understand the concept. I did that a lot throughout the year.” - Head Start Teacher

How PD Prepared Teachers To Assess Children's Math Learning

During interviews, teachers were asked to discuss how the PD had prepared them to assess children's mathematics learning. Teachers in Program Year 1 shared that the information about learning trajectories had helped them become better at assessment techniques:

"Just making that more meaningful for the kids, where they were with their age as opposed to thinking, 'Oh well, they're four and they have to have all of this established.' You have to meet them where they are, so that the instruction is positive, and that really helped me with my assessment." - Head Start Teacher

"I think it made me more aware of what I needed to be looking for. I think previously, with the assessments we had, I was basically just looking for rote counting and number recognition. And now, I look for, 'Can they count a set of seven? Do they know if things are more or less?' I think I look for more than I had previously looked for." - Head Start Teacher

In addition, information about child interviewing techniques provided teachers with better tools to elicit children's thinking and therefore assess where they were at in their mathematical skills and concept development:

"I think it allowed me to actually really listen and change my questioning point of view and how I question the kids, and really push them for more to show me that they understand more than I would have." - Head Start Teacher

In Program Year 2, teachers felt that exposure to quick assessment tools, having clearer definitions of assessments, and being cognitively more aware of intentional teaching had helped prepared them to assess children's mathematics skills development.

Predictors of Teachers' Confidence in Mathematics Instruction

Multiple linear regressions were used to examine factors that might influence teachers' confidence in their mathematics instruction across both program years. These analyses found that teachers' use of project resources helped predict teachers' confidence in their mathematics instruction, when controlling for their prior level of confidence (see Table 17).

Teachers use of Peg + Cat ELM2 professional development resources significantly predicted their confidence in their mathematics instruction.

Table 17: Predictors of Teachers' Confidence in Their Mathematics Instruction

Program Year	Independent Variables**	R ²	B	SE B	β	p
2015-2016	Teachers' confidence in their mathematics instruction before intervention		0.096	0.164	0.082	0.561
	Teacher use of PD activities		0.046	0.014	0.465	.002*
	Teacher use of Peg + Cat transmedia resources		0.022	0.032	0.117	0.491
	Teacher use of math-related FEAs		-0.011	0.031	-0.059	0.729
	Model predicting teachers' confidence in their mathematics instruction after intervention	0.254				.017*

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

**R² denotes the proportion of variance explained by the model.

B denotes the variable estimate.

SE B denotes the standard error of the variable estimate.

β denotes the standardized estimate.

p denotes the p value.

In sum, the Peg + Cat ELM2 project effectively supported teachers' transfer of knowledge to pedagogy. Specifically, hands-on activities, discussions of specific math topics, and brainstorming activities for the classroom during the PD made teachers think about ways to apply lessons learned in their own classrooms. Information about family engagement strategies and access to Peg + Cat transmedia resources also supported teacher transfer. In addition, discussions of children's learning trajectories and child interviewing techniques prepared teachers to assess children's mathematical skills development and elicit children's thinking. Finally, teachers' use of Peg + Cat ELM2 project resources, particularly those activities that were covered during the PD, helped predict teachers' confidence in their mathematics instruction by the end of the program.

EQ2B: How did teachers use the project resources and strategies?

Classroom Activities & Resources

Head Start teachers encountered many different kinds of activities in the PD that they incorporated into their classrooms (see Appendix B for activity descriptions). End-of-year surveys indicated that the largest number of teachers reported utilizing books and graphing activities in Program Year 1 (2014-2015), and books, shape scavenger hunts, and block play in Program Year 2 (2014-2015). In both program years, Think-Pair-Share activities and the Difference Train activity were reported by teachers as being utilized the least (see Table 18).

In both program years, teachers reported using the resources and activities covered in the PD most often to reinforce a math concept or during Centers/Small Group activities. In Program Year 1, teachers also reported using these resources quite often during Circle Time. In both program years, the linear/number line calendar and the 10-frame attendance tended to be utilized daily. Additionally, in Program Year 2, block play and the Magna-Tiles also tended to be used daily within classrooms.

During end-of-year interviews, teachers were asked what changes they had made to their own classrooms as a result of their participation in the PD. The largest number of teachers indicated that they had changed their attendance procedures and materials, incorporated a number line calendar, and had more math resources available in their classrooms overall. The following examples demonstrate how teachers utilized some of the project resources from the PD in their classrooms:

Teachers most often used Peg + Cat ELM2 PD resources to reinforce a math concept or during small group activities.

Attendance Procedures/Materials

“The boys stand on one side of the room and the girls on the other, and I’ll give them each a peg, and they put it on top. So they can physically see how many more, and then they can compare and see, ‘Oh, well. There are two more boys.’ So, I think I’m becoming a lot more concrete and extending the skill.”

Number Line Calendar

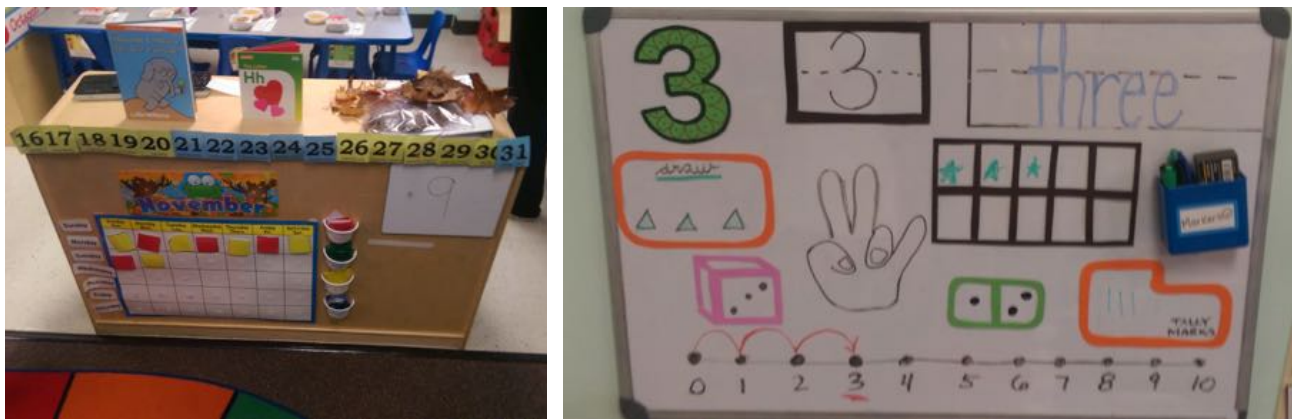
“One of the things I started to do on the number line was if there was a day of the month that was special, I would put a star above it, and then they would know what’s happening on the 29th, or something big’s going to happen.” - Head Start Teacher

Multiple Representations

“Any time we represent a number, whether it is numerically or through representation, there is always more than one way to show it. If there is a number somewhere, there are two dots after it or when it represents a lot of our numerals in one way now. We have a number line, a calendar, like a linear calendar. We still have a format calendar, but we use that now for patterning and other types of activities on the calendar. I have a math board now, where it shows numbers represented all different ways.” - Head Start Teacher

“We were making diagrams...They build it and make up their own, and now they go to art first, make their own blueprints, and then they take that picture to blocks and they try to build it.”
- Head Start Teacher

Figure 8: Examples of PD Resources in Peg + Cat ELM2 Classrooms



FROM LEFT TO RIGHT: A NUMBER LINE CALENDAR AND PATTERN CALENDAR; A BOARD HIGHLIGHTING DIFFERENT WAYS TO REPRESENT THE NUMBER THREE.

Table 18: Teachers’ Self-Reported Use of Peg + Cat ELM2 Professional Development Resources

Classroom Activity	Program Year 1 (2014-2015); N=50	Program Year 2 (2015-2016); N=50
Books (Y1)	45	44
Graphing activity (Y1)	39	36
Attendance chart 10-frame design (Y1)	31	22
Quick Images activity (Y1)	30	19
“Count Your Chickens” 10-frame activity (Y1)	29	27
Child interviewing techniques (Y1)	24	15
Games (Y1)	23	28
Linear or number line calendar (Y1)	20	17
Rekenrek (Y1)	20	13
Think-Pair-Share (Y1)	14	8
Difference Train activity (Y1)	14	9
Shape scavenger hunt (Y2)	N/A	40
Block play/Block towers	N/A	40
Magna-Tiles	N/A	38

Classroom Activity	Program Year 1 (2014-2015); N=50	Program Year 2 (2015-2016); N=50
Positional words	N/A	28
Pattern blocks or Tangrams	N/A	35
Mystery Bag activity	N/A	32
Books (Y2)	N/A	30
Map making activity	N/A	28
Geoboards/geoblocks	N/A	26
“Which is Bigger?” cup activity	N/A	22
Weight activity with pan balance	N/A	18
Cat measuring tool	N/A	18
Other	3	N/A

The following conversation from Program Year 1 illustrates how teachers used ideas from the PD and transformed them in their own classroom (see Table 19). During one PD session, teachers created graphs out of candy bar wrappers, stacking the wrappers of their favorite candy bars on top of one another and comparing different brand’s popularity. During classroom observations, a teacher (HST) asked the children in her class who came early for breakfast to save their cereal lids and to stack them on top of one another on a piece of butcher paper. After all of the children had arrived, she gathered them on the carpet for Circle Time and discussed the activity that some of the children had participated in earlier that morning.

Table 19: Classroom Conversation During Graphing Activity Review and Attendance

Conversation	Interpretation
HST: Who can tell me what we were doing this morning?	The teacher asks the children to recall the earlier graphing activity.
Child 1: We took the cereal and took the thing off.	
Child 2: We wried on the chart, and then we taped it.	
HST: So does anybody remember what this type of thing is called?	The teacher attempts to reintroduce math vocabulary.

Conversation	Interpretation
Children: Paper.	
HST: Remember when we went to the groundhog and saw whether he was going to see his shadow and not see his shadow and we made a graph of how many people said yes and how many people said no? Child 3, I want you to look at our graph and tell me which column has the most papers in it.	The teacher references a prior day's activity to define the concept of a graph for the children. During the Peg + Cat ELM2 PD, facilitators encouraged teachers to connect children's current activities with their prior knowledge or experiences.
Child 3: 1,2,3,4,5.	
HST: Which one has the most? Which cereal is that? Who ate that type of cereal?	The teacher wants the children to interpret the graph, asking them to make comparisons of quantity (i.e. more or less).
Child 4: Golden Grahams.	
HST: Let me get a marker here. We have five here.	The teacher represents the amount of cereal boxes with the corresponding numeral.
Child: I'm five, HST!	One child makes a connection between his age and the number that has been written on the graph.
HST: Child, show me which column has next to the most.	The teacher asks another child to interpret the data on the graph, and compare quantities.
<i>He counts 4, including the black and white photocopy, which was there for reference.</i>	
HST: This one doesn't count, so how many do we have here?	To help the child answer, "which column has the next most," the teacher rephrases her question and focuses on a particular section of the graph.

Conversation	Interpretation
Child: 1,2,3. Three.	The child uses one-to-one correspondence (i.e. assigning a number to each object) to identify the total number of cereal boxes. The child also understands cardinality (i.e. the number of objects in a set as a property of that set). Both principles were covered in the Peg + Cat ELM2 PD.
HST: What's the other kind of cereal people ate?	
Kids: Kix.	
HST: Nobody ate Cheerios. You know what else we can tell from this graph. We can tell how many of our friends ate breakfast and how many didn't. "Child," you're our kid counter. Stand up and count them.	The teacher makes an observation about what kinds of information a graph can tell someone, and then transitions to using the graph to help the children figure out how many children did or did not eat breakfast before class.
<i>Child counts to 15.</i>	The child uses one-to-one correspondence to identify the total number of children.
Child: Fifteen.	The child understands cardinality.
HST: We know that there are 15 kids here. 5 and 1 and 3 do not add up to 15. So how can we tell how many kids ate breakfast today?	The teacher makes another observation, then asks the children to figure out a strategy for answering her question. She uses a questioning strategy from the PD to try to elicit children's thinking.
Child: Nine.	The child who counted the total number of children answers this question correctly.
HST: How did you come up with that answer?	The teacher again uses a questioning strategy from the PD to elicit the child's thinking.
<i>Child comes up and counts each cereal box on the graph.</i>	The child uses one-to-one correspondence to show her answer.

