

Odd Squad: Learning Math with PBS KIDS Transmedia Content at School and Home

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

Michelle Tiu, Ed.M.
Betsy McCarthy, Ph.D.
Linlin Li, Ph.D.

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Highlights of the Findings

In spring 2015, WestEd conducted a study for the CPB-PBS Ready To Learn Initiative of a school- and home-based transmedia mathematics intervention based on the resources in the PBS KIDS *Odd Squad* transmedia suite. The transmedia mathematics intervention, called *Odd Squad Math*, or OSM, for purposes of the study, included a wide variety of *Odd Squad* transmedia assets, including episodes from the television series, educational online games, interstitials (i.e., short video clips), and hands-on activities. The intervention was used in the first-grade classroom and in participants' homes. The current study explores the effectiveness of using *Odd Squad Math* to improve elementary-age students' mathematics learning, specifically in the domains of Algebraic Thinking and Numbers and Operations.

Findings Around Students' Knowledge and Skills in Mathematics

- Over the course of the *Odd Squad* intervention, students' overall knowledge of mathematics in the domains of Numbers and Operations and Algebraic Thinking increased significantly (Pre-test mean = 42.80, Post-test mean = 48.70, $p < 0.001$).
- In sub-categories of mathematical knowledge, students showed significant and positive pre- and post-changes on their knowledge of skip counting (Pre-test mean = 10.92, Post-test mean = 13.61, $p < 0.001$), pattern recognition (Pre-test mean = 9.49, Post-test mean = 10.12, $p < 0.01$), and simple addition and subtraction (Pre-test mean = 18.72, Post-test mean = 20.95, $p < 0.01$).

Advantages of Using the OSM Transmedia Intervention in the Classroom and Home

- Analyses suggest that OSM supported students' mathematics learning. Teachers mentioned that OSM supported mathematics learning for their grade level, especially in the areas of patterns and skip counting. Approximately one third of the parents who took part in OSM home activities mentioned that OSM supported their children's learning of patterns, skip counting, addition, subtraction, and mathematics vocabulary.
- Three out of four teachers mentioned that *Odd Squad's* plot device of showing children constructing and testing arguments, listening and responding to the theories and perspectives of others, and persevering to solve complex problems could be framed to support teaching around the Standards of Mathematical Practice, part of the Common Core State Standards.
- Parents participating in focus groups at the end of the study mentioned they noticed their child practicing and improving in mathematics during the study. Domains of mathematics most often mentioned by parents were addition, subtraction, and mathematics vocabulary.
- A subset of parents who used OSM materials took ideas from them to create their own ways to support their child's learning.
- Teachers and parents often mentioned that the *Odd Squad's* fast-paced and playful narrative, along with the plot device of making viewers and players part of the *Odd Squad* problem-solving team, brought a strong motivational factor to mathematics learning during the intervention.

- Teachers reported that the intervention’s transmedia content, including a storyline with academic content connected across multiple platforms and environments, allowed their students to make useful connections and reinforce their mathematics learning through different media.
- Data suggest that parents had positive experiences with their children when engaging with the OSM activities at home, and that teachers felt the home component of the intervention was useful.

Executive Summary

In spring 2015, WestEd conducted a study for the CPB-PBS Ready To Learn Initiative of a school- and home-based transmedia mathematics intervention based on the resources in the PBS KIDS *Odd Squad* transmedia suite. The transmedia mathematics intervention, called *Odd Squad Math*, or OSM, for purposes of the study, included a wide variety of *Odd Squad* transmedia assets, including episodes from the television series, educational online games, interstitials (i.e., short video clips), and hands-on activities. The current study addresses how children use and learn in transmedia learning environments. A primary feature of the intervention is a transmedia learning environment that includes high-quality video episodes, digital games, and hands-on activities for classroom and home. All learning materials are connected by a strong narrative and carefully curated mathematics content. During the intervention, students are invited to enter the world created by the narrative and to work with its appealing characters to solve mathematics problems in a fun, engaging learning environment.

