PBS KIDS Mathematics Transmedia Suites in Preschool Homes

A Report to the CPB-PBS Ready To Learn Initiative

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Study Overview

During the summer of 2012, WestEd conducted a study of PBS KIDS Mathematics Transmedia Suites in preschool homes as part of the *Ready To Learn Intiative* developed by the Corporation for Public Broadcasting (CPB) and the Public Broadcasting Service (PBS). Funded by the U.S. Department of Education, the CPB-PBS *Ready To Learn* (RTL) Initiative has a goal of promoting early learning and school readiness among young children aged two through eight years old, with a particular interest in reaching children from low-income families. The Initiative supports the development and delivery of high-quality, age-appropriate, educational content designed to increase the early literacy and mathematics skills of young children. This report describes a study of a collection of mathematics games and activities available to children on the PBS KIDS Lab website. The focus of the current study is on the efficacy of three PBS KIDS transmedia suites (*The Cat in the Hat Knows A Lot About That*, *Curious George*, and *Sid the Science Kid* and their accompanying parent support materials) in increasing preschoolers' mathematics skills and enhancing their parents' ability to support their children's mathematics learning in the home environment.

There is growing evidence that economically disadvantaged preschool children have less extensive mathematics knowledge than their middle-income peers (Ginsburg & Russell, 1981; Hughes, 1986; Jordan, Huttenlocher, & Levine, 1994; Starkey & Klein, 1992; Starkey, Klein, & Wakeley, 2004). It has been suggested that this gap in mathematics knowledge may stem, in part, from differing levels of support for early mathematics learning in preschool and at home (Blevins-Knabe & Musun-Miller, 1996; Hart & Risley, 1995; Saxe, Gubermen, & Gearhart, 1987; Starkey & Klein, 2008). This study focuses on the educational outcomes of using the PBS KIDS Mathematics Transmedia suites in the home environment when parents are engaged in their child's mathematics learning.

PBS KIDS Lab (pbskids.org/lab) offers young children access to the newest games from the CPB-PBS *Ready To Learn* Initiative related to several popular PBS KIDS properties, including *The Cat in the Hat Knows A Lot About That*, *Curious George*, and *Sid the Science Kid*. It also provides home activities, classroom activities, out of school activities, and early research results that are related to the newest games. PBS KIDS Lab has age-appropriate games that help children learn and practice early mathematics skills. Figure 1 indicates the specific mathematics concepts that PBS KIDS Lab addresses.

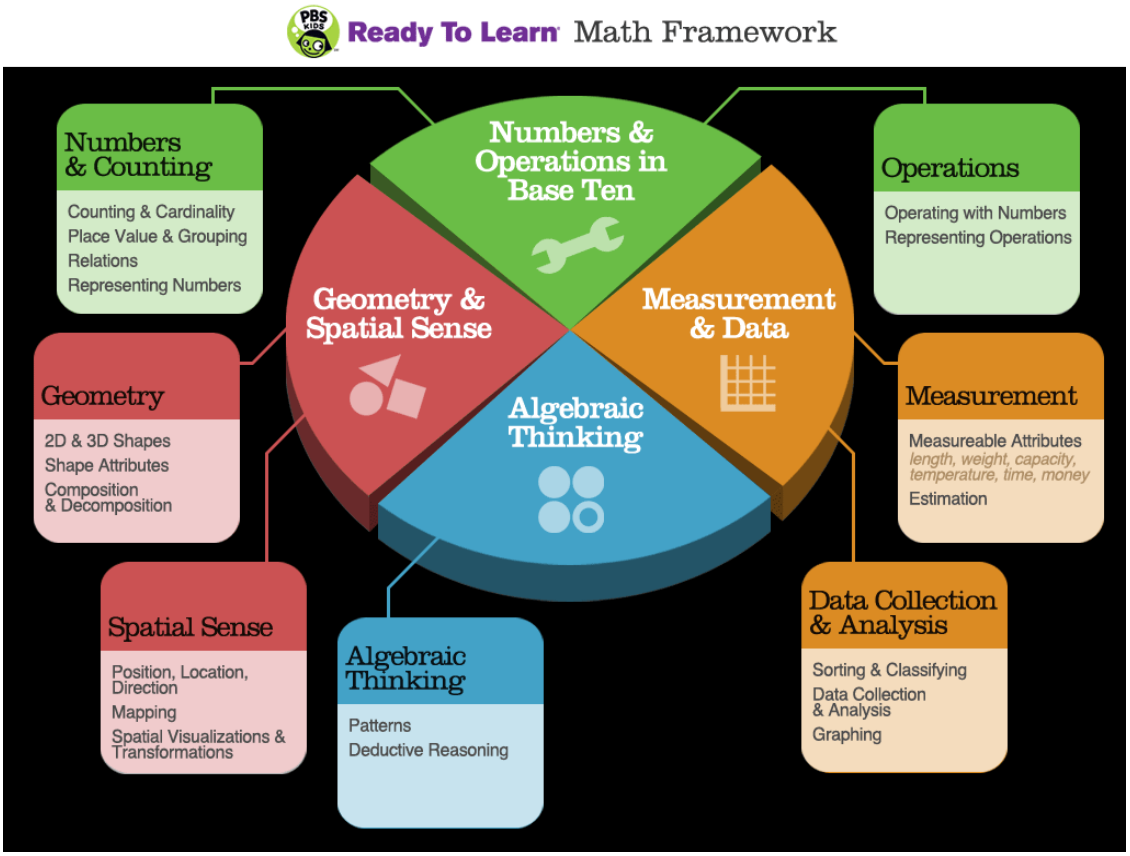


Figure 1. Mathematics Concepts Presented in PBS KIDS Lab's Games and Support Materials

PBS KIDS Lab is designed to support two age groups: 3-5 and 6-8 years old. The focus of the current study is on the efficacy of Ready To Learn's three PBS KIDS transmedia suites, *The Cat in the Hat Knows A Lot About That*, *Curious George*, and *Sid the Science Kid*, in increasing preschoolers' mathematics skills and enhancing parents' ability to support their children's mathematics learning in the home environment. Transmedia suites are comprised of thematically linked content presented across formats (e.g., short-form videos, online games, mobile phone activities, in-classroom digital games) and across media devices (e.g., computers, interactive whiteboards, tablets, mobile digital devices). The suites focus on improving core literacy and numeracy skills for children through the well-planned and coordinated use of multiple media platforms, commonly known as "transmedia storytelling."

Description of Transmedia Suites

The Cat in the Hat Knows A Lot About That series is designed to spark a love of learning and an interest in science in preschool-aged children. *The Cat in the Hat Knows A Lot About That* transmedia suite consists of four games that cover content such as shapes, patterns, classifying, and spatial visualizations. In the study, the games from *The Cat in the Hat Knows A Lot About That* were accessed via laptop computers. A description of each game is presented in Table 1 below.

Table 1. Overview of *The Cat in the Hat Knows A Lot About That* Transmedia Suite

GAME	LEARNING GOALS
The Great Shape Race	Categorize increasingly complex shapes
Hermit Shell Game	Understand size and capacity
Huff Puff-a-Tron	Categorize colors, shapes, sizes, and patterns
Sketch-a-Mite	Draw new shapes and understand how they fit together

The *Curious George* series is designed to inspire children to explore science, engineering, and math in the world around them. The *Curious George* transmedia suite consists of 16 games that cover content related to counting and cardinality. In the study, the games from *Curious George* were accessed via laptop computers. A description of each game is presented in Table 2 below.

Table 2. Overview of the *Curious George* Transmedia Suite

GAME	LEARNING GOALS
Apple Picking	Use number lines to identify missing numbers up to 19
Blast Off	Count backwards from 10 to 0
Bubble Pop	Count aloud by ones up to 50
Bug Catcher	Count and compare two sets of numbers to determine which is greater
Bunny Ride	Count on by ones from a number other than 1
Count with Allie	Count and represent quantities in different ways
Fair Shares	Count and separate items into equal groups
Flower Garden	Count by ones up to 20
Hat Grab	Use a graph to compare numbers
Hide & Seek	Identify numbers from 0-10 as numerals, words, and quantities
High Fives	Count by fives up to 200
Meatball Launcher	Count 1 to 5 objects upon request
Monkey Jump	Count up to 40 with the understanding that each number is one more than the last
Museum of Tens	Add objects to complete a set of 10
Ribbit	Recognize and use the addition and subtraction signs
Train Station	Add and decompose numbers up to a total of 10

The *Sid the Science Kid* series is designed to promote exploration, discovery, and science readiness among preschoolers. The *Sid the Science Kid* transmedia suite consists of nine games that cover content such as spatial reasoning, measurement, sorting, counting, and patterns. In the study, the games from *Sid the Science Kid* were accessed via laptop computers. A description of each game is presented in Table 3 below.