Conversation	Interpretation
<p>HST: Does everyone see how she did that? She counted all the cereal. Now I want to count up to see how many of our friends did not eat cereal...Child, put 9 together. Okay. Show your friends. Count it out for us, Child.</p>	<p>The teacher revoices the strategy to make sure that the other children observed it. The teacher then focuses on another skill from the PD, counting on from a number. She also asks the child to take colored pegs to represent the number 9. Employing multiple representations of numbers was another strategy covered in the PD.</p>
<p>HST: Oops. Try again. Do you want us to help and count with her?</p>	<p>The child has trouble counting the 9 pegs, so the teacher involves the whole class in counting the pegs out loud.</p>
<p>HST: Okay, we're going to count up to 15. Ready? Child is going to get the number of how many kids did not eat cereal. We had 9. Count up to 15. What comes after 9?</p>	<p>The teacher returns to the idea of counting on, asking the children to start from 9, instead of 1, and to count up to 15.</p>
<p><i>The children all point and count to each peg together.</i></p>	<p>The children use one-to-one correspondence to count the pegs.</p>
<p>Children: 10, 11,12,13,14,15.</p>	
<p>HST: Child, how many pegs do you have now? Child has 9 and Child has 6. What do you think will happen when we put them all together? This represents who ate cereal and this represents who didn't eat cereal.</p>	<p>The teacher restates the question, and lets the children know that the two groups of pegs together represent the total number of children in attendance that day. She then reiterates what each group of pegs represents.</p>
<p>Child: Fifteen.</p>	<p>The child who answers understands cardinality.</p>
<p>HST: How did you get that number? That represents everyone who's here today?</p>	<p>The teacher again tries to elicit the child's thinking by asking her to share her strategy.</p>
<p><i>They all count together, starting from 1 once the two groups of pegs are put together.</i></p>	<p>The class uses one-to-one correspondence to count the total number of pegs again.</p>

Conversation	Interpretation
HST: We had 9 people eat cereal and 6 people did not, and all together we have?	The teacher reiterates the concept of adding the two groups of children together, and asks the children to respond with the total number of people in attendance.
All: 15.	The children appear to understand cardinality.

Here, the teacher was able to adapt an activity that she experienced during the PD, and cover several mathematical concepts with children in her classroom during the everyday attendance routine. The teacher referenced prior activities to help define the idea of graphing, incorporated multiple representations (cereal boxes, numerals, and pegs), worked on children’s data interpretation skills, covered key ideas around number, such as quantity (how many?), comparison (more or less), cardinality, and counting on, and elicited children’s thinking by asking “how” questions.

Figure 9: Photographs from PD & Classroom Graphing Activities in Program Year 1



In the next example from Program Year 2, a teacher (HST) is approached by a child who has been building with Tinker Toys in the block play area of the classroom (see Table 20). The child brings his creation over to the teacher, and she asks him various questions about it.

Table 20: Classroom Conversation During Block Play Activity

Conversation	Interpretation
HST: How did you make that?	The teacher opens the conversation with an open-ended “process” question.
Child: I followed the map.	The “map” is a poster with a diagram of different ways to configure Tinker Toys. The child can be seen looking at the map in Figure 11.
HST: Let’s go look at the map, and let’s compare.	The teacher is calling attention to the diagram representation versus the 3D, physical representation. The idea of encouraging children to use multiple representations was covered during the PD.
HST: How many legs do we see on the picture for our map? Let’s count.	The teacher asks a question about quantity using the diagram.
Child: 1, 2, 3, 4.	The child uses one-to-one correspondence.
HST: Let’s count how many legs your structure has.	The teacher wants the child to compare the quantity of legs on the diagram to the quantity of legs on the structure he has built to see if they are the same amount.
Child: 1, 2, 3, 4.	The child uses one-to-one correspondence.
HST: Great! It matches the map.	The teacher makes the observation that the two representations have the same amount of legs.
Child: Look, I’m spinning the swing!	The child draws the teacher’s attention to another feature of his structure.
HST: I love the structure of the swing set that you created. What is another word that we’ve been talking about?	<p>The teacher uses process praise, rather than general encouragement, which was emphasized in the PD as part of supporting a growth mindset in young children.</p> <p>The teacher attempts to link the swing feature that is drawing the child’s attention to a new discussion about shapes.</p>

Conversation	Interpretation
Child: Turn it.	The child is still focused on building his structure, and does not answer the teacher's question at this time.
<i>The child changes the structure to add in another seat for the swing set.</i>	
HST: What's different about this now?	The teacher again focuses the conversation on a feature of the structure that the child is interested in.
Child: I added the seat.	
HST: What shape are the seats?	The teacher revisits her earlier question, asking the child to identify the name of the shape of the seats.
<i>HST turns her fingers around and around in a circular motion.</i>	The teacher provides a hint about the shape of the seats using her fingers. Fingers were emphasized during the PD as an important tool for math.
Child: Circle!	The child correctly identifies the shape.
HST: First swing, how many red pieces did it have?	The teacher now asks about the quantity of red pieces that the child's original structure had.
Child: One, and one yellow circle.	The child responds, now incorporating math vocabulary into his answer.
HST: And then look at the one you just added. How many red pieces do you have?	The teacher reminds the child of the newly added piece to the structure, and asks about the quantity of red pieces in his new structure.
Child: Two.	The child is able to subitize (i.e. name the quantity without counting).
HST: And how many circles?	The teacher incorporates math vocabulary into her question.
Child: Two.	The child subitizes the amount again.

Conversation	Interpretation
<p>HST: I love your architecture and it is so creative, maybe you could bring it over to art, and you could draw it, and then you could teach your friends how to build this from your drawing and instruction page.</p>	<p>The teacher again uses process praise regarding the child’s structure, and encourages him to make his own written diagram representation of the structure for other children to use.</p>

In the second example above, the teacher was able to take an activity that the child was already doing and position it as an opportunity to highlight shape and number math concepts and vocabulary. In addition, the teacher referenced multiple representations, and used process praise to further support the child’s development of a growth mindset. As both classroom examples illustrate, teachers were able to take math concepts, activities and strategies that they experienced in the PD, and adapt them into their own classroom practices.

Figure 10: Photographs from Classroom Block Play Activity in Program Year 2



Family Engagement Activities

In Program Year 1, participating teachers (N=50) reported conducting an average of 5.96 out of 9 possible *Peg + Cat + Us* Family Engagement Activities (FEAs) in their classrooms. In Program Year 2, participating teachers (N=50) conducted an average of 7.54 out of 13 possible *Peg + Cat + Us* Family Engagement Activities in their classrooms. The largest percentage of

teachers reported using the Counting Collage for family engagement in the first program year (80%), and Dice and Action Game in the second program year (80%) (see Table 21).

Table 21: Teachers’ Self-Reported Use of Peg + Cat Family Engagement Activities

Family Engagement Activity	Program Year 1 (2014-2015); N=50	Program Year 2 (2015-2016); N=50
Counting Collage	40	29
Bedtime Routines	38	24
Sorting Socks & Silverware	37	25
Dice & Action Game	36	40
Patterns with Music/Dance	31	20
54321 Calm Down Strategy	30	25
Now How Many? Add One More	29	28
Five Fingers/Tracing Your Hand	28	25
FEA w/Measuring Tape	N/A	38
FEA w/Shape Cards	N/A	37
FEA w/Placemat	N/A	37
FEA w/Out on a Limb DVD	N/A	15
Other Math-related Family Engagement Activities	29	34

During the second program year, teachers were encouraged to come up with their own math-related family engagement activities in addition to those that they had been exposed to during the first program year. Furthermore, PD facilitators suggested doing a family engagement activity to introduce parents and children to the resources that they were taking home. Thus, a large number of teachers in the second program year conducted FEAs around the project’s various transmedia resources.

FEAs were more effective when teachers introduced the math concepts or activities to children beforehand or revisited the concepts later in class.

During the PD, facilitators suggested that the FEAs would be more effective if teachers introduced the concepts or activities beforehand and/or revisited the concept later on in the week. Teachers heard this suggestion, and several shared during interviews that they had gone over the math concepts with children in advance or afterwards during circle time, during transition activities, or in small group/center time. A few teachers also reported using Peg + Cat media or characters to

introduce a particular math activity or concept. For example, one teacher positioned a sorting FEA as a “Really Big Problem,” which the character of Peg can be heard saying in each Peg + Cat episode: “We just grabbed our crayons. We dumped them all out. We dumped out all of our markers. We were like, ‘We have a huge problem. We need help sorting all of these things,’ so that everybody had something they could do.”

Teachers reported spending increasing amounts of time on planning FEAs over the course of the Peg + Cat ELM2 project. On a scale from 1 (none) to 5 (a considerable amount), teachers reported spending more time planning for FEAs by the end of each program year (M=3.81), compared to the beginning of those program years (M=3.23).

Teachers adapted activities and ideas from the PD into FEAs within their own classrooms.

The Dice & Action Game was selected by the largest number of teachers as the most successful Peg + Cat + Us FEA in both program years. Teachers liked that the Dice & Action Game was a gross motor activity and that it encouraged parents and children to play together: “The children loved completing an activity where they could count and then incorporate their whole bodies in an action as well. It held their attention and the children had fun playing the game.” - Head Start Teacher

“The parents really interacted with it. We were able to take turns with the game and work together counting.” - Head Start Teacher

Teachers tended to adapt the Dice & Action Game activity by having children come up with their own actions, in addition to the Peg + Cat-themed actions written on the accompanying Action Cards. Teachers also utilized the dice in class for other purposes:

“The one that the kids would clap or stomp 70 times, or whatever it was. We did that with - we rolled the dice and they would have to pick up that number of frogs. They would put it on their lily pad. The next person went, and after all of the frogs were done, we would go and we would count. Whoever had the most, that was the person who we would just put them in line, ‘I have the most. She was next. She was second. She was third,’ so we were graphing who had the most, who had the least. At the same time, they’re counting.” - Head Start Teacher

In the second program year, teachers also considered the Shape Cards to be highly successful. They liked that children could practice using the Shape Cards during class and at home, both before and after the FEA. Teachers tended to adapt the Shape Cards by utilizing them for different games:

“We used the Shape Cards to play a variety of different games. In one game we sorted the cards, and in another we made patterns with the specific cards.” - Head Start Teacher

“We played the game Go Fish with the Shape Cards.” - Head Start Teacher

“For the Shape Cards, I had students choose a card, sit under that shape, and then find objects in the classroom that were their team’s shape (‘Team Triangle’ found triangular objects in the classroom).” - Head Start Teacher

Teachers felt that the Counting Collage and Bedtime Routines had been the least successful FEAs in their classrooms. For the Counting Collage, teachers thought that there were too many steps for families to follow: *“There were many parts to the activity. It took lots of time to prepare all of the materials to include on the collage. Also, the parents were a little confused with all of the parts included.”* For the Bedtime Routines, teachers noted that some of the children in their classroom did not have a set routine at night, or that the images provided did not reflect activities that were culturally part of the children’s routines:

“With the bedtime routine, it was a little bit hard because not all my parents and kids had routines. Some let them sleep on the couch, some have – like a lot of them have nothing. So for them to do a sequencing with the pictures that were provided was difficult. Because then I kind of feel like I put people in uncomfortable positions because they didn’t have a routine.”