The purpose of the study was to test the promise of using *Odd Squad Math* to enhance first-grade students’ mathematics learning. During the study, participating students used a school- and home-based intervention that included videos, online games, interstitials, and hands-on activities from the *Odd Squad* transmedia suite. The research questions that guided the study were:

1. Does the use of *Odd Squad Math* lead to gains in students’ mathematics knowledge in the domains of Algebraic Thinking (specifically, the topic of patterns) and Numbers and Operations (specifically, the topic of skip counting)?
2. What are the advantages of using the *Odd Squad Math* intervention in the elementary school classroom?

The Study Intervention

The *Odd Squad Math* intervention featured two primary components — an in-class component and an at-home component. The resources included in both the in-class and at-home components were drawn from the *Odd Squad* transmedia suite, including seven episodes from the television series, two educational online games, three interstitials, and five hands-on activities. OSM was designed for use in the first-grade classroom and in participants’ homes, and focused on the mathematics domains of Algebraic Thinking and Numbers and Operations.

OSM featured two “cases” consisting of content from the *Odd Squad* transmedia suite focused on the mathematical domains of Algebraic Thinking and Numbers and Operations. Each case included 4–6 days of classroom activities, with each day of activities taking between 15 and 30 minutes to complete. Teachers were provided with a recommended sequence and pacing of activities for each case, though they were free to use the resources in the order and timeframe that worked best for their classrooms (e.g., moving an activity that involved technology to a day when the school laptop cart was available). The OSM activities

did not need to be conducted on consecutive days in the classroom, and could be used by teachers over the course of 2–4 weeks in their classrooms.

On the first day of each case, teachers showed a 10-minute full-length *Odd Squad* episode during class time. The purpose of viewing the episode was to introduce the mathematics content of the case and to introduce the narrative storyline that would be explored. On the second day of each case, students were encouraged to play an interactive, educational online game from the PBS KIDS *Odd Squad* website. The online games were related to the storyline that was presented in the full-length episode, which allowed students to take an active role as an “agent” in the case. The remaining days of each case included a mix of interstitials and hands-on activities that allowed students to further reinforce and practice the skills that were explored in the first two days of the case.

The at-home component included five at-home *Odd Squad* episodes and accompanying activities. The at-home activities were aligned and sequenced with the in-class activities, such that a concept would first be introduced in the classroom and then be reinforced and further practiced at home. For each at-home episode and activity, parents were encouraged to co-view an *Odd Squad* episode with their child. After watching the *Odd Squad* episode together, parents were encouraged to follow a detailed activity guide that was related to the episode. The activity guide included a description and explanation of the mathematics content and vocabulary that was used in the episode. The activity guide also included a list of suggested questions that parents could ask their child about the mathematics content in the episode, along with accompanying answers. Lastly, the activity guide provided a short mathematics activity that parents could complete with their child in order to further practice the mathematics content. Each at-home episode and activity took approximately 30 minutes to complete: 15 minutes to co-view the *Odd Squad* episode, and 15 minutes to complete the questions and suggested activities in the activity guide.

Study Methodology

Participants

Four first-grade teachers from the San Francisco Bay Area and their classrooms (n = 83 first-grade students and their families) participated in the study. All participants were recruited from elementary schools serving low-income communities, and all participants in the study received the *Odd Squad Math* intervention.

Instruments

Student Verbal Mathematics Assessment. Students were assessed using a one-on-one verbal mathematics assessment. The items included in this assessment were selected or adapted from the TEMA-3. The TEMA-3, or the Test of Early Mathematics Ability, third edition, is a test of children’s informal and formal mathematics knowledge, developed by Western Psychological Services. The TEMA-3 is a standardized, nationally normed achievement test (Ginsburg & Baroody, 2003). The test is designed for use with children ages 3 years and 0 months through 8 years and 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. Researchers selected and adapted a subset of items from the TEMA-3 that are aligned to the domains of Numbers and Operations and the skill of skip counting that were focused on in the intervention. Students were assessed using this verbal mathematics assessment both before and after participating in the intervention.