Table 3. Overview of the *Sid the Science Kid* Transmedia Suite

GAME	LEARNING GOALS
Crystals Rule	Use non-standard measuring tools
Pan Balance	Balance items on a scale
Snow Search	Find objects using a map
Snowflake Match	Compare and match shapes
Sorting Box	Sort objects according to color, shape, and type
Vegetable Harvest	Count small groups of objects
Vegetable Patterns	Complete simple patterns
Vegetable Planting	Group objects according to size and capacity
Weather Surprise	Read a thermometer and understand cool and warm climates

The Study's Logic Model

The study's logic model (see Appendix D) posits that use of the aforementioned three PBS KIDS transmedia suites, along with their corresponding parent support materials available on PBS KIDS Lab, will increase preschool students' early mathematics abilities. In addition, use of the suites and related parent activities will increase parents' awareness of strategies to directly support their child's mathematics learning in the home environment. Specifically, the study applied a quasi-experimental design to address the following research questions:

1. Does student use of the PBS KIDS transmedia suites increase children's knowledge and skills in mathematics?
2. Does parents' awareness and support of their children's mathematics learning at home increase after interacting with their children around the suites and using support materials related to the suites?

Study Design and Methodology

Intervention and Comparison Conditions

The study of the PBS KIDS Mathematics Transmedia Suites in preschool homes used a quasi-experimental, non-equivalent groups design, which randomly assigned two Head Start centers to either an intervention or comparison group[1]. The study took place over eight weeks in the summer of 2012. The intervention was based on the three aforementioned PBS KIDS transmedia suites and was comprised of three mathematics concepts found in those suites: numbers and operations in base ten, measurement and data, and geometry and spatial sense. The eight-week intervention suggested that parents and children work together on PBS KIDS transmedia activities for 30 minutes per day for four days per week, and encouraged parents to attend weekly parent meetings at their child's preschool.

[1] This study was approved by an independent Institutional Review Board (IRB).

Each week of the intervention focused on a specific mathematics concept and included four days of activities for children at home. The first day of each week began with a hands-on activity, which introduced the week's mathematics concept. The second day of each week included a pre-game, hands-on activity and an online game from the transmedia suites. The third day of each week allowed for children and parents to play three online games from the transmedia suites. The fourth day of each week was a "free play" day, where children could elect to replay any of the online games that they had seen on the second and third days of the intervention week. Each activity focused on the week's mathematics concept. All hands-on activities in the program were taken from PBS KIDS Lab home activities.

During each week of the Ready To Learn study, parents in the intervention group met at their child's preschool for one hour. Parents were encouraged to attend a total of eight parent meetings, one for each week of the intervention. To encourage parents to attend each meeting, WestEd researchers sent parents reminder messages via weekly phone calls, emails, and text messages. WestEd researchers arranged child care for preschoolers while their parents attended meetings, and provided a meal for the parents and their children after the meeting. In addition, parents received a gift card at each parent meeting that they attended.

During each parent meeting, parents were encouraged to describe the activities they undertook with their children the previous week; whether they felt their children learned from those activities; and what challenges they had encountered. In preparation for the following week, parent meeting facilitators described the mathematics concepts in the PBS KIDS transmedia activities so that parents could better understand the activities and support their children's learning and engagement. During the last parent meeting, children were invited to join the meeting to play PBS KIDS apps using iPod Touches.

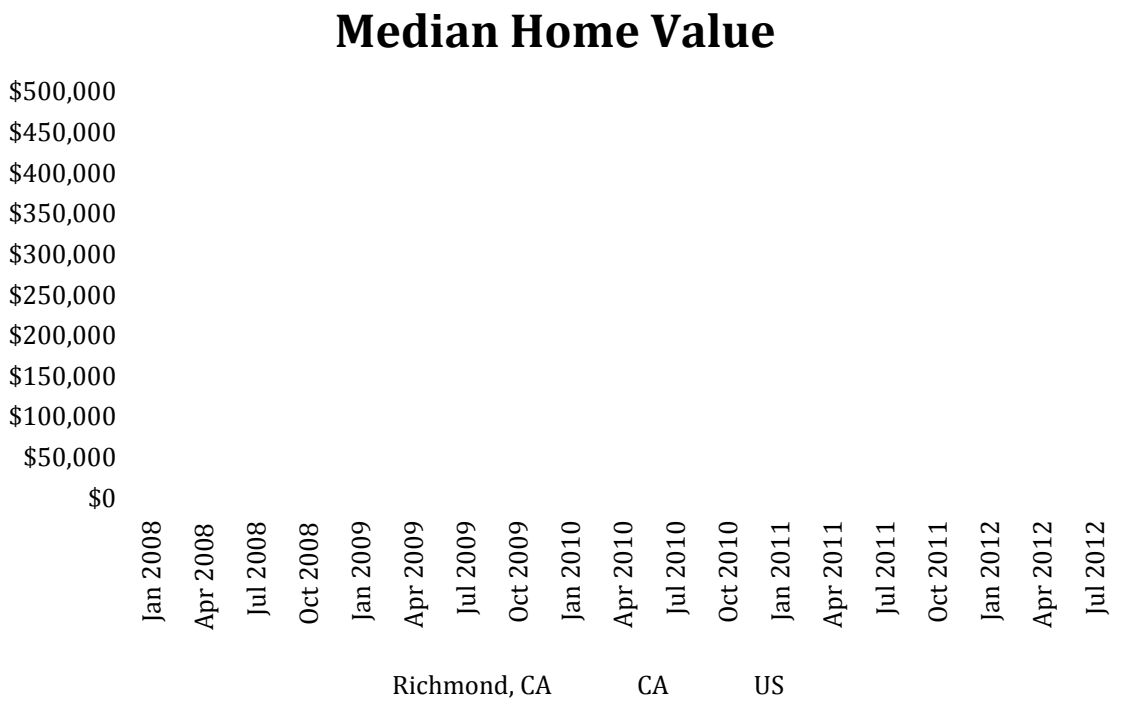
Parents of intervention group students also received a weekly program of PBS KIDS transmedia activities to use with their children. Child/parent dyads in the intervention group accessed the intervention materials, including games from the transmedia suites and home-activity-supporting materials for parents, via Google Chromebooks and iPod Touches. Children and parents in the intervention group were provided with Chromebooks to take home for the duration of the study. A 3G data plan was provided for each Chromebook so that participants could access the Internet. The Chromebook browser and settings were configured such that participants only had access to specific PBS websites. Parents were also provided with contact information of WestEd staff who could provide technical support and troubleshooting assistance.

Comparison group dyads used business-as-usual mathematics games and supporting materials. These materials were not provided by WestEd researchers, but rather were educational materials that parents would normally have used with their children.

Comparison group parents met twice throughout the study, once during the first week of the study and again during the eighth week of the study. At the first meeting, parents were given a list of suggested mathematics topics to study with their children that aligned with the skills that intervention group students practiced in the PBS KIDS transmedia suites. At the last meeting, parents were encouraged to describe what activities they had done with their children and were given several educational books to use with their children as a gift for completing their participation in the study.

Background of Implementation Sites

Researchers recruited 90 families with preschool-aged children through two Head Start centers. One family had two preschool-aged children, therefore, a total of 91 children and 90 parents were recruited. The Head Start centers primarily serve families from a low-income community in Richmond, CA. Richmond is located in the East Bay of the greater San Francisco Bay Area. It has historically been a site for heavy industry, although the city has been undergoing a shift towards a service and commercial economy since the 1970s. According to 2000 and 2010 census data, the city experienced a population change from 2000 to 2010 as a result of a sharp increase in immigration to the area. The Hispanic or Latino population rose from 27% to 40% from 2000 to 2010. During this period, the city had up to 16.4% of its families living below the poverty level[2]. When the recession occurred in 2008, Richmond was especially hard hit and its real estate prices fell sharply. Figure 2 shows the considerable drop in median home values from 2008 to 2012, especially compared to the U.S. median home values. In addition, the rate of foreclosures and unemployment increased, as well as the crime rate[3]. This background demonstrates the considerable challenges for families from low-income communities in Richmond.



Source: Zillow Home Value Index, zillow.com

Figure 2. Change in Housing Prices from 2008-2012 (Richmond, CA, and U.S.)

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[2] Percent of individuals living below poverty level in US and California based on 2000 census data are 12.4% and 14.2%, respectively. Percent of individuals living below poverty level in US and California based on 2010 census data are 13.8% and 13.7%, respectively. *Source: Profile of Selected Economic Characteristics: 2000 and 2010 Census Summary File.*

[3] "25 Most Dangerous Cities According to FBI. World City Information (www.city-infos.com) 2012-01-13. http://www.city-infos.com/25-most-dangerous-cities-according-to-fbi/. Retreived 2012-09-13.