- Head Start Teacher

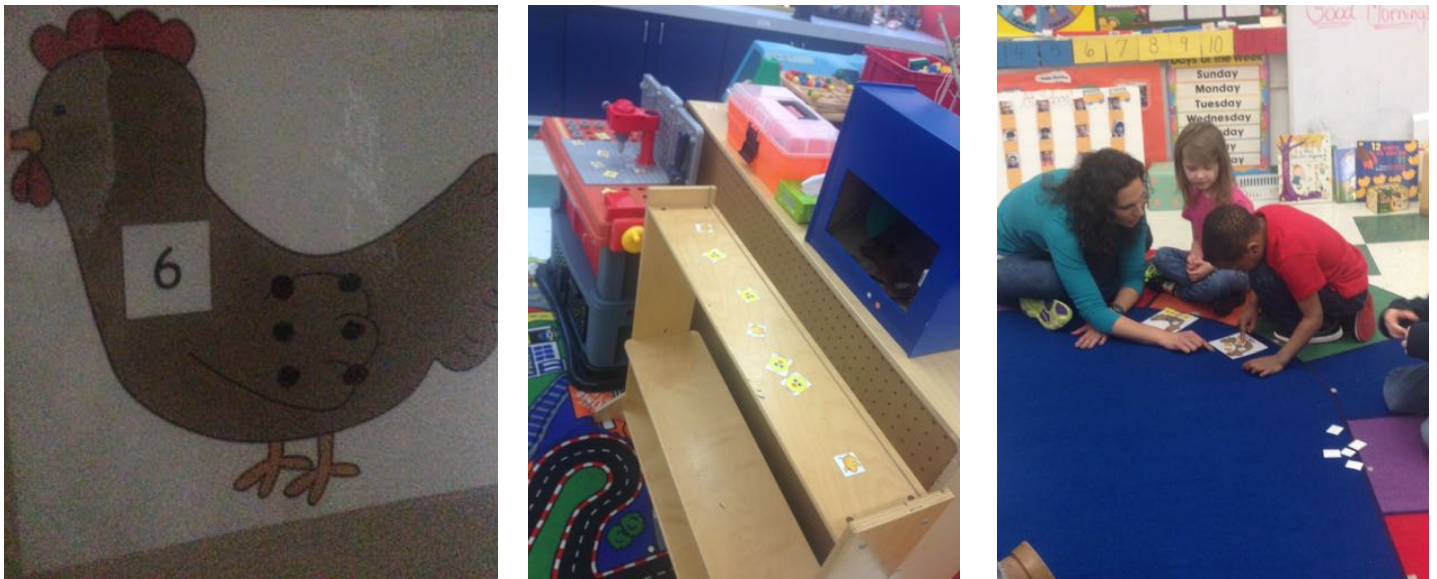
Thus, in Program Year 2 (2015-2016), several teachers chose not to re-try these two activities for family engagement time.

FEA Adaptations

Observations of FEAs in both program years indicated that teachers were adapting lessons learned from the PD into their family engagement time. For example, one teacher in Program Year 1 took the “Picking Up Chickens” activity that had been presented as a teacher activity in the PD (i.e. teachers had to collect paper chickens hidden around the room to fill a 10-frame), and modified it as an FEA. The teacher passed out a hen to each child with a number and a dice representation written on it. As was covered in the PD, the teacher differentiated instruction by giving specifically numbered chickens to different children, based on what she knew they could accomplish. The teacher told the children that they needed to find the matching number of missing chicks around the classroom, and encouraged parents to participate with their children.

The teacher also incorporated Peg + Cat throughout the FEA. She referenced Peg + Cat at the beginning of the activity saying, *“Okay kids, I have a Really Big Problem! Who’s ready to help us find all these chickens and pick them up?”* She then played the “Picking Up Chickens” song from the Peg + Cat CD, while the children began picking up the chickens. Then, at the end of the activity, the teacher had the children sing the “Problem Solved” song from Peg + Cat to celebrate the conclusion of the activity, and thanked parents for coming.

Figure 11: Photographs from Picking Up Chickens FEA in Program Year 1



In a second example from Program Year 2, a teacher (HST) designed her own activity around three concepts covered in the PD: shape recognition, counting, and subitizing (see Table 22). Here, the teacher created a Peg + Cat-themed pizza, modeled after the online game, *Peg’s Pizza Place*. During the FEA, the teacher instructed families to roll dice to decide the number of each kind of shape to put on their pizza. The teacher first asked the children to let their parents know which shapes they had available (i.e. letting children take the lead). When children completed their pizza, the teacher reviewed the idea of quantity, asking various children, “How many triangles do you have? How many circles? How many squares?” Throughout the FEA, the teacher being observed modeled math vocabulary, questions to ask, and strategies to use around quantity and shape attributes for parents. The conversation below picks up while families are making shape pizzas together, and the teacher approaches a parent after her child has gone to another part of the room.

Table 22: FEA Conversation During Shape Pizza Activity

Conversation	Interpretation
HST: Does she recognize all the shapes?	The teacher initiates the conversation with a parent around her child’s shape recognition skills.
Parent: She has trouble with triangles.	

Conversation	Interpretation
HST: I tell them to look at the sides. It's the only one. I blew their minds the other day. A square is a rectangle. What? It's just a special kind of rectangle.	The teacher provides the parent with a strategy to help her child recognize specific shapes. She also shares one of the other concepts that the children had gone over previously. Both shape attributes and the concept of squares as a special kind of rectangle were covered in the Peg + Cat ELM2 PD.
<i>The child returns to the table.</i>	
Parent: How many triangles?	When the child returns, the parent models the questioning that the teacher has been using with other children throughout the FEA.

Figure 12: Photographs from Shape Pizza FEA in Program Year 2



Peg + Cat ELM2 Transmedia Resource Use in Head Start Classrooms

Overall, most participating teachers utilized the Peg + Cat ELM2 transmedia resources in their classrooms (see Table 23). In Program Year 1, teachers (N=50) reported using an average of 6.94 transmedia resources during the year (Range from 2 to 10). In Program Year 2, teachers (N=50) reported using an average of 5.18 transmedia resources during the year (Range from 1 to 9 resources). In the first program year, the greatest number of participating teachers reported using the Lending Box materials and the Take-Home Activity Sheets. In the second program year, the greatest number of teachers reported using the Peg + Cat video

clips and episodes in their classrooms. This shift may be due to an increased emphasis in the second program year’s PD on strategies to incorporate media into the classroom.

Table 23: Teachers’ Self-Reported Use of Peg + Cat ELM2 Transmedia Resources

Peg + Cat Transmedia Resource	Program Year 1 (2014-2015); N=50	Program Year 2 (2015-2016); N=50
Lending Box materials	41	40
Peg + Cat video clips or episodes	37	42
Peg + Cat songs	32	36
Peg + Cat online games or apps	31	39
Activity Sheets	41	N/A
Trading Cards	37	N/A
Placemats	N/A	33
Measuring Tape	N/A	28
Shape Cards	N/A	27
Out on a Limb DVD and Family Activity Guide	N/A	7
Other Peg + Cat Resource	3	7

In the first program year (2014-2015), the majority of teachers reported using the Lending Box, Activity Sheets, and Trading Cards approximately once a week. They also reported using video clips or episodes of Peg + Cat several times a month, whereas the songs and online games or apps tended to be used several times a week. In the second program year (2015-2016), the majority of teachers reported using the video clips or episodes of Peg + Cat, songs, and online games or apps several times a month. Most teachers used the Shape Cards and the Out on a Limb DVD in their classrooms once a month, the Measuring Tape once to several times a month, and the Placemats less than once a month.

In both program years, Peg + Cat video clips or episodes were most often used by teachers to introduce a math concept (62% in PY1; 76% in PY2) or reinforce a math concept (73% in PY1; 76% in PY2). Peg + Cat online games or apps were most often used by teachers during Centers/Small Groups (71% in PY1; 67% in PY2) or to reinforce a math concept (68% in PY1; 67% in PY2). The Lending Box was most often used by teachers as a take-home activity (85% in PY1; 73% in PY2).

Interestingly, Peg + Cat songs were used differently depending on the program year. In the first program year (2014-2015), the songs were most often used by teachers (69%) during

Family Engagement Activities, whereas in the second program year, the songs were most often used by teachers (72%) during transition time.

Regarding the items that were only available during the first program year, the Activity Sheets (88%) and Trading Cards (97%) were most often used by teachers as take-home activities. Similarly, the Out on a Limb DVD & Activity Guide from the second program year were also most often used as a take home activity (71%). The Measuring Tape (71%) and Shape Cards (67%) from Program Year 2 (2015-2016) were most often used by teachers to reinforce a math concept. The Placemats were used most often as either a take-home activity (48%) or to reinforce a math concept (48%).

Teachers' Use of the Lending Box

During end-of-year interviews in both program years, teachers reported having families in their classrooms check out Lending Box items in many different timeframes. Some made the Lending Box materials available on a first come, first serve basis. Others rotated, and asked children to check out items over the weekend or for an entire week before returning them. The Lending Box was typically introduced to families during an FEA, in a parent newsletter, in individual parent-teacher conversations, or to children during in-class activities.

During an interview, one teacher shared how she felt that the Lending Box helped her talk with families about math:

“So, the Lending Box gave me a chance to talk to the parents one-on-one about how important math was in the house and ways to extend, and there’s different ways of extending it like taking these activities home and there are other things in your house that you can use to do math... So, I think the Lending Box really was the best thing that you guys offered to us because it was, like I said, it was just a way for us to open – kind of get the door open and get in and then make the parents feel comfortable in understanding math.” - Head Start Teacher

Thus, the Lending Box was mainly utilized as a tool to connect math concepts and activities from the classroom to the home environment.

Figure 13: Using the Peg + Cat Lending Box in Classrooms



Teachers' Use of Peg + Cat Video Clips Or Episodes

During end-of-year interviews, teachers reported using video clips or episodes of Peg + Cat before an FEA or in support of a math concept:

"I think we did when we were measuring their names, we related it back, like every activity related back to an episode or a clip that we watched. Whatever skill was present in that video or that clip, that's the skill that we focused on that activity and made it correlate with that video."

- Head Start Teacher

"They love the video clips. They really do. They're engaging, and they're excited to find out what comes next. It's an awesome way to start when I'm talking about whatever subject or whatever theme that we're going to be doing in the class, and, 'How did Peg do it and what was the problem?' I'll shut them off and say, 'What do you think is going to happen next?'"

- Head Start Teacher

The goal of the PD was not to increase teachers' use of video in the classroom, but rather to incorporate the general math concepts and strategies highlighted in Peg + Cat into their pedagogical practice. Thus, as expected, only 3 out of 14 classroom observations in Program Year 1, and 2 out of 13 observations in Program Year 2 included Peg + Cat clips being shown during the school day. Similarly, only 4 out of 23 FEA observations in Program Year 1, and 2 out of 12 FEA observations in Program Year 2 included a clip from the show beforehand.

Figure 14: Using Peg + Cat Video Clips in Classrooms



Teachers' Use of Peg + Cat Songs

Only 3 out of 14 classroom observations in Program Year 1, and no classroom observations in Program Year 2, included Peg + Cat songs being played during the school day. However, during end-of-year interviews from both years, teachers shared that they had used the music from the show during circle time, clean-up time, and transition time. Teachers liked that the songs reinforced the concepts that they were covering in class:

"It's a very fun, engaging way to incorporate math topics, especially through the music and the cute characters. They use social-emotional topics that the children can relate to, as well, so I think it works very well with this age group...Research has proven that music paired with information really helps children remember, so using the Pentagirls song and stuff, it helped them remember how many sides were in a given shape." - Head Start Teacher

Teachers were also encouraged during the PD to play Peg + Cat songs before Family Engagement Activities to help set the tone for the experience. In fact, music from the show was often played at the beginning of PD sessions or before discussions of family engagement strategies to energize the teachers. During FEA observations, only 4 out of 23 classrooms in Program Year 1, and 1 out of 12 classrooms observed in Program Year 2 included Peg + Cat songs during their FEAs. One teacher shared that she used the "Sorty Sort Sort" song during an FEA, where she had children sort clothes, and during transition time to help reinforce the concept:

"I was trying to explain to them, you know, what sorting means, how everything has a home and sometimes you take a big pile of something and you sort them by different attributes. So I use that song when we clean up because sometimes they don't put the toys back in the right spot, but we also use it...just kind of to have it in the background, just so they kind of get that correlation between what they're doing and the word 'sort.'" - Head Start Teacher

Another teacher linked thematically to the Peg + Cat episode, *The Beethoven Problem*, by asking families to use bratwurst (which was featured in the episode) during an FEA, to make patterns inspired by the main song, “Short, Short, Short, Long,” from the episode:

“Just relating it to what the children learned by using the words in the ‘Short, Short, Short, Long’ because they love that song so much and they’re always singing it. Relating that activity to the pattern, I feel it helped it because they were able to dig into that prior knowledge.”

- Head Start Teacher

Figure 15: Family Engagement Activity on Patterns Inspired By Peg + Cat Song



Teachers’ Use of Peg + Cat Online Games or Apps

During end-of-year interviews, teachers reported using the online games and apps in class, typically as one of the options during small group/center time or as a large group during circle time. Classroom observations indicated that teachers did not use online games and apps in their classrooms very often, with 1 out of 14 observations in Program Year 1, and 5 out of 13 observations in Program Year 2 including Peg + Cat online games. Similarly, no FEA observations in Program Year 1, and 4 out of 12 FEA observations in Program Year 2 included Peg + Cat online games. The slight increase in use of online games and apps in the classroom and during FEAs in Program Year 2 may have been due to the increased emphasis within the Year 2 PD sessions on strategies for incorporating media in the classroom.