Student-Written Mathematics Assessment. Students were assessed using a researcher-developed mathematics proximal assessment both before and after participating in the intervention. The pencil-and-paper assessment was administered to students either at the class level or in small groups, with the test administrator (the teacher or a teaching assistant) reading assessment instructions aloud to students. The proximal assessment addressed the domains of Numbers and Operations and Algebraic Thinking. The assessment was not a timed test, and no precise time limits were imposed on students being tested.

Mathematics Assessment Resource Service (MARS) Assessment. The Mathematics Assessment Resource Service (MARS) assessments are performance-based tasks that require extended open responses from students. The tasks assess math concepts and skills that correspond to the core ideas taught at each grade level. The tasks also assess the mathematical processes of problem solving, reasoning, and communication. The MARS tasks are scored using a detailed, point-scoring rubric. Each task is assigned a point total that corresponds to the complexity of the task and the proportional amount of time that the average student would spend on the task in relation to the entire exam. The combination of open tasks and weighted rubrics provides a rich picture of student performance, including their problem-solving approaches, strategies to find solutions, explanation of student thinking, and justification of their findings. A subset of tasks related to the domains of Numbers and Operations and Algebraic Thinking was selected for use in the study. Students were assessed using this subset of MARS tasks both before and after participating in the intervention.

Student Mathematics Vocabulary Assessment. Students were assessed using a researcher-developed mathematics vocabulary assessment both before and after participating in the intervention. The one-on-one assessment was administered to individual students to assess students' mathematics vocabulary. Students were required to verbally provide definitions of mathematics-related words (e.g., pattern, conjecture) that were emphasized in *Odd Squad Math* intervention. Researchers used a detailed rubric to evaluate the quality of the students' definitions and scored the items correct, incorrect, or partially correct.

Teacher Interviews. After participating in the intervention, classroom teachers participated in a teacher interview. Teachers were asked to elaborate on how the *Odd Squad Math* intervention was incorporated into their regular classroom environment, how their students responded to the content, whether they felt the content helped to support their students' learning in mathematics, and whether they felt the content helped to develop their students' mathematical practices.

Parent Survey. Before and after participation in the intervention, parents of participating students were asked to complete a short parent survey. The survey included items related to parents' awareness of children's mathematical development and to parents' support of their child's mathematics learning in their home environment. The survey also collected demographic information from parents, and was available for parents to complete in both English and Spanish.

Parent Focus Groups. After participating in the intervention, parents were invited to participate in a brief focus group at their child's school. In the focus group, parents were asked to elaborate on how the *Odd Squad Math* episodes, activities, and online games were used in the home environment, how their child responded to the content, and whether they felt the intervention helped them to support their child's learning in mathematics and increased their awareness of their child's learning in mathematics. Focus groups were conducted in either English or Spanish, depending on parents' language preference, and were facilitated by a WestEd researcher. Each focus group lasted 20–30 minutes.

Results

Successful Implementation

- Four first-grade teachers and their classrooms (n = 83 first-grade students) participated in the study. With the exception of one teacher who skipped one hands-on activity, the teachers used all episodes, games, and activities as recommended in the OSM intervention. Pre- and post-assessment data were collected for all 83 students who participated in the study.
- Approximately 80 percent of participating families used OSM during the intervention. About 80 percent of families watched all of the episodes included in the home component of the intervention, and about half of these families used the other components along with the episodes.

Findings Around Students' Knowledge and Skills in Mathematics

- Over the course of the *Odd Squad* intervention, students' overall knowledge of mathematics in the domains of Numbers and Operations and Algebraic Thinking increased significantly (Pre-test mean = 42.80, Post-test mean = 48.70, $p < 0.001$).
- In sub-categories of mathematical knowledge, students showed significant and positive changes from pre- to post-test on their knowledge of skip counting (Pre-test mean = 10.92, Post-test mean = 13.61, $p < 0.001$), pattern recognition (Pre-test mean = 9.49, Post-test mean = 10.12, $p < 0.01$), and simple addition and subtraction (Pre-test mean = 18.72, Post-test mean = 20.95, $p < 0.01$).