The public schools in Richmond are administered by the West Contra Costa Unified School District (WCCUSD). In the 2010-11 academic year, WCCUSD included 58 schools and served approximately 30,000 students. Based on the district's 2011 Academic Performance Index (API) score of 709, the district was considered to be low performing. (The Californa state average API[4] score was 779, and the school performance target was 800.) As shown in Table 4, students in the WCCUSD are primarily from low-income households, with two thirds of the students eligible for free or reduced price meals. About half of the students in the district are Hispanic or Latino with significant subgroups of African American and Asian students. About one third of the students are English-language learners and 14% of the students receive special education services. The WCCUSD demographics reflected those of its participating Head Start centers.

Table 4. West Contra Costa Unified School District Demographics

DEMOGRAPHIC PROFILE	2011-12 ACADEMIC YEAR (*N*=30,037)
School Profile	
Hispanic or Latino	48%
Black or African American	23%
White	12%
Asian/Pacific Islander	17%
Native American	0.2%
Two or More Races	0.4%
Free and Reduced Price Meals	65%
LEP/ELL Students	33%
Special Education	14%
API	709[a]

[a] Average California 2010 API growth is 779.
Source: California Department of Education

Sample Recruitment

A total of 90 families, with 91 preschool-aged children were recruited through two Head Start centers in Richmond, resulting in 46 children in the intervention condition and 45 children in the comparison condition. Parents were invited to participate in the study through the distribution of informational letters and consent forms through the preschool centers. The informational letters explained the purpose of the study, the study

[4] The API is the cornerstone of California's Public Schools Accountability Act of 1999 and is a measure of schools' academic performance and growth from year to year. Each school's API is calculated based on a number of performance indicators including a battery of statewide assessments designed to measure student achievement. The API is a numeric index measuring a school's academic progress across multiple subject areas. API scores range from 200 to 1000, with a school performance target of 800.

tasks, risks, and benefits, and provided contact information for the principal investigator. Both the informational letters and the consent forms were available in English and Spanish. All parents who participated in the study received the informational letter and signed a consent document for him/herself and his/her child(ren), and are protected by the Institutional Review Board (IRB). Participating children's average age is 4.5 years old. All children are qualified for Free and Reduced Lunch program. The majority of the children (54.9%) are Hispanic, followed by African American (30.8%). Approximately 45% of children's preferred language is Spanish. Detailed equivalent test results on the intervention and comparison groups' difference in demographic characteristics and baseline are presented in the section on sample characteristics.

Instruments

Baseline Measures

The following measures were collected from both the intervention and comparison groups before the intervention began. They were used to test the baseline equivalence between the intervention and comparison groups and/or served as covariates in the impact analyses.

Test of Early Mathematics Ability (TEMA). The Test of Early Mathematics Ability, third edition, is a primary test of children's informal and formal mathematics knowledge, developed by Western Psychological Services. It is a standardized, nationally normed achievement test (Ginsburg & Baroody, 2003). The test is designed for use with children ages 3 years, 0 months through 8 years, 11 months. It measures four categories of informal mathematics: Numbering, Number Comparisons, Calculation, and Concepts. It also measures four categories of formal mathematics: Numeral Literacy, Number Facts, Calculation, and Basic 10 Concepts. Table 5 provides a description of each category of informal and formal mathematics. The test contains 72 items (each item may have multiple problems) in two forms. The TEMA-3 is not a timed test, and no precise time limits are required for children being tested. Depending on children's mathematics ability, children will be able to complete all 72 items or the relevant portion of the test. On average, it takes 45-60 minutes to administer.

Table 5. Description of Categories of Mathematics in TEMA-3

Categories of Mathematics	Description of the Categories
Informal Mathematics	
Numbering	Precounting numbering abilities: e.g., children learn to recognize collections of one or two items and label them "one" and "two".
Number Comparisons	Comparing two or more collections: e.g., children learn the term *more* and use it to label the larger of two collections that obviously differ in number.
Calculation	Mentally and nonverbally adding two small, previously viewed collections; solving word problems with sums up to 12 by counting or reasoning: e.g., after seeing one item covered and a second item slipped under the cover, children can determine the sum and indicate their answer by producing two items.
Concepts	Determing key aspects of understanding that underlie number and calculation skills at the counting phase: e.g., children learn that a whole is the sum of its parts and that the whole is larger than any single part.

Categories of Mathematics	Description of the Categories
Formal Mathematics	
Numeral Literacy	A major transition in children's ability to represent numbers involves the ability to read, write, and understand numerals: e.g., children learn that the numeral 2 is read aloud as "two" and conversely that the spoken word "two" is written as 2.
Number Facts	Mastery of the basic number combinations and ability to quickly generate the answer to single-digit addition, subtraction, and multiplication facts: e.g., children have learned that 2+0=2 and 3+0=3, they may extract a principle to the effect that adding zero to any number does not change it.
Calculation	Addition and subtraction accuracy: e.g., children can talk aloud as a problem is being solved and can justify their procedure.
Basic 10 Concepts	Grouping by 10: e.g., children understand that when one carries, one is really regrouping by units of 10s, 100s, and so on.

The test examiner's manual reports an alpha of 0.94 for Form A and an alpha of 0.96 for Form B (Ginsburg & Baroody, 2003, p.32). The manual also discusses test content-description validity, criterion-prediction validity, and construct-identification validity. The test has been matched for content coverage and difficulty.

For the purposes of this study, the TEMA-3 experimental score was used to analyze children's mathematics ability. The experimental score is simply the number of problems scored correct on the TEMA-3 (one point per correct response). Each TEMA-3 item may have multiple problems. The total number of problems in the TEMA-3 is 201. Therefore, the experimental score ranges from 0 to 201. The TEMA-3 Form A was used as a pre/post measure for children. The pre-test was administered to students after they were assigned to the intervention or comparison condition in mid-June of 2012; the post-test was administered in late July and early August of 2012 at the conclusion of the study.

Researcher-Developed Measure of Mathematics Skills. Given that the TEMA-3 only tests children's numerical sense, WestEd researchers developed a measure of mathematics skills that addressed the remaining two mathematics concepts that are practiced in the transmedia suites: Measurement and Data, and Geometry and Spatial Sense. The researcher-developed measure of mathematics skills includes 15 items and measures three early mathematics concepts: Numbers and Operations in base ten (six items), Measurement and Data (five items), and Geometry and Spatial Sense (four items). The researcher-developed measure of mathematics skills is not a timed test, and no precise time limits are required for children being tested. On average, it takes 15-20 minutes to administer the test.

The scores from the researcher-developed measure of mathematics skills were calculated by summing the number of items scored partially correct (one point per partially correct response) and the number of items scored correct (two points per correct response). Partially correct responses are not available for six items; therefore, the scores range from 0 to 24. The 15 items showed good reliability on the pre-test (alpha = .80) and on the post-test (alpha= .82). Both the pre-test and post-test of the researcher-developed measure of mathematics skills were administered in conjunction with the TEMA-3 test. Students were randomly assigned to be tested by either the TEMA-3 or researcher-developed measure of mathematics skills first. The order of the tests was the same for any given student for pre-test and post-test.

Other Baseline Measures Used to Test Group Equivalence and Serve as Covariates. Four family demographic information items were collected. In addition, two scales were adapted from the Home Learning Environment (HLE) survey (Starkey, Klein, Chang, Dong, Pang, & Zhou, 1999)[5] to guage parent awareness of their child's mathematics development and the available resource at home to support the child's learning.

- ***Age***: 3-year-olds, 4-year-olds, or 5-year-olds
- ***Race/Ethnicity***: African American, Hispanic, or Other
- ***Preferred Language***: English or Spanish
- ***Parent Education***: Undergraduate and above; some college or technical school; or high school or less
- ***"Parents' Awareness of Their Children's Mathematics Development" Scale***: This scale consisted of 12 items. Parents rated the items using a dichotomous (Yes/No) scale. Based on the current study sample, the 12 items showed marginal reliability (KR20 = .63).
- ***"Resource Availability to Support Learning at Home" Scale***: This scale consisted of items in six areas: books and language activities (six items), store-bought games (three items), educational activities using technology (six items), other educational or mentally stimulating activities and toys (six items), educational activities in the home routine (four items), and activities the child participated in away from home (three items). Parents rated the items using a dichotomous (Yes/No) scale. Based on the current study sample, the 28 items showed acceptable reliability (KR20 = .78).