Teachers appreciated that the online games were age appropriate, and utilized them because the children in their classrooms were already familiar with the characters of Peg and Cat:

“The activities online have definitely been a good resource for them to engage in their own math activities after we’ve talked about them in their own way, too, in their own time, in their own pace.” - Head Start Teacher

Figure 16: Using Peg + Cat Online Games in Classrooms



Teachers' Use of Peg + Cat Activity Sheets

During end-of-year interviews in Program Year 1, teachers noted that they mostly sent the Activity Sheets home with children after an FEA or relevant classroom lesson: *"Taking home something that we're doing all the time and we're talking about in the class I think was always helpful and beneficial."* Although they were not encouraged to do so, a few teachers used the sheets during class, as part of an FEA, or as an introduction to an activity. However, most teachers preferred not to use worksheets at all in class, as Head Start emphasizes the use of more hands-on activities.

Figure 17: Using Peg + Cat Activity Sheets During FEAs



Teachers' Use of the Peg + Cat Trading Cards

During end-of-year interviews in Program Year 1, teachers shared that they mostly sent the Trading Cards home after an FEA or as a reward for children sharing work that they had done at home with their families. When teachers introduced the Trading Cards to parents, they noted that the cards provided an explanation of or reminder of a math concept for children, and were connected to Peg + Cat: *"I think it gets the kids excited for the concept that's on it because it connects it back to the activity that we've done."*

Teachers' Use of Peg + Cat Placemats

During end-of-year interviews in Program Year 2, teachers all reported sending the Placemats home with children. Most sent the Placemats home at the beginning of the year or during their first home visit. A few sent the Placemats home after an FEA. Because teachers sent the Placemats home early in the year, most teachers did not have any available to use within their classrooms. When they talked to families about the Placemats, teachers explained possible games to play or encouraged families to utilize the Placemats during meal time: *"I think it's just being there and being present just helps, is a helpful bridge to bring math to the dinner table. I just think of it being there, it opens up conversation with the family."* Teachers liked that the Placemats connected what children were doing in class to what they could do at home: *"I really liked that it's a bridge between school and what you see all the time at home. It can incorporate math into anything, even if you're just sitting at the table, you can have math anywhere."*

Figure 18: Family Engagement Activity Using Peg + Cat Floormat and Placemats



However, teachers did receive a large Floor Mat, which was identical to the Placemat, for use in their classrooms. Teachers tended to use the Floor Mat for bean bag toss activities, as a reference for children to use to point to numbers, for counting activities, and along with dice to support number recognition:

“I use the number mat all the time. I’ll just have the kids throw bean bags to their favorite number or I might have them jump or hop to their favorite number, or just certain things that I can see what number in math, gonna to see if they notice a number that’s not counting one-on-one - to see a number. How many items? What was that number?” - Head Start Teacher

Teachers’ Use of the Peg + Cat Measuring Tape

During end-of-year interviews in Program Year 2, teachers all reported sending the Measuring Tape home with children as part of a tote bag of items: *“We really stressed that these are things that we’re going to be using in school, and now that you have the same things at home, you can really support what’s going on in the classroom.”* Teachers tended to send the Measuring Tape home after they had introduced the concept of measurement in class, or during a home visit. Several teachers introduced the Measuring Tape during FEAs, while others pulled the tape out of the Lending Box for use in the classroom: *“I always had a Measuring Tape out in the math area, so every single day the children knew it was there. They could pull it out and they could measure and explore with it. That was just a favorite.”*

Teachers tended to talk with families about the Measuring Tape as a connection to everyday life, as a method for comparing longer or shorter, or alongside non-standard forms of measurement: *“I really had to regroup and tell [parents] it’s not about [their children] knowing if it’s four inches or five inches. It’s just the practice that they are measuring things and learning that things are bigger or smaller or the comparing size of this. It’s not the product. It’s the process.”*

Figure 19: Using the Peg + Cat Measuring Tape & Cat Measuring Tool in Classrooms



However, several teachers noted that the presence of the Measuring Tape sent mixed messages from the Peg + Cat ELM2 project. During the PD, facilitators stressed that it was less important that children knew how to accurately use the tool, and more important for them to be able to compare the length, width, and size of various objects. Several activities in the PD emphasized non-standard units of measurement, such as how many shoes it took to get across the room or how many blocks tall a child was. Thus, a few teachers incorporated non-standard measuring devices, such as the Cat measuring tool from the Peg + Cat website, which had been introduced in the PD, into their classrooms:

“During class, I introduced the concept of measuring and explained that measuring is how we find out what size something is. I modeled the use of the [Cat] measuring tool and then had the group measuring things around the room using the measuring tool. They also experimented with other non-standard units of measurement, and then they got to move around the room and measure different things around the room.” - Head Start Teacher

Teachers’ Use of the Peg + Cat Shape Cards

During end-of-year interviews in Program Year 2, teachers reported sending the Shape Cards home with children, as part of the tote bag. Teachers typically distributed the Shape Cards during a home visit. Teachers also had a set of Shape Cards in their own classrooms that they used to play various games, often modeling their use for parents during FEAs: *“They were very versatile. You can use them in different ways. During pick up or drop off, like the parents can see us using them, how we use them and how they can do it at home...I will hand out cards. I will have them find a friend with the same shape. My friend has the same attributes.”*

Figure 20: Using the Peg + Cat Shape Cards in Classrooms



Teachers' Use of the Out-on-a-Limb DVD & Family Activity Guide

During end-of-year interviews in Program Year 2, teachers reported sending the Out-on-a-Limb DVD home with children, as part of the tote bag. Teachers typically distributed the DVD during a home visit, or after an FEA. Several teachers admitted that they had forgotten that the DVD contained a Family Activity Guide, and had not made parents aware of its presence. Most teachers did not use the Out-on-a-Limb DVD in class. A few showed an episode or clip from the DVD, but reported that they did not do so very often.

Teachers' References to Peg + Cat

During classroom site visits in Program Year 2, several teachers (6 out of 13) were observed connecting Peg + Cat characters or ideas to classroom activities or mathematics concepts. These teachers did so during mealtimes (1), pickup (4), and circle time (2). In addition, a few teachers (3 out of 13) were observed using problem-solving strategies highlighted in the show in their classrooms during attendance (1), circle time (1), hand washing routines (1), and small groups (1). Additional references to Peg + Cat in Program Year 1 beyond what has already been described were not observed. Here, one teacher shares how she tried to integrate Peg + Cat throughout her classroom lessons:

"When I talk about circles, they know that Cat likes circles, or if I'm talking about triangles they know, 'Oh, hey! The pig from Peg and Cat likes triangles.' So I always try to bring it back to Peg and Cat just so they make that correlation. So they get pretty excited when they see Peg and Cat." - Head Start Teacher

Figure 21: Using Other Peg + Cat Resources in Classrooms





Teachers' Use of PD Strategies

During end-of-year interviews, teachers shared examples of strategies that they had used to encourage children in their classroom to keep trying when faced with a difficult problem. These strategies included giving children more time to finish an activity, revisiting the concept at a later date, encouraging children to ask a friend, presenting the information in a different way, differentiating instruction by presenting questions and activities at the appropriate level for that child, and encouraging the child.

As stated in previous sections, teachers also modeled how to talk about math with children for parents during FEAs, and incorporated questioning strategies to elicit children's mathematical thinking.

In sum, teachers frequently incorporated resources and activities from the PD, including Peg + Cat transmedia resources, into their classrooms, during FEAs, and as take-home materials for families. Teachers also utilized several strategies that they were exposed to during the PD, including ways to encourage children's persistence in mathematics, modeling math talk for parents, and incorporating questioning techniques to elicit children's mathematical thinking.

EQ3A: What are the key parent-reported program elements that support or hinder parents’ a.) interest, engagement, and confidence in exploring mathematics with their children, and b.) the development of knowledge of math as accessible and important for their children, and c.) development of strategies to support children’s mathematics learning and engagement?

Predictors of Parents’ Interest in Math

Multiple linear regressions were used to examine factors that might influence parents’ interest in mathematics. These analyses found that after controlling for parents’ prior interest in mathematics, teachers’ confidence, combined with teachers’ and parents’ use of project resources, helped predict parents’ interest in mathematics, as reported by parents (see Table 24).

Table 24: Predictors of Parents’ Interest in Mathematics

Program Year	Independent Variables**	R ²	B	SE B	β	p
2014-2015	Parents’ interest in mathematics before intervention	0.286	0.085	0.300	.001*	
	Teacher confidence in math instruction	0.005	0.017	0.026	0.765	
	Teacher use of project resources	0.001	0.014	0.007	0.941	
	Parent use of project resources	0.002	0.022	0.006	0.942	
	Model predicting parents’ interest in mathematics after intervention	0.092			.020*	
2015-2016	Parents’ interest in mathematics before intervention	0.573	0.120	0.500	.000*	
	Teacher confidence in math instruction	0.050	0.291	0.022	0.863	
	Teacher use of project resources	-0.009	0.012	-0.091	0.469	
	Parent use of project resources	0.047	0.023	0.207	0.051	
	Model predicting parents’ interest in mathematics after intervention	0.335			.000*	

* Indicates a significant difference at the p<.05 level.
 **R² denotes the proportion of variance explained by the model.
 B denotes the variable estimate.
 SE B denotes the standard error of the variable estimate.
 β denotes the standardized estimate.
 p denotes the p value.

Predictors of Parents' Engagement Around Math With Their Children

Predictors of the Frequency of Parents' Math Talk With Their Children

Multiple linear regressions were used to examine factors that might influence the frequency that parents reported talking about mathematics with their children (see Table 25). These analyses found that after controlling for prior levels of math talk, teachers' confidence, combined with teachers' and parents' use of project resources, helped predict the frequency of parents' math conversations with their children. In Program Year 2 (2015-2016), further analyses revealed that parents' use of project resources, made a unique contribution to the variance in how often parents talked with their children about mathematics at the end of the program year, after controlling for parents' prior frequency of math talk.

Table 25: Predictors of the Frequency of Parents' Math Talk

Program Year	Independent Variables**	R ²	B	SE B	β	p
2014-2015	Parents' frequency of math talk before intervention		0.251	0.045	0.450	.000*
	Teacher confidence in math instruction		-0.034	0.020	-0.134	0.093
	Teacher use of project resources		0.004	0.017	0.018	0.823
	Parent use of project resources		0.017	0.027	0.051	0.527
	Model predicting parents' frequency of math talk after intervention	0.234				.000*
2015-2016	Parents' frequency of math talk before intervention		0.352	0.353	0.108	0.321
	Teacher confidence in math instruction		-1.633	1.672	-0.128	0.332
	Teacher use of project resources		0.087	0.067	0.168	0.200
	Parent use of project resources		0.388	0.125	0.332	.003*
	Model predicting parents' frequency of math talk after intervention	0.146				.017*

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

** R^2 denotes the proportion of variance explained by the model.

B denotes the variable estimate.

$SE B$ denotes the standard error of the variable estimate.

β denotes the standardized estimate.

p denotes the p value.

Analyses showed that parents' use of project resources in Program Year 2 predicted how often parents talked to their children about math.

Predictors of the Frequency of Parents' Math Activities With Their Children

Multiple linear regressions were used to examine factors that might influence the frequency that parents reported doing math-related activities with their children. These analyses found

Analyses showed that parents' use of project resources in Program Year 2 predicted how often parents engaged in math-related activities with their children.

that after controlling for prior engagement, teachers' confidence, combined with teachers' and parents' use of project resources, helped predict the frequency of math-related activities, as reported by parents (see Table 26). In Program Year 2 (2015-2016), further analyses revealed that after controlling for parents' prior level of math engagement, parents' use of project resources uniquely predicted how often parents engaged in math-related activities with their children at the end of the program year. Statistical analyses of models that might predict the frequency of parent-child math-related activities in Program Year 1 were not calculated, as information about the prior frequency of parents' and children's math-related activities was not collected on the pre-survey that year.

Table 26: Predictors of the Frequency of Parents' Engagement in Math Activities

Program Year	Independent Variables**	R ²	B	SE B	β	p
2015-2016	Parents' frequency of math talk before intervention		0.362	0.086	0.428	.000*
	Teacher confidence in math instruction		-0.369	0.962	-0.047	0.702
	Teacher use of project resources		-0.012	0.039	-0.037	0.763
	Parent use of project resources		0.150	0.073	0.208	.045*
	Model predicting parents' frequency of math talk after intervention	0.253				.000*

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

**R² denotes the proportion of variance explained by the model.

B denotes the variable estimate.