Advantages of Using the OSM Transmedia Intervention in the Classroom and Home

- **Odd Squad Math Supported Students' Learning of Mathematics.** Analyses of the qualitative data — teacher interviews and parent focus groups — suggest that OSM supported students' mathematics learning. In particular, teachers mentioned that OSM supported mathematics learning for their grade level, especially in the areas of patterns and skip counting. Approximately one-third of the parents who took part in OSM home activities mentioned that OSM supported their children's learning of patterns, skip counting, addition, subtraction, and mathematics vocabulary.
- **Potential of Odd Squad Math to Support the Standards of Mathematical Practice.** Analysis of teacher interview data showed that three of the four participating teachers reported that the OSM's narrative-based structure supported learning in specific areas of the Standards of Mathematical Practice. These teachers mentioned that *Odd Squad* shows examples of children constructing and testing arguments, listening and responding to the theories and perspectives of others, and persevering to solve complex problems. Teachers mentioned that the activities featured in the show could be framed to support teaching around the Standards of Mathematical Practice (CCSS-M).
- **Parents Noticed Their Children Improving on Target Mathematics Content.** The majority of parents participating in focus groups at the end of the study mentioned they noticed their child practicing and improving in mathematics during the study. Domains of mathematics most often mentioned by parents were addition, subtraction, and mathematics vocabulary. A subgroup of parents mentioned additional mathematics topics, including pattern recognition and skip counting.
- **Parents Created Other Learning Activities to Support the OSM Content.** Qualitative data analysis suggests that a subset of parents who used OSM materials took ideas from the *Odd Squad* materials to create their own ways to support their child's learning.

- **Exciting Storyline in Odd Squad Math Spurred Engagement in Mathematics.** OSM involves episodes, games, and activities that include a fast-paced, playful narrative domain that draws students into storylines. OSM invites students to be a part of the *Odd Squad* team and to help solve “cases” that involve using mathematics. In interviews and focus groups, teachers and parents often mentioned that these engaging aspects of OSM boosted students’ interest in mathematics and in solving mathematics problems. All of the teachers mentioned that the *Odd Squad* plot device of making viewers and players part of the *Odd Squad* problem-solving team brought a strong motivational factor to mathematics learning during the intervention.
- **Transmedia Content in Odd Squad Math Adds Educational Value.** Qualitative data analysis suggests that the intervention’s transmedia content, including a storyline with academic content that is connected across multiple platforms and environments, added educational value to the OSM learning environment. Teachers reported that the combination of episodes, digital games, and hands-on activities allowed their students to make useful connections and reinforce their mathematics learning through different media.
- **Parents Appreciated Odd Squad Math.** Parents reported they had positive experiences with their children when engaging with the OSM activities at home. Parents said that they were impressed with the mathematics content and felt that it was teaching meaningful mathematics concepts to their children. Parents reported that engaging in the OSM episodes and activities together with their children inspired meaningful dialogue and that they were able to learn from OSM alongside their children. Several parents mentioned that while using OSM with their children, they saw their children successfully learning through play. These parents reported realizing that learning through play was an effective way for their children to gain an understanding of and solidify new math concepts.
- **Teachers Felt the Home Components of Odd Squad Math Were Useful.** All teachers mentioned that they liked the idea of having families involved in the intervention. Teachers commented that by including families in OSM, students became more involved in the *Odd Squad* narrative and the mathematics content.

Odd Squad: Learning Math with PBS KIDS Transmedia Content at School and Home

Introduction

As part of the CPB-PBS Ready To Learn Initiative, PBS KIDS designed and developed the *Odd Squad* television series and transmedia suite, which included educational media, television episodes, online games, and hands-on resources.¹ As a part of the U.S. Department of Education’s Ready To Learn program, the collaboration of CPB, PBS, and the U.S. Department of Education has played a significant role in advancing the use of transmedia in early math learning. *Odd Squad* is a live-action television series that features “special agents” who use math to solve “odd” cases, and it emphasizes the importance of problem solving, teamwork, and perseverance. The *Odd Squad* transmedia suite uses connected narrative arcs throughout educational resources and media platforms to engage children and support learning around specific math topics.