Other Baseline Measures Only Used to Test Group Equivalence. Variables/items related to how many times the child engaged in different types of home activities alone, with another child, and with an adult were also adapted from the HLE survey. The items focus on the following six areas: books and language activities, store-bought games, educational activities using technology, other educational or mentally stimulating activities and toys, educational activities in the home routine, and activities the child participated in away from home. They were used only to test the baseline equivalence between intervention and comparison groups in this report. The detailed description of the item response choices is included in Appendix A, Table A1.

Confirmatory Primary Outcome Measures

Test of Early Mathematics Ability (TEMA). As mentioned earlier, the TEMA-3 was used as a primary pre/post measure for students. The detailed description of the test is presented above.

Researcher-Developed Measure of Mathematics Skills. As mentioned earlier, the researcher-developed measure in mathematics skills was used as the other pre/post measure for students. The detailed description of the test is presented above.

Parent Survey and Focus Group Outcome Measures. "Parents' Awareness of Their Children's Mathematics Development" scale was utilized to measure parents' knowledge about typical preschool children's mathematics abilities and skills. This scale was discussed earlier in this section. In addition, researchers organized a weekly focus group at the beginning of each parent meeting. Parents were asked to elaborate on

[5] The HLE is a parent survey of home mathematics activities. This survey includes three sections. The first section is a demographic section that acquires parents' education, ethnicity, preferred language at home, and their relationship with the child. The second section obtains parents' awareness of their children's mathematics development. The third section asks parents to report on the types of activities that their children did last week and how frequently their children did each activity alone, with another child, and with an adult.

how they used the previous week's transmedia activities/games with their children, how their children responded to the activities/games, and whether the activities/games were helpful for their awareness and support of their children's mathematics learning at home.

Implementation Measures

The following measures and/or data sources were collected during the intervention. They were used to address implementation fidelity and dosage.

Weekly Fidelity Survey. Each week, all intervention parents were asked to respond in a survey about activities from the previous week including: (1) which activities/games they played with their children, (2) how long their children played the activities/games, (3) how their children liked the activities/games, and (4) whether they had anything to share regarding the activities. (See Appendix B for a sample weekly fidelity survey.)

Electronic Usage Logs. The Chromebooks and a custom-designed WestEd website were configured in order to track activities and log when participants accessed the PBS KIDS transmedia suites, which games from the suites were accessed, and approximately how long participants used each game. Researchers configured the Chromebook settings and installed a browser plug-in to redirect study participants to the custom WestEd website, such that the website and PBS KIDS games were the only online sites participants could access. The custom PBS/WestEd website used a login system that connected to Google Analytics. Each time participants logged in to PBS KIDS Lab via the custom website, their username was identified within Google Analytics. This allowed researchers to identify usage data from study participants. Data was downloaded from Google Analytics and compiled by WestEd researchers.

Data Collection

Table 6 below provides an overview of the timeline of data collection.

Table 6. Data Collection Activities

					INTERVENTION		COMPARISON	
Instrument	**Key Questions or Scales Used**	**Timeline**	**Duration**	**Data Collection Method**	**Parent**	**Student**	**Parent**	**Student**
Baseline/Pre-Intervention Measures								
TEMA-3	Mathematics knowledge	After group assignment	Mid June 2012	Certified assessors conducted individual assessments		X		X
Researcher-Developed Measure of Mathematics Skills	Mathematics knowledge	After group assignment	Mid June 2012	Trained assessors conducted individual assessments		X		X

					INTERVENTION		COMPARISON	
Instrument	**Key Questions or Scales Used**	**Timeline**	**Duration**	**Data Collection Method**	**Parent**	**Student**	**Parent**	**Student**
Parent Survey	• Age • Race/ethnicity • Preferred language • Parent education • Parents' awareness of their children's mathematics development • Resource availability to support learning at home • Frequency of children's diverse activities at home	Start of the intervention	Mid June-Early July 2012	Parent meeting facilitators collected the survey during the first parent meeting	X		X	
Implementation Measures								
Weekly Fidelity Survey	• Played games and activities • Frequency of played games and activities • Interests in the games and activities	During the intervention	Mid June – Early August 2012	Parent meeting facilitators collected the fidelity survey at the beginning of each parent meeting	X			
Electronic Usage Logs	• Played online games • Frequency of played online games	During the intervention	Mid June – Early August 2012	Automatically collected through dynamic PBS/WestEd website	X	X		

					INTERVENTION		COMPARISON	
Instrument	**Key Questions or Scales Used**	**Timeline**	**Duration**	**Data Collection Method**	**Parent**	**Student**	**Parent**	**Student**
Outcome Measures								
TEMA-3	Mathematics knowledge	End of intervention	Late July-Early August 2012	Certified assessors conducted individual assessments		X		X
Researcher-Developed Measure of Mathematics Skills	Mathematics knowledge	End of intervention	Late July-Early August 2012	Trained assessors conducted individual assessments		X		X
Parent Survey	Parents' awareness of their children's mathematics development	End of intervention	Late July-Early August 2012	Parent meeting facilitators collected the survey during the last parent meeting	X		X	
Weekly Focus Group	Parents' reflection on their awareness and support of their children's mathematics development	During the intervention	Mid June – Early August 2012	Parent meeting facilitators collected the fidelity survey at the beginning of each parent meeting	X			

Data Quality Assurance Procedures and Response Rates

Certified TEMA assessors administered the TEMA-3 test to students. The same certified TEMA assessors also administered the researcher-developed measure of mathematics skills. Assessors were trained on how to conduct the measure of mathematics skills and score the assessment results. Parent meeting facilitators were trained on the procedures for collecting the HLE survey and the weekly fidelity surveys. They were also trained on how to conduct weekly focus groups using a focus group protocol.

Several steps were taken to ensure high response rates for the outcome measures. The participant consent forms distributed at the beginning of the study informed parents of the timeline of the primary pre/post-measures for students. During the final parent meetings, facilitators reminded the parents of the timeline of the post-measures to ensure that students would not leave their preschool center before completing the post-measures. Researchers also communicated consistently with parents, preschool directors, and teachers to identify any potential changes in a child's or parent's participation in the program. As a result, this study achieved a 100% response rate for the student outcome measures, with only one student missing five items on

the researcher-developed measure of mathematics skills, and a 98% response rate for the parent outcome measures, with only five parents missing less than 2 items on the outcome measure (Table 7).

Table 7. Response Rates for Each Outcome Measure

	Overall		Intervention		Comparison	
Outcome Measure	**N**	**%**	**N**	**%**	**N**	**%**
TEMA-3	91[a]	100%	46	100%	45	100%
Students without a missing response	91	100%	46	100%	45	100%
Students missing 5 or fewer items	0	0	0	0	0	0
Researcher-Developed Measure of Mathematics Skills	91	100%	46	100%	45	100%
Students without a missing response	90	99%	46	100%	44	98%
Students missing 5 or fewer items	1	1%	0	0	1	2%
Parents' Awareness of Their Children's Mathematics Development	90	98%	45	96%	45	100%
Parents without a missing response	83	92%	41	91%	42	93%
Parents missing 2 or fewer items	5	6%	2	4%	3	7%
Parents completely missing 12 items	2	2%	2	4%	0	0

[a] A total of 90 families participated in the study. The family with two preschool-aged children was assigned to the intervention condition. Therefore, a total of 91 children and 90 parents were included in the study

Sample Characteristics

The target age group of the study sample was preschoolers aged three through five years old and their parents. Two Head Start centers agreed to be randomly assigned to either the intervention or comparison condition. A total of 90 families were recruited. One family had two preschool-aged children, resulting in 46 children in the intervention condition and 45 children in the comparison condition. Table 8 presents the individual characteristics of participants by experimental condition.

The intervention and comparison groups did not differ significantly in age, ethnic composition, preferred language, or parent education level. In addition, the intervention and comparison groups were equivalent at baseline as measured by the researcher-developed measure in mathematics skills. However, comparison group

children had higher pre-test scores on the TEMA-3 [6](see Table 9). Additionally, the baseline equivalence test on the resource availability to support learning at home showed no significant difference between intervention and comparison families. However, comparison group parents had a significantly better understanding of what abilities and skills young children should develop. A pre-test measure of the children's TEMA-3 score and parents' awareness of children's mathematics development at baseline are included in impact analyses as a covariate to adjust for the baseline differences.