SE B denotes the standard error of the variable estimate.

β denotes the standardized estimate.

p denotes the p value.

Predictors of Parents' Confidence in Exploring Mathematics with their Children

Multiple linear regressions were used to examine factors that might influence parents' confidence in exploring math with their children. These analyses found that after controlling for parents' prior level of confidence, teachers' confidence, combined with teachers' and parents' use of project resources, helped predict parents' confidence in math overall (see Table 27). In Program Year 1 (2014-2015), further analyses revealed that after controlling for

parents' prior confidence in their own math abilities, parents' use of project resources uniquely predicted parents' confidence in exploring mathematics with their children.

Table 27: Predictors of Parents' Confidence in Exploring Mathematics With Their Children

Program Year	Independent Variables**	R ²	B	SE B	β	p
2014-2015	Parents' confidence in exploring math with their child before intervention		0.052	0.101	0.059	0.608
	Parents' confidence in their own math abilities before intervention		0.344	0.084	0.464	.000*
	Teacher confidence in math instruction		0.009	0.012	0.059	0.457
	Teacher use of project resources		0.002	0.010	0.012	0.876
	Parent use of project resources		0.032	0.016	0.164	.040*
	Model predicting parents' confidence in exploring math with their child after intervention	0.269				.000*
2015-2016	Parents' confidence in exploring math with their child before intervention		0.317	0.158	0.292	.050*
	Parents' confidence in their own math abilities before intervention		0.377	0.346	0.161	0.280
	Teacher confidence in math instruction		0.828	0.779	0.150	0.292
	Teacher use of project resources		-0.041	0.031	-0.180	0.077
	Parent use of project resources		0.107	0.059	0.206	0.195
	Model predicting parents' confidence in exploring math with their child after intervention	0.242				.004*

* Indicates a significant difference at the p<.05 level.
 **R² denotes the proportion of variance explained by the model.
 B denotes the variable estimate.
 SE B denotes the standard error of the variable estimate.
 β denotes the standardized estimate.
 p denotes the p value.

Analyses showed that parents' use of project resources in Program Year 1 predicted parents' confidence in exploring mathematics with their children.

Predictors of Parents' Beliefs About Mathematics

Predictors of Parents' Belief in the Importance of Mathematics

Multiple linear regressions were used to examine factors that might influence parents' belief in the importance of mathematics for their children. These analyses did not reveal an adequate model for predicting parents' beliefs, after controlling for their prior beliefs (see Table 28).

Table 28: Predictors of Parents' Belief in the Importance of Mathematics

Program Year	Independent Variables**	R ²	B	SE B	β	p
2015-2016	Parents' belief about the importance of math before intervention		0.198	0.095	0.234	.040*
	Model predicting parents' belief about the importance of math after intervention	0.055				.040*

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

** R^2 denotes the proportion of variance explained by the model.

B denotes the variable estimate.

$SE B$ denotes the standard error of the variable estimate.

β denotes the standardized estimate.

p denotes the p value.

Predictors of Parents' Beliefs About Mathematics Exposure At Home and At School

Multiple linear regressions were used to examine factors that might influence parents' beliefs about children's exposure to math.

Table 29: Predictors of Parents' Beliefs About Math Exposure At Home and At School

Program Year	Independent Variables**	R ²	B	SE B	β	p
2015-2016	Parents' beliefs about math accessibility before intervention		0.424	0.214	0.225	0.051
	Teacher confidence in math instruction		0.101	0.331	0.041	0.762
	Teacher use of project resources		0.013	0.014	0.125	0.350
	Parent use of project resources		0.052	0.026	0.225	0.053
	Model predicting parents' beliefs about math accessibility after intervention	0.154				.016*

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

** R^2 denotes the proportion of variance explained by the model.

B denotes the variable estimate.

$SE B$ denotes the standard error of the variable estimate.

β denotes the standardized estimate.

p denotes the p value.

These analyses did not reveal an adequate model for predicting parents' beliefs about math exposure at the end of Program Year 1 (2014-2015). In Program Year 2 (2015-2016), analyses found that after controlling for parents' prior beliefs, teachers' confidence, combined with teachers' and parents' use of project resources, helped predict parents' beliefs about math exposure overall (see Table 29).

Parents' Development of Strategies to Support Their Children's Exploration of Math

Overall, parents felt that their experiences in the Peg + Cat ELM2 program had prepared them to support their children's mathematics learning and engagement: *"It gave...things to do here with her, you know, that I didn't think of on my own. So it was really different, but really good though – support system, you know, making it easier for me to progress here at home with her."*

Parents felt that their experiences with Peg + Cat ELM2 helped them support their children's math interest and engagement.

During end-of-year interviews, several parents shared that the project had helped them figure out their children's current level of math knowledge and skills: *"I think it kind of made me more aware of what she knows and what she doesn't know and it just kind of gave me a starting point to work on some different things."*

Parents also indicated that they encouraged their children to keep trying when faced with a difficult problem:

"Just keep trying. I said don't ever give up. I said persist or I don't ever want to hear you say – 'I'll save it till tomorrow.' You'll get the answer eventually. Just take a breather, go get something to drink, calm down, come back." - Head Start Parent

"[My role] was just to encourage her to want to do more, not to give up." - Head Start Parent

Impacts of Peg + Cat Transmedia Resources on Parents

During post-surveys at the end of each program year, parents were asked how the various Peg + Cat transmedia resources had impacted their own interest in math (see Table 30). In Program Year 1, the highest percentage of parents indicated that going on the Peg + Cat website had made them more interested in mathematics. In Program Year 2, the highest percentage of parents indicated that playing with Peg + Cat apps on a tablet or mobile device had made them more interested in mathematics.

During post-surveys at the end of each program year, parents were also asked how the various Peg + Cat transmedia resources had helped them find ways to talk with their children about math (see Table 31). In both program years, the highest percentage of parents indicated that watching Peg + Cat on television helped them find ways to talk about math with their children.

Table 30: Transmedia Resources That Impacted Parents' Own Interest in Math

Transmedia Resource	Program Year	Percentage of Respondents Who Agreed	Total Number of Respondents
Watch Peg + Cat on television	2014-2015	25%	61
	2015-2016	15%	52
Go on the Peg + Cat website	2014-2015	39%	51
	2015-2016	15%	41
Play Peg + Cat online games on a computer	2014-2015	30%	50
	2015-2016	8%	37
Play with Peg + Cat apps on a tablet or mobile device	2014-2015	32%	41
	2015-2016	19%	32
Listen to Peg + Cat songs	2014-2015	34%	35
	2015-2016	7%	35
Looking at the Peg + Cat Trading Cards	2014-2015	21%	57
	2015-2016	N/A	N/A
Doing a Peg + Cat Activity Sheet	2014-2015	21%	57
	2015-2016	N/A	N/A
Playing with an item from the Peg + Cat + Us Lending Box	2014-2015	20%	77
	2015-2016	12%	95
Doing a Peg + Cat + Us Family Engagement Activity	2014-2015	15%	116
	2015-2016	12%	52
Playing with Peg + Cat Shape Cards	2014-2015	N/A	N/A
	2015-2016	10%	50
Using the Peg + Cat Placemat	2014-2015	N/A	N/A
	2015-2016	7%	41
Using the Peg + Cat Measuring Tape	2014-2015	N/A	N/A
	2015-2016	10%	41
Using the Peg + Cat Out-on-a-Limb DVD	2014-2015	N/A	N/A
	2015-2016	15%	46

Table 31: Transmedia Resources That Helped Parents Talk About Math With Children

Transmedia Resource	Program Year	Percentage of Respondents Who Agreed	Total Number of Respondents
Watch Peg + Cat on television	2014-2015	55%	69
	2015-2016	46%	52
Go on the Peg + Cat website	2014-2015	47%	47
	2015-2016	44%	41
Play Peg + Cat online games on a computer	2014-2015	44%	57
	2015-2016	32%	37
Play with Peg + Cat apps on a tablet or mobile device	2014-2015	51%	41
	2015-2016	44%	32
Listen to Peg + Cat songs	2014-2015	41%	51
	2015-2016	37%	35
Looking at the Peg + Cat Trading Cards	2014-2015	43%	60
	2015-2016	N/A	N/A
Doing a Peg + Cat Activity Sheet	2014-2015	42%	81
	2015-2016	N/A	N/A
Playing with an item from the Peg + Cat + Us Lending Box	2014-2015	35%	78
	2015-2016	35%	52
Doing a Peg + Cat + Us Family Engagement Activity	2014-2015	34%	115
	2015-2016	26%	95
Playing with Peg + Cat Shape Cards	2014-2015	N/A	N/A
	2015-2016	36%	50
Using the Peg + Cat Placemat	2014-2015	N/A	N/A
	2015-2016	27%	41
Using the Peg + Cat Measuring Tape	2014-2015	N/A	N/A
	2015-2016	29%	41
Using the Peg + Cat Out-on-a-Limb DVD	2014-2015	N/A	N/A
	2015-2016	33%	46

Impacts of Peg + Cat Episodes & Video Clips on Parents

During end of year interviews, parents indicated that the show provided them with a way to approach math with their children in a fun way:

"I think a lot of parents, we have good intentions. But how do you approach a child? And the Peg and Cat series to me kind of breaks that off, so you can have that with them. It's showing you how to do it, and to get your child's attention, enthusiasm into learning the math and the words." - Head Start Parent

Impacts of Peg + Cat Activity Sheets on Parents

During end of year interviews, one parent shared that the Activity Sheets provided a low-stress connection between what her child was doing at school and what they could do together at home:

"When it comes to me, I get instantly frustrated with anything math-related, so having it in a nice, relaxing setting was different...It helped 1,000 times just in being able to take like an educational thing that crossed over from school into the home and it really helped us know what to do to support him to make his education a little bit better." - Head Start Parent

Impacts of the Peg + Cat Lending Box on Parents

During end-of-year interviews, parents indicated that by using the Lending Box resources with their children, they had learned that math can be fun and new ways to use math:

"Just different ways to implement math and kind of make it fun for kids...I kind of just learned other ways to teach math to him and sometimes he wouldn't even realize he was learning."
- Head Start Parent

"That was actually a way we could - I could do stuff with her and have her learn at the same time because it was games, you know?" - Head Start Parent

Teachers felt that the Lending Box provided an activity for parents and children to do together, and that it was a resource for them to practice math skills together at home:

"When you give them something to do together it's crucial in their learning math, where they're engaging in that process." - Head Start Teacher

"It continues at home, and I think that's huge for them to have something that they can take from school, take it home and do that, and still be successful because they already have done it and they've been successful in the classroom with it, and then taking it home and maybe showing a brother or a sister what they've learned and making them excited about it at home."
- Head Start Teacher

“She rolled the dice and that’s how many toys she had to pick up to clean her room,’ and I said, ‘Well, that’s fine. She’s still using math and that’s exactly what we want you to do is just use math in the home in however it works for you.’ So our families are just taking things home and using them in their own way in their own daily routines and I think that’s pretty cool.”

- Head Start Teacher

Impacts of Math-Related Family Engagement Activities on Parents

During end-of-year interviews, parents indicated that by participating in math-related FEAs together with their children, they had learned about their children’s interest in and understanding of math: *“It gave me time to spend time with my daughter and she got to explain to me what all she was doing, how she was learning how to do things.”* Parents also used FEAs as opportunities to support their children’s math exploration, and encourage them to be persistent problem-solvers: *“I just want her to know that it’s fun to learn math and even when she’s struggling, that she can keep trying, that it’s okay that she doesn’t know everything right now.”* Parents were pleased to discover via FEAs that they were already doing math at home, and that math could be incorporated into everyday activities: *“I really liked the sorting, for example, because he normally would help me with the laundry and stuff, but we’d never really look at it and think math. So I thought that was good, that that was helpful because we start to do that now. Or just like with the setting, getting the table ready, like he would help put out the plates and he will count them.”*

Impacts of Peg + Cat Shape Cards on Parents

During end-of-year interviews, parents indicated that the Shape Cards helped them have fun with math, find out what their children already knew about shapes, and to focus on different shape attributes with their children: *“To be enthusiastic with her when she was recognizing the rooftop is this shape, wheels are this shape, and the back of the window is this shape.”* One parent shared that the Shape Cards *“just made it fun and interesting for both of us. It was something that we could do together.”* Another mother thought, *“I definitely think they helped. They helped with his age counting and recognizing things, and we get you out in the community and say, ‘Oh, that’s a square. That’s an octagon.’”*

Impacts of Peg + Cat Placemats on Parents

During end-of-year interviews, parents indicated that the Placemat helped make math fun, was a visual reminder for their children, and provided parents with a way to incorporate math into mealtimes. Parents felt that their role with their children, while using the Placemat was to ask questions: *“Just like use it as a little tool to go over things.”*

In sum, Peg + Cat ELM2 parent resources helped predict parent interest, engagement, and confidence in mathematics. In some cases the project resources also helped predict parents’ beliefs about math exposure, but not their beliefs about the importance of math. Specific

resources that fostered parents' math interest were the Peg + Cat website, online games and apps. Parents also felt that the Peg + Cat television series had given them ways to talk with their children about mathematics. Taken together, these findings indicate that Peg + Cat ELM2 resources successfully impacted parents.