¹ “Transmedia” connotes a technique of representing a narrative or story experience across multiple platforms and formats.

In spring 2015, WestEd conducted a study of a school- and home-based transmedia mathematics intervention based on the resources in the *Odd Squad* transmedia suite. The transmedia mathematics intervention, called *Odd Squad Math*, or OSM, for purposes of the study, included a wide variety of *Odd Squad* transmedia assets, including episodes from the television series, educational online games, interstitials (i.e., short video clips), and hands-on activities. The intervention was used in the first-grade classroom and in participants' homes. The current study explores the effectiveness of using *Odd Squad Math* to improve elementary-age students' mathematics learning, specifically in the domains of Algebraic Thinking and Numbers and Operations.

Review of Literature

Growth in Technology and Digital Learning in the Classroom and at Home

With increased access to computers, video streaming, and mobile technologies, a growing number of young students are interacting with educational digital media via computers, tablets, mobile phones, and other devices. In families with children age 8 and under, there has been tremendous growth in ownership of tablet devices, from 8 percent of all families in 2011 to 40 percent in 2013. In addition, the percentage of all children with access to a tablet, smartphone, or other mobile device at home jumped from 52 percent in 2011 to 75 percent in 2013 (Common Sense Media, 2013). At the same time, the use of computers and tablets at school is growing rapidly. It is estimated that over 73 percent of elementary school students have access to computers in the classroom (Project Tomorrow, 2015) and over one third have access to school-issued mobile devices (Nagel, 2014). Though the use of digital media and games for learning has grown significantly in the past several years, growth in the use of digital products such as video streaming and games in the classroom is recent (Ash, 2012; Lisenbee, 2009; National Institute for Literacy, 2008; Project Tomorrow, 2014 Rideout, Lauricella, & Wartella, 2011; Rosen & Jaruszewicz, 2009; Takeuchi & Vaala, 2014).

The Promise of Learning with Transmedia

With increased growth in access to digital learning media, educators, families, and researchers are recognizing that digital learning media brings unique advantages to support students' learning (Hsu, Tsai, & Liang, 2011; Huang, 2011; Papastergiou, 2009; Wang & Chen, 2010). One particular type of digital media experience that shows great promise for student learning is called "transmedia storytelling," or "transmedia." Transmedia connotes the technique of representing a narrative or story experience across multiple platforms and formats (Herr-Stephenson, Alper, Reilly, & Jenkins, 2013; Jenkins, 2006). Numerous studies have found positive impacts of transmedia in the learning environment, including a deepened motivation to engage in academic content and persevere in problem solving, creation of a unified learning experience, improvement of the learning process by means of integrating knowledge and skills, and gains in student achievement (Andreu, Marti, & Aldas, 2012; Cohen, Ducamp, Kjellstrom, & Tillman, 2012; Gilardi & Reid, 2011; Karoulis & Demetriadis, 2005; McCarthy, Li, & Tiu, 2012; McCarthy, Li, Atienza, Sexton, & Tiu, 2013; McCarthy, Li, Tiu, Atienza, & Sexton, 2015; Pasnik & Llorente, 2013). Taken together, these studies suggest that transmedia brings particular advantages to learning interactions that may be beneficial. These advantages include 1) engaging, narrative-based content that often enhances students' motivation to learn; 2) academic content presented in multiple modalities, allowing children to experience content in different contexts and providing multiple supports for different types of learners; and 3) numerous opportunities to engage in academic content at school and home.

The Current Study

The current study addresses the need for research on how children use and learn in transmedia learning environments. A primary feature of the intervention is a transmedia learning environment that includes high-quality video episodes, digital games, and hands-on activities for classroom and home. All learning materials are connected by a strong narrative domain and carefully curated mathematics content. During the intervention, students are invited to enter the world of the narrative domain's storylines and to work with the domain's appealing characters to solve mathematics problems in a fun, engaging learning milieu.