Table 8. Participant Demographic Information, by Experimental Condition

	Intervention		Comparison		*p*-value
	Number	Percent	Number	Percent	
Age of the Child					0.57
3-year-old	7	15.56%	6	13.33%	
4-year-old	31	68.89%	28	62.22%	--
5-year-old	7	15.56%	11	24.44%	--
Race/Ethnicity					0.44
African American	12	26.67%	16	35.56%	--
Hispanic	28	62.22%	22	48.89%	--
Other	5	11.11%	7	15.56%	--
Preferred Language					0.29
English	22	48.89%	27	60.00%	--
Spanish	23	51.11%	18	40.00%	--
Parent Education					0.15
Undergraduate and above	4	8.89%	6	13.33%	--
Some college or technical school	19	42.22%	26	57.78%	--
High school or less	22	48.89%	13	28.89%	--

[6] The preliminary descriptive checks for outliers indicated that one student from the treatment group had extreme TEMA scores on both pre and post tests. This student's data was dropped from corresponding baseline equivalent test and impact analysis of student outcomes.

Table 9. Key Measures at Baseline, by Experimental Condition

Measure	Intervention	Comparison	Difference	*p*-value
Researcher-Developed Measure of Mathematics Skills				
Mean	9.11	9.98	-0.87	0.44
Standard deviation	5.07	5.41	--	--
N	45	45	--	--
TEMA (Experimental Scores)				
Mean	27.58	35.76	-8.18*	0.03
Standard deviation	17.9	16.72	--	--
N	45	45	--	--
Parents' Awareness of Children's Math Development				
Mean	8.66	9.49	-0.83*	0.05
Standard deviation	1.99	1.93	--	--
N	44[a]	45	--	--
Resource Availability to Support Learning at Home				
Mean	14.77	16.47	-1.69	0.13
Standard deviation	5.38	4.97	--	--
N	44	45	--	--

* *Significantly different from zero at the .05 level, two-tailed test.*

[a] One parent in intervention condition did not return the pre parent survey. Therefore, a total of 44 parents in intervention condition have baseline measures related to parents' awareness of children's math development and resource availability to support learning at home.

Fidelity of Implementation at the Intervention Site

During the eight-week study, families in the intervention condition were presented with a program that included a total of 14 hands-on home activities (two activities per week) and 30 online games (three core program games and three additional games per week)[7]. Electronic usage logs and fidelity surveys were collected from week one through week seven.

Based on the electronic usage logs, on average, child/parent dyads played the online games three days per week. The majority (97.8%) of the child/parent dyads in the intervention group played the online games at least one day a week for five weeks, with 64.4% of child/parent dyads playing the online games every week during the intervention. In addition, child/parent dyads played the online games for an average of 1,213 minutes across seven weeks (173 minutes per week). Appendix A, Tables A2 and A3, provide the frequency of PBS KIDS online game usage by week. The most frequently played games included: *Huff Puff-a-Tron* and *The Great Shape Race* from *The Cat in the Hat Knows A Lot About That* suite; *Hide & Seek*, *Apple Picking*, *Blast Off*, *Hat Grab*, *Fair Shares*, and *Monkey Jump* from the *Curious George* suite; and *Vegetable Harvest* from the *Sid the Science Kid* suite (see Appendix A, Table A4). According to the fidelity surveys, parents were also actively

[7] All games are from the three target suites and one shape game is from the Dinosaur Train transmedia suite. Some games may be provided in more than one week.

involved in the hands-on home activities related to the online games. Parents and children used hands-on home activities for 20-40 minutes per week. The majority of the child/parent dyads used the hands-on home activities every week (88.9%). Appendix A, Table A5, provides the frequency of home activities used by child/parent dyads.

Data Analysis Methods

A general linear model with pre-tests as covariates was utilized to investigate the impact of Ready To Learn's three mathematics-related PBS KIDS transmedia suites, along with their corresponding parent support materials available on PBS KIDS Lab, on children's outcomes after accounting for the pre-existing differences in the pre-intervention baseline measures. This method is preferred for analyzing pre/post design data because it can eliminate systematic bias and reduce error variance (Bonate, 2000; Dimitrov & Rumrill, 2002). The method takes into account regression toward the mean (Bland & Altman, 1994), which refers to the concept that when a first measurement of a variable is an extreme value it will tend to be closer to the average on a later measurement. Given that regression toward the mean is a relatively common phenomenon, the researchers applied a general linear model with pre-tests as covariates in this study to increase statistical power and obtain a more precise and less biased estimate of the group effects (Bonate, 2000; Dimitrov & Rumrill, 2002; Keppel & Wickens, 2004). In this study, researchers compared the intervention group's post-intervention outcomes with the comparison group's post-intervention outcomes after adjusting for differences in baseline test results, baseline parents' awareness of children's mathematics development, and participant demographic characteristics (i.e., race/ethnicity and child age). Two student outcomes as measured by the TEMA-3 and researcher-developed measure of mathematics skills were used as dependent variables. The intervention status (intervention vs. comparison) was used as the independent variable. Adjusted intervention and comparison group means were reported for each outcome variable.

Several approaches were utilized to address missing data. For outcome measures, missing item responses were treated as incorrect responses. Participants who missed all the items in the outcome measures were removed from the corresponding analyses. Participants who had more than 10% of missing data on the covariates were also removed from the impact analysis. Series mean method was utilized to replace the other missing data on the covariates.

Qualitative data collected from open-ended survey questions and weekly focus groups were analyzed using grounded theory, or constant comparative analysis (Strauss and Corbin, 1998). In an initial data reduction approach, respondents' comments were reviewed and assigned categories of meaning (open coding). Then, these categories along with quantitative data results were reviewed for causal linkages and non-causal relationships related to the central phenomenon (axial coding), which allowed the researcher to develop a "story" that connects the categories (selective coding) and, finally, posit hypotheses or theoretical propositions. These qualitative analyses provided descriptions of 1) how child/parent dyads used the three mathematics-related PBS KIDS transmedia suites, along with their corresponding parent support materials available on PBS KIDS Lab, and 2) how the PBS KIDS transmedia suites, along with their corresponding parent support materials, may increase parents' awareness and support of their children's mathematics learning at home.

Impact Results

Children's Knowledge and Skills in Mathematics

The results indicate that the intervention was positively associated with gains in children's knowledge and skills in mathematics, as measured by the TEMA-3. Adjusted mean differences on the post-test measure of the TEMA-3 show that the intervention group exceeded the comparison group (point estimate of 4.82; effect size = 0.27[8]). This difference was significant at the .01 level, after accounting for differences in baseline test results, baseline parents' awareness of children's mathematics development, and participant demographic characteristics (i.e., race/ethnicity and child age). However, the intervention was not significantly associated with gains in children's knowledge and skills in mathematics, as measured by the researcher-developed measure in mathematics skills (see Table 10). Analysis of each individual measure in mathematics skills item also did not show pre/post group differences (see Appendix A, Table A6). One possible explanation for these outcomes is that games and activities in the intervention focused primarily on numerical sense, which was measured by the TEMA-3. The majority of the intervention program included activities and games related to numerical sense, such as numbers, counting, counting backwards and skip counting, adding, and comparing. Only two weeks of the intervention program featured activities and games that emphasized shapes and sorting (this mirrored the distribution of skills across the games in the transmedia suites). In addition, the researcher-developed measure of mathematics skills was only 15 items long and only tested a small subset of skills related to measurement and data, and geometry and spatial sense. These included a limited number of items that tested sorting (three items) and shapes (four items), which may not be sensitive enough to detect changes.

Table 10. Impact Analysis of Student Outcome Measures

	Adjusted Mean					
Impact Measure	Intervention (Standard Error)	Comparison (Standard Error)	Difference (Standard Error)	*p*-value	95% Confidence Interval	Sample Size
TEMA-3 (Experimental Scores)	36.71 (1.24)	31.89 (1.24)	4.82** (1.63)	.004	1.58 – 8.06	90
Researcher-Developed Measure of Mathematics Skills	11.35 (.62)	10.65 (.62)	0.70 (.89)	.435	-1.08 – 2.48	90

** *Significantly different from zero at the .01 level, two-tailed test.*

Parents' Awareness and Support of Their Children's Mathematics Learning

Involvement in Children's Play

The study findings suggest that Ready To Learn's three mathematics-related PBS KIDS transmedia suites, along with their corresponding parent support materials available on PBS KIDS Lab and the parent meetings, provide parents a platform to involve themselves in their children's mathematics learning. Parents who

[8] Effect size was calculated by dividing impact estimate by the comparison group unadjusted standard deviation of the outcome variable (*SD*=17.93).

participated in the intervention were encouraged to play six core games with their children per week (two hands-on games, and four online games). Researchers analyzed the average number of games that parents played with their children per week. This information was derived from questions on the weekly fidelity surveys regarding their engagement in the activities. In general, the parents played more than five games per week with their children (M=5.43, SD=0.86), which indicated a high level of engagement in their children's play with PBS KIDS transmedia games and the supporting hands-on home activities.