EQ3b: How did parents use project resources and strategies?

Parents' Use of Family Engagement Activities

According to the Family Engagement Activity Sign-in Sheets that teachers collected, a total of 1780 parents attended 221 FEAs across 46 classrooms in Program Year 1, and a total of 2733 parents attended 351 FEAs across 48 classrooms in Program Year 2. On average, 8.31 parents attended each FEA in Program Year 1, and 7.8 parents attended each FEA in Program Year 2. During end-of-year interviews, parents cited work schedules as the main reason that they might not attend an FEA.

Parents felt that their role with their children during FEAs was either to read instructions, provide encouragement, to generally help their children, or to ask questions:

"We would just talk about why things were sorted, how they were sorted, or I would ask for like, 'What comes next in these patterns?' or 'How do we know that there's this many or that many?'" - Head Start Parent

Teachers observed that parents engaged with their children during the FEAs:

"I felt that the kids knew what to do, but I also heard a lot more with the parents saying, 'Well, how many is that?,' and 'Can you count them?' So it was nice to see the parent actually engaging with them and saying how many or how many bugs you have or how many patterns you see." - Head Start Teacher

In addition, teachers saw parents sharing ideas with one another during FEAs, particularly about their children's abilities or connections to everyday experiences: *"I could see parents going, 'I didn't know they could do this!' or 'We can do this at home,' you know, spitballing ideas back-and-forth."* Here, one teacher shares how the Bedtime Routines FEA generated rich conversations between parents and children regarding the order of various activities that they did at home:

"Well, I actually was able to hear some of the families ask the students, themselves, 'So what do you do first and what do you do second? And what comes next?' And 'I see that you put brushing your teeth before snack,' and kind of getting them to think about the habits that they've created at home and I have heard one of the little girls that said, 'Well, we don't have snacks before we go to bed,' and her mom said, 'Well, that's a good idea, should we add that to our routine?' And another family used to not read books, so they have decided that would be part of their routine. So it was nice to have them engaged in the conversation and kind of give

and take as to what they've already established and creating a new routine, based on the information that they were given." - Head Start Teacher

Teachers also observed that some families were letting their children take the lead and encouraging them to figure things out on their own during FEAs, which was an idea that the PD facilitators emphasized: *"I saw one Grandma helping her daughter count to 5, and before the Grandma just told her the answer. But I saw the Grandma this time just kept asking her, 'Let's try again. You can do this. Let's count. What comes after 3?'"*

In addition, teachers noted that parents used questioning strategies to elicit their children's thinking that the teachers themselves had modeled: *"I was asking them, well, when she was to take three fish, 'Oh! You have two. How many more do you need?' [Child's] mom starting doing that when they rolled five. 'Oh, you took three. Now how many more do you need?' and she'd hold up two fingers."*

Figure 22: Photographs from Playdough Shapes FEA in Program Year 2



Parents' Use of the Lending Box

On their post-surveys in the first program year (2014-2015), parents (75%, n=135) reported that their children used this resource. Of those, 61% reported that they used the Lending Box items with their children. On their post-surveys in the second program year (2015-2016), parents (74%, n=107) reported that their children used the Lending Box. Of those, 49% reported that they used the Lending Box items with their children. This slight reduction in

use was likely due to the fact that families received individualized tote bags full of items for their families to use in the second program year, and the Lending Box, a classroom-wide resource, had already been available for one year.

Families' Lending Box use was also tracked via forms that they filled out to check out Lending Box items from their children's classrooms for use at home (see Table 32). In Program Year 1, 841 families in 38 classrooms checked out an item from the Lending Box. In Program Year 2, 892 families in 41 classrooms checked out an item from the Lending Box. In Program Year 1 (2014-2015), the Calculator was the most frequently checked out item, with the Dice & Action Game being the second most used item. In Program Year 2 (2015-2016), the Dice & Action Game was the most frequently checked out item. The Dominoes and Calculator were also checked out quite a bit in Program Year 2.

Table 32: Families' Use of the Lending Box Items

Lending Box Item	Program Year	Number of Reported Checkouts
Timer	2014-2015	84
	2015-2016	61
Dominoes	2014-2015	70
	2015-2016	90
Measuring Tape	2014-2015	N/A
	2015-2016	61
Calculator	2014-2015	194
	2015-2016	81
Peg + Cat Music CD	2014-2015	79
	2015-2016	24
Peg + Cat Chickens DVD	2014-2015	64
	2015-2016	59
Peg Rocks! DVD	2014-2015	N/A
	2015-2016	71
Peg Pirates DVD	2014-2015	N/A
	2015-2016	55
Peg+ Cat Out on a Limb DVD	2014-2015	N/A

Lending Box Item	Program Year	Number of Reported Checkouts
	2015-2016	31
Trading Cards	2014-2015	N/A
	2015-2016	29
Shape Cards	2014-2015	N/A
	2015-2016	29
Jumbo Playing Cards	2014-2015	98
	2015-2016	59
Dice & Action Game	2014-2015	131
	2015-2016	184
Anno's Counting Book	2014-2015	70
	2015-2016	17
Five Creatures Book	2014-2015	38
	2015-2016	36

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

The following examples reveal how parents used the most popular Lending Box items with their children:

Dice & Action Game

"We had a mom come back. She took the dice game home and she used it with her daughter to clean her room every night...I mean she adapted it to her environment. They'd roll the dice and that's how many toys she had to pick up and maybe something else and then they'd go back and roll the dice."

- Head Start Teacher

Calculator

"Well, for example with the calculator, she went, 'What is this?' I said, 'You can add with that,' and I explained to her what the calculator was, showed her the different things she could do with the calculator. Then she took the calculator, and she has a cash register and coin in it, too. She took the calculator with her cash register and her little play food and tried to figure out on the calculator by adding with making up her own figures, but trying to use the calculator by figuring out how much the food was. So I'm trying to teach her money, too, and how much money she's going to need before she gets to the register. That was good for her." - Head Start Parent

Parents felt that their role with their children while using Lending Box items was to do the activity together and encourage their children: *“I think I was there to help him and support him, and play along if he wanted me to.”* Parents tended to talk with their children about how to do the activity or the math content within the activity.

When the Peg + Cat ELM2 project resources were used at home, many parents reported using them with their children.

Parents’ Use of Other Peg + Cat ELM2 Transmedia Resources

On their pre-post surveys, parents were asked whether they used Peg + Cat ELM2 project-related transmedia resources together with their children at home. At the end of each program year, a significantly higher percentage of parents reported that they had engaged with their child around one of the Peg + Cat transmedia resources that had already been available to them at the beginning of the program year (see Table 33).

Table 33: Changes in Parents’ Use of Peg + Cat ELM2 Transmedia Resources With Their Children

Transmedia Resource	Program Year	Pre	Post	Significance Level	Number of Respondents
Watch Peg + Cat on television	2014-2015	27%	47%	.000*	135
	2015-2016	28%	49%	.000*	107
Go on the Peg + Cat website	2014-2015	11%	33%	.000*	135
	2015-2016	12%	38%	.000*	107
Play Peg + Cat online games on a computer	2014-2015	9%	37%	.000*	135
	2015-2016	9%	35%	.000*	107
Play with Peg + Cat apps on a tablet or mobile device	2014-2015	7%	27%	.000*	135
	2015-2016	16%	30%	.005*	107
Listen to Peg + Cat songs	2014-2015	N/A	30%	N/A	135
	2015-2016	12%	33%	.000*	107

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

Parents’ Use of Peg + Cat Activity Sheets

On their post-surveys in the first program year (2014-2015), parents (75%, $n=135$) reported that their children used this resource. Of those, 61% reported that they used the Activity Sheets with their children. During end-of-year interviews, parents shared that they tended to use the Activity Sheets to talk about math with their children: *“He just likes them because he can identify the numbers to count...He’s like, ‘There’s only three chicks on the paper and there’s two over*

here, and if I count them together I have five.'" However, some families thought that the Activity Sheets did not have a lot of substance:

"Some of them like it didn't really seem like there was anything to do. Like it would say like, 'Count,' but there wasn't like any kind of coordinating write or draw activity or color. It was more like what to talk about it, and I kind of prefer like some activity where I can kind of verify that she knows whatever the task or skill is. So sometimes when it was like just counting flowers, okay, we could do that. We were done in 20 seconds, and then I was kind of making up something and go along with it. So that was just kind of – that kind of made it a little bit more difficult and less helpful." - Head Start Parent

Partly due to reactions such as the one above, the Activity Sheets were not continued as part of the PD in Program Year 2.

Parents' Use of Peg + Cat Trading Cards

On their post-surveys in the first program year (2014-2015), parents (66%, n=135) reported that their children used this resource. Of those, 43% reported that they used the Trading Cards with their children. Parents reported that they or their children tended to lose the Trading Cards, or put them somewhere and forgot about them. Those who did utilize the Trading Cards, tended to use them as reminders of a specific math concept: *"I'm saving them because, you know, activities come up, and she could have these as a reference to look back and just keep her – you know, to refresh her memory about what she learned...for kindergarten."*

In Program Year 2, the Trading Cards were available on a large binder ring in the Lending Box, but were not handed out separately for parents to take home.

Parents' Use of the Peg + Cat Shape Cards

The Shape Cards were first available to parents in Program Year 2. On their post-surveys at the end of the second program year (2015-2016), parents (78%, n=107) reported that their children used this resource. Of those, 47% reported that they used the Shape Cards with their children. During interviews, parents indicated that they tended to use the Shape Cards together with their children, but that their child also used them alone or with other people. Parents tended to make up various games with the cards, and talked about shape names, shape attributes, and finding shapes in daily life while playing with the Shape Cards: *"We do like, matching games or Go Fish, or we sort them by shapes, or colors, and it's just like a little fun thing to do, and learn, and practice."*

Parents' Use of the Peg + Cat Placemats

The Placemats were first available to parents in Program Year 2. On their post-surveys in the second program year (2015-2016), parents (73%, n=107) reported that their children used this resource. Of those, 38% reported that they used the Placemats with their children. Parents

shared that they often asked their children questions about the Placemat: *“I’ll just point to a number and ask her what it was, and then I’d have her count like, how many it was, just so she could like, recognize like, this is – these are six, and this is what the number six looks like.”* Parents tended to talk about number recognition with their children when referencing the Placemat:

“They loved that. They were able to use them, like some would just use them every night at dinner and would say, ‘Okay, well how many carrots do you have on your plate?’ or, ‘How many pieces of chicken nugget?’ or something like that, and they would correspond the number with the amount of food that they would have on their plate. So a lot of our families really enjoyed getting those.” - Head Start Teacher

“Some of the families have shared that some of the kids use them to eat as their placemat, or they use it as math time and work on writing their numbers and counting.”
- Head Start Teacher

Parents’ Use of the Peg + Cat Measuring Tape

The Measuring Tape was first available to parents in Program Year 2. On their post-surveys in the second program year (2015-2016), parents (71%, n=107) reported that their children used this resource. Of those, 38% reported that they used the Measuring Tape with their children. During interviews, parents reported that their children enthusiastically measured everything. Parents shared that they just wanted their children to play with and experience the Measuring Tape as a resource: *“I just think it’s just a great learning tool. So whenever I get something to figure out how wide something is, she gets her little tape and she’s right there understanding what she’s supposed to do with it.”* Parents used the Measuring Tape to discuss how long or short items were with their children, or for practice with number recognition.

During end-of-year interviews, teachers also reported back on parents’ use of the Measuring Tape. One teacher shared about a father in her classroom, who was in construction: *“He said he was proud to see them do that. They had their own little Measuring Tape like Dad.”* Another teacher stated that the children in her class were interested in height (i.e. how tall they were, how tall their parents were, and who was the tallest), while her colleague shared that one child measured how big around his head was.