Study of *Odd Squad Math*

Research Questions

The purpose of the study was to test the promise of using *Odd Squad Math* to enhance first-grade students' mathematics learning. During the study, participating students used a school- and home-based intervention that included videos, online games, interstitials, and hands-on activities from the *Odd Squad* transmedia suite. The research questions that guided the study were:

1. Does the use of *Odd Squad Math* lead to gains in students' mathematics knowledge in the domains of Algebraic Thinking (specifically, the topic of patterns) and Numbers and Operations (specifically, the topic of skip counting)?
2. What are the advantages of using the *Odd Squad Math* intervention in the elementary school classroom?

The Intervention

The *Odd Squad Math*, or OSM, intervention featured two primary components — an in-class component and an at-home component. The resources included in both the in-class and at-home components were drawn from the *Odd Squad* transmedia suite, including seven episodes from the television series, two educational online games, three interstitials (i.e., short video clips), and five hands-on activities. OSM was designed for use in the first-grade classroom and in participants' homes, and focused on the mathematics domains of Algebraic Thinking and Numbers and Operations.

In-Class Activities: Odd Squad Math Cases

OSM featured two “cases” consisting of content from the *Odd Squad* transmedia suite focused on the mathematical domains of Algebraic Thinking and Numbers and Operations. The first case focused on the topic of patterns, and the second case focused on the topic of skip counting. The cases featured a variety of resources that were related both mathematically and thematically, and were selected from the larger *Odd Squad* transmedia suite available on the PBS KIDS website. The learning objectives for each of the OSM cases are presented in the table below. (The appendix provides a detailed overview of each OSM case.)

Table 1. Learning objectives for *Odd Squad Math* cases.

Case	Learning Objectives
Case 1: Patterns	Students will be able to: <ul style="list-style-type: none"> • Identify and extend color, picture, sound, or number patterns • Use algebraic thinking and reason inductively by looking for patterns
Case 2: Skip Counting & Fact Families	Students will be able to: <ul style="list-style-type: none"> • Skip count by 2's, 5's, and 10's • Understand subtraction as an unknown addend problem • Determine the unknown whole number in addition or subtraction number sentences

Each OSM case was centered around a full-length *Odd Squad* episode that provided a narrative and mathematics theme for the case. Case 1 featured the episode “Dance Like Nobody’s Watching” and engaged students in recognizing and generating patterns in the context of creating and breaking secret codes. Case 2 featured the episode “The Trouble with Centigurps” and engaged students in counting by 2’s, 5’s, and 10’s in the context of searching for an imaginary creature called a “centigurp.” The remaining activities in each case were selected and intentionally sequenced around the particular math topic and narrative theme that were established by the featured *Odd Squad* episode. The table below presents a list of the transmedia resources and activities included in each case.

Table 2. List of *Odd Squad* transmedia resources and activities included in *Odd Squad Math*.

	Case 1: Patterns	Case 2: Skip Counting & Fact Families
Odd Squad Episodes	Dance Like Nobody's Watching Totally Odd Squad* A Case of the Sing-Alongs*	The Trouble with Centigurps Picture Day* O Games, Part 1* O Games, Part 2*
Interstitials (Short Videos)	Training Video: How to Deal with a Spider-Cat Bite	Odd Report: Raining Cats and Dogs Odd Report: Giant Sighting
Online Games	Code Breaker	Catch the Centigurps
Activities	The Patternista	Fact Families The Case of the Centigurps Odd Squad Hundreds Chart Odd Squad Number Line

* Indicates a resource that was used at home by parents and children.

Each case included 4–6 days of classroom activities, with each day of activities taking between 15 and 30 minutes to complete. Teachers were provided with a recommended sequence and pacing of activities for each case (see the appendix), though they were free to use the resources in the order and timeframe that worked best for their classrooms (e.g., moving an activity that involved technology to a day when the school laptop cart was available). The OSM activities did not need to be conducted on consecutive days in the classroom, and could be used by teachers over the course of two to four weeks in their classrooms.