The target population of this project was economically disadvantaged preschool families. These parents, like all parents, want their children to succeed in school. The current project fostered a welcoming environment to encourage parent involvement in their child's learning by providing the intervention program materials, weekly parent meetings to support the understanding and utilization of the program, and technical assistance to answer questions and address concerns. As evidenced by data from the weekly fidelity surveys and focus groups, parents were: interested in the project, felt welcomed and supported, and were willing to be involved in their children's learning. The following quotes, taken from completed fidelity suverys and transcripts of focus groups, are typical of parents' comments about the awareness of the importance in their child's learning.

> *Thank you for calling me to remind me of the meeting. My son has enjoyed very much the games and it has given me the opportunity to share more time with him. I think he has enjoyed it and is learning. At the same time, I hope to continue helping him learn with all his games.*

> *Thank you for the opportunity that this program is providing to help our children and to help us parents, so we help our children to prepare and advance in their studies, which helps us to get involved more with them and to know about their educational development.*

> *This is very important for me and my family. This program is very good for my children and not just for the child that participates, but for all those who play the games. I am happy to be able to help my child with the help of you all.*

According to parents' reflections on the weekly fidelity surveys and focus groups, parents viewed their role as facilitators and/or teachers. Through involvement in their children's play, parents realized that their children enjoy learning when they help them get started, explain what they do not understand, or just keep them company.

> *I used the fruit and the flowers a lot to [teach him to] count and for colors. He loved it. Now he is constantly doing it outside of home. Pointing at objects and guessing what color it is.*

> *I used the cutouts to show how many trains George had and told him to count past the train to see how many he needed. My child enjoyed this game and stayed attentive.*

> *I liked the game, however it was a little harder to explain to him at first. But after the second time around, it got better.*

> *My daughter really enjoys learning and she told me she "has so much fun working on the computer with me." I can see her learning more.*

Parents reported feeling empowered to support their children's mathematics learning. They felt proud of their children's progress. A grandmother of a participating child, who typically attended the meetings with the mother and the child, shared her excitement upon seeing her grandchild playing with the computer games for the first time. Apparently, another older child in the family wanted to use the computer to show the child other games, but the child responded, "I want to do it myself." Hearing this, the grandmother said she felt proud that her grandchild was successful at working on the computer by himself. Similar statements indicated that parents felt empowered to teach their children because of the teaching and learning resources provided by the intervention materials.

> *We love these [parent meetings], because they teach me how to learn to educate better my daughter. I am getting practical and simple advice, which is also very enjoyable. I think that she is having fun and learning and I am thankful for these activities that are so creative, and the enrichment for all the families.*

> *My child and I enjoyed participating in this study. She was able to learn a lot about numbers, and I learned different ways to teach her. PBS is a great learning resource.*

> *To me, the ideas shared with parents are fantastic, so we can teach our children how to learn and to count while playing with numbers.*

> *This program is not only teaching our children but the whole family, like grandparents and aunts and uncles. It is important to me that we are getting more ideas to help our children.*

Awareness of Children's Mathematics Interests and Ability

Mathematics provides children with the foundation for problem-solving and reasoning abilities, as well as critical thinking skills. However, parents may not be aware of their children's mathematics learning and may not understand how the mathematics skills their children are learning relate to everyday life. Data analysis suggests that the current project assisted families with understanding children's mathematics development, helping them to create conditions at home to promote mathematics activities, and to apply PBS KIDS online mathematics games to support children's mathematics learning.

To detect whether interacting with children around the PBS KIDS transmedia suites and using related support materials increases parent's awareness of their children's mathematics learning at home, researchers analyzed the composite sum scores for intervention parents' awareness of their children's mathematics development. This information was derived from parent survey questions on their knowledge about typical preschool children's mathematics abilities and skills. The results indicated that parents' awareness of their children's mathematics development significantly increased over the course of the intervention (Pre M=8.65 (2.01), Post M=10.26 (1.38), df=42, p< .001).

Analysis of fidelity survey and focus group data suggests that parents were surprised at the depth of their children's mathematics skills:

> *I was surprised that my child knew the names for pentagons and octagons, when I had forgotten them.*

> *I am very impressed that my son is using operations, geometry, spatial sense, measurement, data collection and analysis, algebraic thinking. I will continue to include them when we learn.*

> *I was surprised that he knew what the missing number was so quickly. At first I thought it was him taking a guess, but when he kept getting them correct it surprised me.*

Through working with their children on the PBS KIDS transmedia suites, parents identified their children's interest areas and the potential challenges their children were facing:

> *She likes* Count with Allie. *She liked giving the dogs doggy bones.* Museum of Tens--*she liked playing because all of the different things on the wall and counting them.*

> *In the game with the different activities, I saw him very motivated, counting which were missing to complete the quantity of 10. In the game of completing the tens, he had difficulty at the beginning, but I saw him very concentrated to not mess up and do it better. At the end he did it very well. In the vegetable activities, I saw him very attentive seeing which were missing and he liked where he had to complete the shapes of snow. I saw my child very attentive when he had to search in the snow to find the houses that are buried in the snow. The other activities I knew that he understood because some he had already done well in the classroom before.*

> *He had a hard time with [one] game. He has numbers memorized and can recognize a few by letter, but asking for it in a sequence, like the game did, was a bit challenging for my son.*

The study results suggest that the intervention program helped parents think about their child's mathematics learning in the home environment. They also suggest the three mathematics-related PBS KIDS transmedia suites, along with their corresponding parent support materials available on PBS KIDS Lab, helped parents support their child's mathematics learning over the course of the eight-week intervention. In addition, parents indicated they would continue to support their children's mathematics learning.

Summary of Key Findings

This CPB-PBS Ready To Learn study was designed to test whether the use of PBS KIDS transmedia suites and related support materials increases children's mathematics ability and increases parents' awareness and support of their children's mathematics learning at home. The results indicate that children who were exposed to the PBS KIDS transmedia suites and related support materials in the summer of 2012 outscored their comparison group peers on the TEMA-3, by 4.82 problems with an effect size of 0.27. This difference was significant at the 0.01 level. TEMA-3 is a widely used, standardized, nationally normed achievement test. It measures children's numerical sense, which is the primary focus of the intervention. The treatment group's significant improvement in performance on this assessment shows the impact of the intervention on children's numerical sense development. Children's mathematics ability was also assessed using a researcher-developed measure of mathematics skills. The results indicated no observed differences between the intervention and comparison groups in children's mathematics ability on the small subset of skills covered by the assessment.

The results related to parents' awareness and support of their children's mathematics learning at home indicate that parents were highly involved in supporting their children's mathematics learning. They viewed themselves as facilitators and/or teachers when working with their children. They also felt empowered to teach their children using knowledge gained from the intervention program. Through the intervention program, parents became more aware of their children's mathematics ability. For instance, parents began to identify what their children could do in mathematics, what their children's areas of interest in mathematics were, and what potential challenges their children were facing.

A joint position statement by two leading professional organizations in early childhood and mathematics, the National Association for the Education of Young Children and the National Council of Teachers of Mathematics, assert that early childhood mathematics education should apply children's everyday activities and should continue to introduce or expand upon important mathematics ideas (National Association for the Education of Young Children and National Council of Teachers of Mathematics, 2002). Educators and parents may be looking for ways to strengthen their formal and informal mathematics education for young children. The current intervention program responds to this position recommendation and the needs in early childhood mathematics education by utilizing three PBS KIDS transmedia suites as the platform to encourage children's mathematics learning. The current intervention program uses the transmedia suites to weave mathematics into children's lives through the use of popular PBS KIDS properties, such as *The Cat in the Hat Knows A Lot About That*, *Curious George,* and *Sid the Science Kid*. It also introduces easily adopted and adapted hands-on home activities for parents. Parents can use the PBS KIDS transmedia suites and related support materials as resources to incorporate early mathematics activities into their children's daily lives and their home environment.

Recommendations and Implications for Future Research

Replication of this study is necessary to refine understanding of the impacts associated with the PBS KIDS transmedia suites and the support materials[9]. The childrens' outcome analyses indicated that intervention children significantly improved their mathematics skills in numerical sense, but not in measurement and data, geometry and spatial sense. However, intervention group parents claimed that their children enjoyed the games and activities related to color and shapes and that they were learning these concepts. Given the fact that the current project has limited dosage on the intervention related to measurement and data and geometry and spatial sense, future studies might extend the current program to a longer period of time, and include more PBS KIDS transmedia suites that address the corresponding mathematics concepts. In addition, further investigation on measure(s) that address mathematics concepts beyond numbers and arithmetic will be needed.