Parents’ Use of the Out-on-a-Limb DVD & Family Activity Guide

The DVD & Family Activity Guide were first available to parents in Program Year 2. On their post-surveys in the second program year (2015-2016), parents (73%, n=107) reported that their children used this resource. Of those, 43% reported that they watched the DVD with their children. During interviews, parents reported that their children tended to watch the DVD alone or with other people. Parents appeared to be unaware of the Family Activity Guide accompanying the DVD. When parents talked to their children about the DVD, they

tended to discuss what situations had occurred in the storyline, and what Peg and Cat did to resolve those problems.

In sum, families utilized the Peg + Cat media resources that were available to them throughout both program years more frequently at the end of each year, compared to the beginning. A large percentage of parents also used the various take-home transmedia resources that were provided by teachers, and actively participated in Family Engagement Activities.

EQ4: Do teachers' participation in, and outcomes from, the project's professional development and children's involvement with program resources and activities impact children's interest in and positive and persistent attitudes towards mathematics?

Predictors of Children's Interest in Mathematics

Analyses showed that parents' use of project resources in Program Year 1 predicted their children's parent-reported interest in math.

Multiple linear regressions were used to explore the factors that might predict children's interest in mathematics at the end of each program year. Factors that went into the model included parent's reports of their children's prior interest in mathematics at the beginning of the program year, teachers' confidence in mathematics pedagogy, teachers' use of project resources, and parents' use of project resources. Since different resources were available for parent and teacher use, each program year was examined separately. Statistical analyses revealed that all of the factors above helped predict children's interest in math overall (see Table 34).

In Program Year 1 (2014-2015), parents' use of project resources made a unique contribution to the variance in their children's interest in math at the end of the program year, after controlling for their children's prior interest. There were no unique contributors in Program Year 2.

Analyses showed that parents' use of project resources in Program Year 2 predicted their children's parent-reported persistence in math.

Table 34: Predictors of Children’s Math Interest

Program Year	Independent variables**	R ²	B	SE B	β	p
2014-2015	Children’s interest in math before intervention		0.273	0.084	0.270	.002*
	Teacher confidence in math instruction		0.009	0.012	0.057	0.491
	Teacher use of project resources		-0.006	0.011	-0.046	0.580
	Parent use of project resources		0.061	0.017	0.305	.000*
	Model predicting children’s interest in math after intervention	0.176				.000*
2015-2016	Children’s interest in math before intervention		0.579	0.107	0.565	.000*
	Teacher confidence in math instruction		0.020	0.225	0.011	0.930
	Teacher use of project resources		-0.009	0.009	-0.111	0.360
	Parent use of project resources		0.017	0.018	0.093	0.364
	Model predicting children’s interest in math after intervention	0.335				.000*

* Indicates a significant difference at the $p < .05$ level.
 **R² denotes the proportion of variance explained by the model.
 B denotes the variable estimate.
 SE B denotes the standard error of the variable estimate.
 β denotes the standardized estimate.
 p denotes the p value.

Predictors of Children’s Positive & Persistent Attitudes Towards Mathematics

Multiple linear regressions were used to explore the factors that might predict children’s persistence in mathematics at the end of each program year. Factors that went into the model included parent’s reports of their children’s prior level of persistence in mathematics at the beginning of the program year, teachers’ confidence in mathematics pedagogy, teachers’ use of project resources, and parents’ use of project resources. Since different resources were available for parent and teacher use, each program year was examined separately.

Statistical analyses revealed that all of the above factors helped predict children’s persistence in math overall (see Table 35). In Program Year 2 (2015-2016), parents’ use of project resources made a unique contribution to the variance in their children’s persistence in math at the end of that year, after controlling for their children’s level of persistence in math at the beginning of the year. There were no unique contributors to children’s persistence in math in Program Year 1 (2014-2015).

Table 35: Predictors of Children’s Persistence in Mathematics

Program Year	Independent variables**	R ²	B	SE B	β	p
2014-2015	Children’s persistence in math before intervention		0.394	0.084	0.398	.000*
	Teacher confidence in math instruction		0.024	0.034	0.059	0.480
	Teacher use of project resources		-0.059	0.030	-0.163	0.052
	Parent use of project resources		0.028	0.046	0.050	0.551
	Model predicting children’s persistence in math after intervention	0.188				.000*
2015-2016	Children’s persistence in math before intervention		0.676	0.151	0.454	.000*
	Teacher confidence in math instruction		0.026	0.326	0.009	0.937
	Teacher use of project resources		0.002	0.013	0.019	0.870
	Parent use of project resources		0.068	0.026	0.265	.010*
	Model predicting children’s persistence in math after intervention	0.342				.000*

* Indicates a significant difference at the p<.05 level.
 **R² denotes the proportion of variance explained by the model.
 B denotes the variable estimate.
 SE B denotes the standard error of the variable estimate.
 β denotes the standardized estimate.
 p denotes the p value.

Parents reported that their children used technology to explore math significantly more often by the end of each program year, compared to the beginning of each program year.

Impacts of Peg + Cat Transmedia Resources on Children

In general, parents reported that their children utilized technology to explore mathematics significantly more often at the end of both program years, compared to the beginning of each year (see Table 36).

Specifically, in the first program year (2014-2015), a significantly higher percentage of parents reported that their children used television, Internet, and tablet computers to explore mathematics by the end of the program year. In the second program year (2015-2016), a significantly higher percentage of parents reported that their children used computers, Internet, and tablet computers to explore mathematics by the end of the program year. This shift provides initial evidence that the Peg + Cat ELM2 project had an impact on families’ use of transmedia resources to explore math.

Table 36: Changes in Children’s Technology Use for Exploring Mathematics, As Reported By Parents

Media	Program Year	Pre	Post	Significance Level	Number of Respondents
Television	2014-2015	62%	73%	.030*	135
	2015-2016	67%	71%	0.508	107
DVD or VHS Player	2014-2015	27%	25%	0.614	135
	2015-2016	27%	31%	0.580	107
Computer or Laptop	2014-2015	39%	42%	0.581	135
	2015-2016	28%	42%	.011*	107
Internet	2014-2015	30%	42%	.009*	135
	2015-2016	31%	50%	.001*	107
Smartphone	2014-2015	44%	53%	0.074	135
	2015-2016	64%	57%	0.145	107
Tablet Computer or iPad	2014-2015	52%	67%	.001*	135
	2015-2016	62%	73%	.033*	107
Music Player	2014-2015	13%	14%	0.696	135
	2015-2016	12%	16%	0.287	107
None	2014-2015	7%	2%	.004*	135
	2015-2016	5%	2%	0.259	107

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

Parents also thought that the Peg + Cat transmedia resources positively impacted their children. During post-surveys at the end of each program year, parents were asked how the various Peg + Cat transmedia resources had impacted their children’s interest in math (see Table 37) and understanding of math (see Table 38).

In Program Year 1, the highest percentage of parents indicated that watching Peg + Cat on television and doing a Peg + Cat FEA had made their children more interested in mathematics. In Program Year 2, the highest percentage of parents indicated that using the Lending Box had made their children more interested in mathematics. In Program Year 1, the highest percentage of parents indicated that Watching Peg + Cat on television had helped their children better understand math. In Program 2, the highest percentage of parents indicated that using Peg + Cat apps helped their children better understand math.

Table 37: Transmedia Resources That Impacted Children’s Interest in Math, As Reported By Parents

Transmedia Resource	Program Year	Percentage of Respondents Who Agreed	Total Number of Respondents
Watch Peg + Cat on television	2014-2015	51%	106
	2015-2016	52%	86
Go on the Peg + Cat website	2014-2015	41%	80
	2015-2016	42%	57
Play Peg + Cat online games on a computer	2014-2015	38%	82
	2015-2016	48%	50
Play with Peg + Cat apps on a tablet or mobile device	2014-2015	42%	83
	2015-2016	44%	61
Listen to Peg + Cat songs	2014-2015	32%	92
	2015-2016	53%	68
Looking at the Peg + Cat Trading Cards	2014-2015	42%	97
	2015-2016	N/A	N/A
Doing a Peg + Cat Activity Sheet	2014-2015	44%	108
	2015-2016	N/A	N/A
Playing with an item from the Peg + Cat + Us Lending Box	2014-2015	51%	112
	2015-2016	62%	65
Doing a Peg + Cat + Us Family Engagement Activity	2014-2015	46%	120
	2015-2016	45%	95
Using the Peg + Cat Measuring Tape	2014-2015	N/A	N/A
	2015-2016	49%	67
Using the Peg + Cat Placemat	2014-2015	N/A	N/A
	2015-2016	56%	66
Using the Peg + Cat Shape Cards	2014-2015	N/A	N/A
	2015-2016	60%	75
Using the Peg + Cat Out-on-a-Limb DVD & Family Activity Guide	2014-2015	N/A	N/A
	2015-2016	46%	67

Table 38: Transmedia Resources That Impacted Children’s Understanding of Math, As Reported By Parents

Transmedia Resource	Program Year	Percentage of Respondents Who Agreed	Total Number of Respondents
Watch Peg + Cat on television	2014-2015	45%	107
	2015-2016	42%	86
Go on the Peg + Cat website	2014-2015	40%	82
	2015-2016	42%	57
Play Peg + Cat online games on a computer	2014-2015	37%	79
	2015-2016	48%	50
Play with Peg + Cat apps on a tablet or mobile device	2014-2015	38%	81
	2015-2016	46%	61
Listen to Peg + Cat songs	2014-2015	37%	93
	2015-2016	44%	68
Looking at the Peg + Cat Trading Cards	2014-2015	41%	101
	2015-2016	N/A	N/A
Doing a Peg + Cat Activity Sheet	2014-2015	43%	109
	2015-2016	N/A	N/A
Playing with an item from the Peg + Cat + Us Lending Box	2014-2015	40%	110
	2015-2016	46%	65
Doing a Peg + Cat + Us Family Engagement Activity	2014-2015	41%	119
	2015-2016	45%	95
Using the Peg + Cat Measuring Tape	2014-2015	N/A	N/A
	2015-2016	42%	67
Using the Peg + Cat Placemat	2014-2015	N/A	N/A
	2015-2016	46%	66
Using the Peg + Cat Shape Cards	2014-2015	N/A	N/A
	2015-2016	37%	75
Using the Peg + Cat Out-on-a-Limb DVD & Family Activity Guide	2014-2015	N/A	N/A
	2015-2016	36%	67

During end-of-year interviews, parents shared that the Peg + Cat transmedia resources grabbed their children's attention and motivated their children to do math activities at home. For parents whose children watched the show, the media was enjoyable, helped make math easy to understand, and highlighted problem solving. During interviews, a few parents described how the episodes from the show supported their children's understanding of math:

"I just feel like its age appropriate, so it's like they understand but they also make kids talk back to the TV. 'Oh, I'm four, how neat.' Because that is what my son will say, so watching the video or watching the TV is like answering the questions, and he's trying to figure out the answers too. So that's how it supports him - it makes him think, it keeps their attention and it gives different ways to practice learning." - Head Start Parent

For parents whose children listened to the music, the songs were fun and engaging, and helped make math easy to understand and remember: *"Because it's catchy little tune. Something she can learn quickly. It's like a song that stays in your head. Not too complicated for her, you know?"*

For parents whose children played the online games and apps, these resources provided exposure to math concepts at a young age. Here, one parent explains how she felt that the games supported her child: *"It's something that like, you see. It's like actually brought to life, but that you can also – It's hands-on and is really like, engaging, and it's fun."* Another parent shared how the games supported her daughter's persistence in mathematics: *"They're colorful. I guess you could say they're a little more interactive. They don't make it like she lost. You know what I mean? 'Try again. You're almost there. Almost got it!' So it's not negative like how some games may, 'Wah-wah,' when you lose or whatever. It doesn't frustrate her...It does the opposite."*

Overall, parents felt like the Peg + Cat transmedia resources helped their children understand the importance of math: *"I feel like it's a very good program for the children and helps them get an understanding of why they have to use math and why it's important and why they're gonna need it in everyday life."*

In both program years, teachers were asked on post-surveys to rate the effectiveness of Peg + Cat transmedia resources on children's exploration of mathematics. (see Table 39). All resources were deemed by teachers to be at least somewhat effective. In both program years, teachers rated the online games and apps as most effective in supporting children's exploration of mathematics.