For the current project, WestEd researchers supported participating families in learning mathematics by organizing the PBS KIDS transmedia suites and support materials, facilitating weekly parent meetings, and offering technical assistance. This approach is time consuming and expensive, which may limit the scale-up of the intervention model. Future studies can apply an alternative approach, such as the "train the trainer" model. For instance, researchers or professional development providers could offer comprehensive training and technical support to schools, districts, and communities to build their own capacities to support everyday mathematics learning at home using the intervention materials. School staff could be trained on how to adopt

[9] All of the transmedia suites and the support materials are free and can be accessed through http://pbskids.org/lab.

and adapt the intervention materials to reflect the school culture, facilitate the parent meetings to meet diverse families' needs, and provide corresponding technical assistance and follow-ups to encourage family involvement. This "train the trainer" model would respond to the lack of learning programs in preschool homes among diverse, low-income families, and limited kindergarten readiness opportunities in low-income communities.

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Appendix A

Table A1. Baseline Frequency of Different Types of Activities at Home, by Experimental Condition

Measure	Intervention	Comparison	*p*-value based on Mann-Whitney U Test (*p*-value based on Median Test-pooled sample median)[a]
Books and Language Activities			
# of times child did alone			
Median	5.5	9.0**	.01 (.09)
Minimum	0	0	
Maximum	20	48	
N	44	44	
# of times child did with another child			
Median	3.0	4.5	.29 (.67)
Minimum	0	0	
Maximum	18	31	
N	44	44	
# of times child did with another adult			
Median	5.5	8.0	.19 (.29)
Minimum	0	0	
Maximum	23	48	
N	44	44	
Store-Bought Games			
# of times child did alone			
Median	1.0	1.5	.33 (1.00)
Minimum	0	0	
Maximum	12	14	
N	44	44	
# of times child did with another child			
Median	0	0.5	.68 (1.00)
Minimum	0	0	
Maximum	9	8	
N	44	44	
# of times child did with another adult			
Median	2.0	1.0	.76 (.67)
Minimum	0	0	
Maximum	9	10	
N	44	44	
Educational Activities Using Technology			
# of times child did alone	3.5	5.0	.09 (.33)
Median	0	0	
Minimum	16	40	
Maximum	44	45	

N			
# of times child did with another child			
Median	1.0	2.0*	.02 (.35)
Minimum	0	0	
Maximum	17	16	
N	44	45	
# of times child did with another adult			
Median	3.0	2.0	.77 (.60)
Minimum	0	0	
Maximum	16	39	
N	44	45	
Other Educational or Mental Stimulating Activities and Toys			
# of times child did alone			.07 (.17)
Median	4.0	7.0	
Minimum	0	0	
Maximum	19	39	
N	44	45	
# of times child did with another child			
Median	0	2.5	.08 (.09)
Minimum	0	0	
Maximum	13	39	
N	44	44	
# of times child did with another adult			
Median	2.0	4.5*	.03 (.13)
Minimum	0	0	
Maximum	30	39	
N	44	44	
Educational Activities in the Home Routine			
# of times child did alone			
Median	1.0	2.0	.22 (.29)
Minimum	0	0	
Maximum	18	16	
N	44	44	
# of times child did with another child			
Median	0	0	.51 (.83)
Minimum	0	0	
Maximum	9	16	
N	44	44	
# of times child did with another adult			
Median	3.0	5.5**	.01 (.53)
Minimum	0	0	
Maximum	19	16	
N	44	44	
Activities Your Child Participated in Away from Home			
# of times child did alone			
Median	0	0	.71 (.95)
Minimum	0	0	

Maximum	5	9	
N	43	44	
# of times child did with another child			
Median	0	0	.20 (.36)
Minimum	0	0	
Maximum	7	10	
N	43	44	
# of times child did with another adult			
Median	1.0	2.0	.06 (.06)
Minimum	0	0	
Maximum	8	10	
N	43	44	

** Significantly different from zero at the .05 level.*

***Significantly different from zero at the .01 level.*

[a] Preliminary descriptive analysis indicated that the data were widely spread. Nonparametric tests were applied to test whether intervention and comparison groups were equivalent at baseline on frequency of different types of activities at home. Two nonparametric tests were applied: Mann-Whitney U Test that compares distribution across groups, and Median test that compares medians across groups.

Table A2. Frequency of PBS KIDS Online Game Usage: Days

	5-7 days	2-4 days	Less than 2 days
Week 1			
# of Students	20	22	3
%	44.5	49	6.7
Week 2			
# of Students	12	26	7
%	26.7	57.8	15.5
Week 3			
# of Students	8	26	11
%	17.7	57.8	24.5
Week 4			
# of Students	13	27	5
%	29	60	11.1
Week 5			
# of Students	10	23	12
%	22.3	51.1	26.7
Week 6			
# of Students	8	23	14
%	17.7	51.1	31.1
Week 7			
# of Students	9	18	18
%	20	40	40

Table A3. Frequency of PBS KIDS Online Game Usage: Minutes

	More than 210 minutes	150-210 minutes	75-149 minutes	Less than 75 minutes
Week 1				
# of Students	18	12	9	6
%	40	26.7	20	13.3
Week 2				
# of Students	12	6	12	15
%	26.7	13.3	26.7	33.3
Week 3				
# of Students	14	4	11	16
%	31.1	8.9	24.4	35.6
Week 4				
# of Students	14	2	12	17
%	31.1	4.5	26.6	37.8
Week 5				
# of Students	12	5	7	21
%	26.7	11.1	15.5	46.7
Week 6				
# of Students	9	4	13	19
%	20	8.9	28.9	42.2
Week 7				
# of Students	10	2	11	22
%	22.2	4.5	24.4	48.9

Table A4. Most Frequently Used Online Games

Games	Average Days	Average Minutes
***The Cat in the Hat Knows A Lot About That* Transmedia Suite**		
Huff Puff-a-Tron	4.5	40.6
The Great Shape Race	4.6	40.5
***Curious George* Transmedia Suite**		
Hide & Seek	5.4	47.6
Apple Picking	5.3	37.0
Blast Off	5.2	32.2
Hat Grab	4.6	28.6
Fair Shares	4.1	37.5
Monkey Jump	4.5	29.3
***Sid the Science Kid* Transmedia Suite**		
Vegetable Harvest	5.1	35.2

Table A5. Frequency of Hands-on Activities Played at Home

	More than 60 minutes	40-60 minutes	20-40 minutes	Less than 20 minutes
Week 2				
# of Students	3	16	25	1
%	6.7	35.6	55.6	2.2
Week 3				
# of Students	4	7	29	5
%	8.9	15.6	64.4	11.1
Week 4				
# of Students	1	11	26	7
%	2.2	24.4	57.8	15.5
Week 5				
# of Students	1	7	31	6
%	2.2	15.6	68.9	13.4
Week 6				
# of Students	1	11	24	9
%	2.2	24.4	53.3	20
Week 7				
# of Students	0	11	22	12
%	0	24.4	48.9	26.7

Table A6. Researcher-Developed Measure of Mathematics Skills Descriptive Results (*n*=90)

Item	Condition	No Improvement		Improvement (N)		Mastery (N)		Perfect (N)		Total (N)
		N	%	N	%	N	%	N	%	
Sort by Color										
	Treatment	18	40.00%	2	4.44%	10	22.22%	15	33.33%	45
	Comparison	18	40.00%	3	6.67%	10	22.22%	14	31.11%	45
Sort by Shape										
	Treatment	26	57.78%	1	2.22%	9	20.00%	9	20.00%	45
	Comparison	27	60.00%	2	4.44%	8	17.78%	8	17.78%	45
Sort by Size										
	Treatment	23	51.11%	0	0.00%	11	24.44%	11	24.44%	45
	Comparison	26	57.78%	1	2.22%	8	17.78%	10	22.22%	45
Collected the Most										
	Treatment	9	20.00%	--		10	22.22%	26	57.78%	45
	Comparison	12	26.67%	--		11	24.44%	22	48.89%	45
Collected the Least										
	Treatment	22	48.89%	--		5	11.11%	18	40.00%	45
	Comparison	20	44.44%	--		10	22.22%	15	33.33%	45
Count by Fives										
	Treatment	39	86.67%	6	13.33%	0	0.00%	0	0.00%	45
	Comparison	40	88.89%	5	11.11%	0	0.00%	0	0.00%	45
Circles										
	Treatment	28	62.22%	5	11.11%	5	11.11%	7	15.56%	45
	Comparison	28	62.22%	4	8.89%	8	17.78%	5	11.11%	45
Triangles										
	Treatment	24	53.33%	3	6.67%	4	8.89%	14	31.11%	45
	Comparison	17	37.78%	1	2.22%	5	11.11%	22	48.89%	45
Rectangles										
	Treatment	25	55.56%	4	8.89%	11	24.44%	5	11.11%	45
	Comparison	28	62.22%	4	8.89%	4	8.89%	9	20.00%	45
Squares										
	Treatment	28	62.22%	1	2.22%	13	28.89%	3	6.67%	45
	Comparison	29	64.44%	2	4.44%	6	13.33%	8	17.78%	45
Counting Backward From Five										
	Treatment	24	53.33%	14	31.11%	2	4.44%	5	11.11%	45
	Comparison	22	50.00%	15	34.09%	2	4.55%	5	11.36%	44
Make Ten, Seven Ducks										
	Treatment	32	71.11%	--		8	17.78%	5	11.11%	45
	Comparison	27	61.36%	--		7	15.91%	10	22.73%	44
Make Ten, Four Bears										
	Treatment	34	75.56%	--		8	17.78%	3	6.67%	45
	Comparison	34	77.27%	--		8	18.18%	2	4.55%	44

Item	Condition	No Improvement		Improvement (N)		Mastery (N)		Perfect (N)		Total (N)
		N	%	N	%	N	%	N	%	
Missing Low Number										
	Treatment	26	57.78%	--		9	20.00%	10	22.22%	45
	Comparison	20	45.45%	--		8	18.18%	16	36.36%	44
Missing High Number										
	Treatment	28	62.22%	--		9	20.00%	8	17.78%	45
	Comparison	19	43.18%	--		8	18.18%	17	38.64%	44

Appendix B: Sample of Weekly Fidelity Survey

Parent Reflection Log
Reflexión semanal del padre/guardián

week 2 day 1

Child's Name *(Nombre del niño)*: _____

Home Math Activity: Number Cards
Actividad en casa: Tarjetas con números

1. Did you do the activity with your child?
   ¿Hizo la actividad con su hijo/a?
   ☐ Yes *Sí* ☐ No

   If yes, about how long did your child do the activity?
   Si la hicieron, ¿por cuánto tiempo?
   ☐ 5–10 min ☐ 10–15 min
   ☐ 15–20 min ☐ 20–30 min
   ☐ Other *Otro* _____

2. Did you like the activity?
   ¿Le gustó la actividad?
   ☐ Yes *Sí* ☐ No

COMMENTS *COMENTARIOS*

3. Is there anything you want to share with us? *¿Hay algo más que quiere decirnos?*

_____

_____

_____

_____

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 2 • 1

week 2 day 2

Home Math Activity: Hide and Seek (Pre-game Activity)
Actividad en casa: Escondidas (Actividad antes de jugar)

1. Did you do the pre-game activity with your child? *¿Hizo la actividad antes de jugar con su hijo/a?*
   ☐ Yes *Sí* ☐ No

   If yes, about how long did your child do the activity? *Si la hicieron, ¿por cuánto tiempo?*
   ☐ 5–10 min ☐ 10–15 min
   ☐ 15–20 min ☐ 20–30 min
   ☐ Other *Otro* _____

2. Did you like the pre-game activity? *¿Le gustó la actividad antes de jugar?*
   ☐ Yes *Sí* ☐ No

Online Game: Hide and Seek
Juego en línea: Escondidas

3. Did you play the online game with your child? *¿Hizo el juego en línea con su hijo/a?*
   ☐ Yes *Sí* ☐ No

   If yes, about how long did your child play the online game? *Si lo hicieron, ¿por cuánto tiempo jugaron?*
   ☐ 5–10 min ☐ 10–15 min
   ☐ 15–20 min ☐ 20–30 min
   ☐ Other *Otro* _____

COMMENTS *COMENTARIOS*

4. Is there anything you want to share with us? *¿Hay algo más que quiere decirnos?*

_____

_____

_____

Parent Reflection Log
Reflexión semanal del padre/guardián

week 2 day 3

Child's Name *(Nombre del niño)*: _____

Online Games: *Juegos en línea:*	**Flower Garden** *Jardín de flores* 	**Monkey Jump** *El mono salta* 	**Hide and Seek** *Escondidas* 
1. Did you play the online game with your child? *¿Hizo el juego en línea con su hijo/a?*	☐ Yes *Sí* ☐ No	☐ Yes *Sí* ☐ No	☐ Yes *Sí* ☐ No
If yes, about how long did your child play the online game? *Si lo hicieron, ¿por cuánto tiempo jugaron?*	☐ 5–10 min ☐ 10–15 min ☐ 15–20 min ☐ 20–30 min ☐ Other *Otro* _____	☐ 5–10 min ☐ 10–15 min ☐ 15–20 min ☐ 20–30 min ☐ Other *Otro* _____	☐ 5–10 min ☐ 10–15 min ☐ 15–20 min ☐ 20–30 min ☐ Other *Otro* _____
2. Did you like the online game? *¿Le gustó?*	☐ Yes *Sí* ☐ No	☐ Yes *Sí* ☐ No	☐ Yes *Sí* ☐ No

COMMENTS *COMENTARIOS*

3. Is there anything you want to share with us? *¿Hay algo más que quiere decirnos?*

_____

_____

_____

_____

week 2 day 4

Online Games: Free Play
Juegos en línea: juego libre

1. Which online games did your child play? (Please check all that apply.)
   ¿Cuáles juegos en línea hizo su hijo/a? (Por favor marque todos los que aplican.)

- ☐ Hide and Seek *(Escondidas)*
- ☐ Flower Garden *(El jardín de flores)*
- ☐ Monkey Jump *(El mono salta)*
- ☐ Weather Surprise *(El tiempo sorpresa)*
- ☐ Bubble Pop *(Burbujas)*
- ☐ The Great Shape Race *(La gran carrera de formas)*

2. If your child played at least one online game, about how long did your child play the online game(s)?
   Si su hijo/a jugó al menos uno de los juegos en línea, ¿por cuánto tiempo jugó hoy?

- ☐ 5–10 min
- ☐ 10–15 min
- ☐ 15–20 min
- ☐ 20–30 min
- ☐ Other *Otro* _____

COMMENTS *COMENTARIOS*

3. Is there anything you want to share with us? *¿Hay algo más que quiere decirnos?*

_____

_____

_____

_____

Appendix C: Program Outline

	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8
Theme	Shapes	Numbers	Counting	Adding	Comparing	Counting Backward & Skip Counting	Sorting	Exploring Together
Day 1: Hands-on Activity	"What's in the Bag?" (VPK)	"Number Cards" (VPK)	"How Many Colors?" (Lab)	"Train Station" activity (CG)	"Ribbit" activity (CG)	"Hands Down" (Lab)	"Home Collections" (VPK)	"Sid's Science Fair" app (Sid)
Day 2: Hands-on Activity & Online Game	"Buddy's Gem Hunt" (BU & DT)	"Hide and Seek" (BU & CG)	"Apple Picking" (CG)	"Vegetable Harvest" (BU & Sid)	"Bug Catcher" (BU & CG)	"Blast Off" (CG)	"Hat Grab" (CG)	--
Day 3: Online Games	CITH: Huff Puff a Tron, CITH: Great Shape Race, DT: Buddy's Gem Hunt	CG: Hide and Seek, CG: Flower Garden, CG: Monkey Jump	CG: Apple Picking, DT: Buddy's Gem Hunt, CG: Meatball Launcher	CG: Museum of Tens, CG: Train Station, Sid: Vegetable Harvest	CG: Bug Catcher, CG: Apple Picking, CG: Fair Shares	CG: High Five, CG: Blast Off, Sid: Vegetable Harvest	CG: Hat Grab, Sid: Sorting Box, CITH: Great Shape Race	--
Day 4: Free Play Games	CITH: Sketch a Mite, Sid: Crystals Rule, CG: Bunny Ride	Sid: Weather Surprise, CG: Bubble Pop, CITH: Great Shape Race	Sid: Vegetable Planting, CG: Count with Allie, CG: Hide and Seek	Sid: Vegetable Patterns, CG: Ribbit, CITH: Huff Puff a Tron	Sid: Pan Balance, CITH: Hermit Shell Game, CG: Meatball Launcher	Sid: Snowflake Match, CG: Bunny Ride, DT: Buddy's Gem Hunt	Sid: Snow Search, CG: Blast Off, CG: Apple Picking	--

Key:
VPK – Chicago Virtual Pre-K Activity
Lab – PBS KIDS Lab Activity
BU – Boston University "Teaching Tips" Module Activity
CG – *Curious George*
Sid – *Sid the Science Kid*
CITH – *The Cat in the Hat Knows a Lot About That*
DT – *Dinosaur Train*

Appendix D: Logic Model