During an interview, one teacher shared how children's recollections of Peg + Cat songs increased children's self-efficacy during FEAs: *"Yesterday, I saw the children were actually bringing up instances about 'The Dinosaur Problem' and about 'The Beethoven Problem' and highlighting those and going back and using the thinking and the knowledge that they've already known, and kind of leading the parents and it was more child-led than it was parent-led."* Another

teacher indicated that the calm down strategy highlighted in the Peg + Cat television series was a useful tool for children in her classroom: *“The 5, 4, 3, 2, 1 - that really helped actually when Cat gets frustrated. Children are finding, just with their social/emotional aspect... Sometimes I find kids doing that on their own, or I will say it, and it really helps.”* In general, teachers seemed to like the show’s messaging: *“It’s engaging. It’s colorful. It has a lot of humor. If I had had that as a child, it encourages you to get in the math mindset, and helps you grow and not stay so fixed in how you think. That’s what I think kids would enjoy.”*

Table 39: Teachers’ Perceptions of the Effectiveness of Peg + Cat ELM2 Transmedia Resources On Children’s Exploration of Math

Transmedia Resource	Program Year	Mean*	Number of Respondents
Peg + Cat video clips or episodes	2014-2015	3.49	37
	2015-2016	3.19	42
Peg + Cat online games or apps	2014-2015	3.61	31
	2015-2016	3.28	39
Peg + Cat songs	2014-2015	3.53	32
	2015-2016	3.08	36
Peg + Cat Lending Box materials	2014-2015	3.13	40
	2015-2016	2.60	40
Activity Sheets	2014-2015	2.93	40
	2015-2016	N/A	N/A
Trading Cards	2014-2015	2.75	36
	2015-2016	N/A	N/A
Shape Cards	2014-2015	N/A	N/A
	2015-2016	3.20	25
Measuring Tape	2014-2015	N/A	N/A
	2015-2016	3.03	28
Placemats	2014-2015	N/A	N/A
	2015-2016	2.65	32
Out on a Limb DVD & Family Activity Guide	2014-2015	N/A	N/A
	2015-2016	3.00	7

* On a scale from 1-4, with 1 being “Not At All Effective,” and 4 being “Very Effective.”

Here, one teacher summarizes the impact of the Peg + Cat resources on children’s conversations and positive attitudes towards math in her classroom:

“We certainly used the Peg + Cat weekly. We would definitely watch an episode of it or read one of the books, and then we would stem from there. So we would have conversations on either counting or big or small or tall words, just whatever we were working on that week. The kids totally piqued their interest because it was something they could do at home also. So I think whenever we had that bridge there, that would certainly pique their interest and just hold conversations, whereas before, it was definitely, ‘What did you do at school today?’ and no answer. ‘We played.’ So they were able to take it home and further the lessons there, too.”

- Head Start Teacher

Impacts of Professional Development Resources on Children

In both program years, teachers were asked on post-surveys to rate the effectiveness of resources covered in the PD on children’s exploration of mathematics (see Table 40). Teachers deemed all resources covered in the PD to be at least somewhat effective. In Program Year 1, teachers rated graphing activities as most effective in supporting children’s exploration of mathematics, while they rated child interviewing techniques as most effective in Program Year 2.

Table 40: Teachers’ Perceptions of the Effectiveness of Peg + Cat ELM2 Professional Development Resources On Children’s Exploration of Math

Professional Development Resource	Program Year	Mean*	Number of Respondents
Graphing Activity	2014-2015	3.42	38
	2015-2016	3.30	36
Linear/Number Line Calendar	2014-2015	3.26	31
	2015-2016	3.35	17
Books from Program Year 1	2014-2015	3.23	44
	2015-2016	3.18	44
Quick Images Activity	2014-2015	3.20	30
	2015-2016	3.21	19
Attendance Chart 10-Frame	2014-2015	3.16	19
	2015-2016	3.31	22
Difference Train Activity	2014-2015	3.07	14
	2015-2016	3.13	9

Professional Development Resource	Program Year	Mean*	Number of Respondents
Count Your Chickens 10-Frame Activity	2014-2015	3.00	29
	2015-2016	2.89	27
Child Interviewing Techniques	2014-2015	2.96	24
	2015-2016	3.60	15
Games	2014-2015	2.95	22
	2015-2016	3.14	28
Think-Pair-Share	2014-2015	2.93	14
	2015-2016	3.13	8
Rekenrek	2014-2015	2.55	20
	2015-2016	3.00	13
Shape Scavenger Hunt	2014-2015	N/A	N/A
	2015-2016	3.28	40
Block Play/Block Towers	2014-2015	N/A	N/A
	2015-2016	3.33	40
Magna-Tiles	2014-2015	N/A	N/A
	2015-2016	3.39	38
Positional Words	2014-2015	N/A	N/A
	2015-2016	3.39	38
Pattern Blocks or Tangrams	2014-2015	N/A	N/A
	2015-2016	3.38	35
Mystery Bag Activity	2014-2015	N/A	N/A
	2015-2016	3.13	32
Books from Program Year 2	2014-2015	N/A	N/A
	2015-2016	3.27	30
Map Making Activity	2014-2015	N/A	N/A
	2015-2016	3.00	28
Geoboards/Geoblocks	2014-2015	N/A	N/A
	2015-2016	3.08	26

Professional Development Resource	Program Year	Mean*	Number of Respondents
"Which is Bigger?" Cup Activity	2014-2015	N/A	N/A
	2015-2016	3.14	22
Weight Activity with Pan Balance	2014-2015	N/A	N/A
	2015-2016	3.00	18
Cat Measuring Tool	2014-2015	N/A	N/A
	2015-2016	3.17	18

* On a scale from 1-4, with 1 being "Not At All Effective," and 4 being "Very Effective."

Conclusion

The Peg + Cat ELM2 project sought to combine media-integrated robust teacher training in both math content and facilitation of classroom and family engagement activities with transmedia resources that parents and children could utilize at home. This cohesive approach resulted in increases in teachers' confidence in and knowledge about their mathematics instruction, parents' engagement in activities and conversations with their children around math, and children's positive and persistent attitudes towards math, as reported by their parents. Taken together, these findings suggest that the Peg + Cat ELM2 project positively impacted on teachers, parents, and children.

But what features of the project contributed to teacher, parent, and child outcomes? Teacher outcomes were mediated by their use of resources and activities from the PD sessions, and their use of the project's various transmedia resources. However, the PD resources were unique contributors to changes in teachers' confidence in their mathematics instruction. Although teachers reported that the project's transmedia elements made them more interested in math, helped them find ways to talk with families about mathematics, and gave them ideas for activities to try in the classroom, these resources did not seem to uniquely impact their confidence.

Parent outcomes (except for their beliefs about math) and child outcomes were mediated by teacher confidence, teachers' use of project resources, and parents' use of transmedia resources. Parents' use of transmedia resources was sometimes a unique contributor to the frequency that parents talked about math or engaged in math-related activities with their children, parents' confidence in their own math abilities, and children's interest in and persistence towards mathematics. Thus, Peg + Cat ELM2 project resources, particularly those that involved transmedia, led to positive outcomes for parents and children.

Finally, the Peg + Cat ELM2 project generated some lessons learned regarding the ways that transmedia can support mathematics exploration. Transmedia appears to work best when it is leveraged across multiple settings. For teachers, this meant encountering Peg + Cat video clips, songs, online games, apps, and hands-on activities during PD, and then incorporating these resources into their classroom and family engagement activities. For parents, transmedia was introduced during family engagement activities in their children's classroom and carried over to the home through the Lending Box and other Peg + Cat take-home resources. This resulted in children experiencing math through media in various contexts - within daily classroom routines, during scaffolded family engagement activities, and in everyday life at home. In this way, transmedia was a pervasive thread that gave teachers, parents, and children an approachable and fun way to experience math together.

Appendix A: Study Sample Sizes

Table 41: Sample Sizes Obtained Via Various Evaluation Methodologies

Evaluation Methodology	Sample Size
Classroom Observations	<ul style="list-style-type: none"> • 10 case study teachers were observed 1-3 times in Program Year 1 (n = 26 classroom observations total). • 7 case study teachers were observed 1-2 times in Program Year 2 (n=13 classroom observations total).
FEA Observations	<ul style="list-style-type: none"> • 10 case study teachers and 12 additional teachers were observed 1-2 times in Program Year 1 (n = 29 FEA observations total). • 7 case study teachers were observed 2-3 times in Program Year 2 (n=15 classroom observations total).
FEA Participant Sign in Sheets	<ul style="list-style-type: none"> • 221 sheets were submitted in Program Year 1, representing 45 classrooms. • 351 sheets were submitted in Program Year 2, representing 48 classrooms.
Teacher Pre-Post Surveys	<ul style="list-style-type: none"> • All participating Head Start teachers (n=55) completed both a pre and a post survey across the two years of the project.
Teacher Interviews	<ul style="list-style-type: none"> • 21 teachers were interviewed in Program Year 1. • 21 teachers were interviewed in Program Year 2.
Parent Pre-Post Surveys	<ul style="list-style-type: none"> • 135 parents completed both a pre and a post survey in Program Year 1. • 107 parents completed both a pre and a post survey in Program Year 2.
Parent Interviews	<ul style="list-style-type: none"> • 24 parents were interviewed in Program Year 1. • 11 parents were interviewed in Program Year 2.
Lending Box Checkout Forms	<ul style="list-style-type: none"> • 828 sheets were submitted in Program Year 1, representing 38 classrooms. • 892 sheets were submitted in Program Year 2, representing 41 classrooms.

Appendix B: Peg + Cat ELM2 PD Activities

Table 42: Description of Peg + Cat ELM2 PD Activities

Classroom Activity	Description
Books (Y1)	Facilitators showed teachers how to incorporate math into various books, including <i>10 Black Dots</i> , <i>One Duck Stuck</i> , and <i>Five Creatures</i> .
Graphing activity (Y1)	Teachers stacked chocolate bar wrappers on top of one another to indicate which one they liked most. The result was a bar chart.
Attendance chart 10-frame design (Y1)	An attendance chart in which the number of children in class were represented by rows of 5 or 10 pockets each, so that children could more easily visualize who was present or absent that day.
Quick Images activity (Y1)	Teachers were quickly shown cards with various configurations of dots, and were asked to identify the number of dots on each card.
“Count Your Chickens” 10-frame activity (Y1)	Teachers gathered paper chickens that were hidden around the room, and placed them into a 10-frame (2 rows of 5 blocks).
Child interviewing techniques (Y1)	Teachers practiced questioning strategies to elicit children’s thinking, and determine where children are at on the learning trajectory.
Games (Y1)	Facilitators introduced the teachers to several math-related games that they could use in their classroom, including <i>Bear Tracks</i> and <i>Rolling Film</i> .
Linear or number line calendar (Y1)	A calendar that was displayed as a sequential number line, instead of a traditional arrangement of dates.
Rekenrek (Y1)	A manipulative with two strings, and 5-10 beads on each string.
Think-Pair-Share (Y1)	Child does Turn and Talk with another child.
Difference Train activity (Y1)	Teachers had an object in their hands, then stood in line next to another person whose object differed by 1-2 attributes. The goal of the activity was for every teacher to be in line.
Shape scavenger hunt (Y2)	Finding shapes in the classroom, on classmates’ clothes, and in real life.
Block play/Block towers	General play using blocks or building towers.
Magna-Tiles	Composing and decomposing shapes using triangular or square tiles.
Positional words	A scavenger hunt using positional words.
Pattern blocks or Tangrams	Blocks children use to make various patterns or to match a diagram.
Mystery Bag activity	Children feel a shape hidden in a bag and guess what that shape is.

Classroom Activity	Description
Books (Y2)	Facilitators showed teachers how to incorporate math into various books, including <i>Rosie's Walk</i> and <i>The Perfect Square</i> .
Map making activity	Children make maps to learn about measurement or positional words.
Geoboards/geoblocks	Children stretch rubber bands around a peg board to make shapes, or build with hardwood blocks.
"Which is Bigger?" cup activity	Children fill containers of various sizes with water, and compare the amount of water within them.
Weight activity with pan balance	Children experiment with the weight of different objects using a pan balance.
Cat measuring tool	Children use a paper cutout of Cat as a non-standard form of measurement to figure out how many Cats tall something is.
Other	Other math-related activities that teachers recalled doing with children or in the PD that did not fall into one of the above categories.