On the first day of each case, teachers showed a 10-minute, full-length *Odd Squad* episode during class time. The purpose of viewing the episode was to introduce the mathematics content of the case and to introduce the narrative storyline that would be explored. Teachers had the option of using a “pause-and-play” strategy while viewing the episodes with their class in order to engage their students with questions about the episode and to check for understanding. On the second day of each case, students were encouraged to play an interactive, educational online game from the PBS KIDS *Odd Squad* website. The online games were related to the storyline that was presented in the full-length episode, which allowed students to take an active role as an “agent” in the case. For example, in the episode “Dance Like Nobody’s Watching,” Agent Otto tries to decipher a secret code by “dancing” through a series of booby traps in *Odd Squad* headquarters. In the accompanying game, “Code Breaker,” students are placed in a similar situation as Agent Otto in the episode, but are given the ability to crack the secret code on their own by identifying and extending mathematics patterns.

The remaining days of each case included a mix of interstitial videos and hands-on activities that allowed students to further reinforce and practice the skills that were explored in the first two days of the case. The activities were carefully sequenced to build in difficulty level as the case progressed, to provide variety between types of activities (i.e., interactive media vs. hands-on activities), and to align with the activities that were conducted in the at-home component of the intervention. The interstitial videos provided additional examples of the mathematics content in the context of *Odd Squad* cases and investigations (for example, an odd case where it had been “raining” cats and dogs over town, and where agents needed to use their skip counting skills to determine the total number of animals), and the hands-on activities provided additional opportunities for students to practice their mathematics skills in the classroom (for example, using a number line to visualize skip counting).

In-Class Activities: Odd Squad Kick-off Party

In addition to the activities included in the two cases, OSM also featured a variety of supplemental activities that teachers could use in their classrooms to promote student engagement. OSM suggested that teachers use these activities before beginning the OSM cases in their classroom, in the form of an “*Odd Squad* Kick-off Party.” The purpose of the kick-off party was to introduce students to *Odd Squad* and to allow students to become *Odd Squad* “agents.” During the kick-off party, teachers showed students a brief video clip from *Odd Squad*. The clip introduced students to Olive and Otto, the main agents on the show, and explained that *Odd Squad* agents use mathematics to put things right when “oddness” strikes.

During the kick-off party, students were given the opportunity to become *Odd Squad* agents themselves through a series of three activities. In the first activity, “Find Your Badge Number,” students used an encoder wheel to convert the letters in their names into numbers (e.g., A=1, B=2, C=3), and then added those numbers to determine their *Odd Squad* agent number. In the second activity, “Make Your Own Badge,” students colored and decorated their own *Odd Squad* badges and added their agent number to their badges. Students placed their badges inside clip-on plastic nametag holders, and were encouraged by

teachers to wear their badges each time they engaged in an OSM activity. Lastly, students created an agent profile, username, and avatar on the PBS KIDS *Odd Squad* website, so that any progress made and rewards earned on the website could be saved across play sessions.

Teachers were also provided with *Odd Squad* posters and signs that could be used to decorate their classrooms. They were encouraged to display the decorations, which included case files and stills from the television episodes, before they hosted the kick-off party. The decorations included a “Word Wall” and “Evidence Board” that teachers could use to record and display vocabulary words and “evidence” (for example, a sample pattern or a sequence of numbers) that were collected during the students’ investigation of the *Odd Squad* cases.

At-Home Activities

The intervention featured an at-home component in which parents and children could continue to interact with the OSM resources in their home environment. At the beginning of the intervention, teachers communicated with parents and informed them that their children would be participating in the OSM intervention at school. Teachers also informed parents of the at-home activities that they could use with their children to reinforce and extend their children’s mathematics learning at home.

Parents were provided with DVDs that featured all of the *Odd Squad* episodes included in the at-home component. In addition, the DVDs included all of the *Odd Squad* episodes and interstitials that were shown during the in-class component so that parents and children could re-watch episodes and reinforce learning at home. Parents were also given a Parent Binder that contained resources and activities that they could use at home with their children. The Parent Binder included descriptions of *Odd Squad* online games and helpful tips on playing each game; detailed descriptions and screenshots of all *Odd Squad* episodes²; and detailed at-home activity guides to accompany each episode. All resources included in the Parent Binder were provided in both English and Spanish.

In total, the at-home component included five at-home *Odd Squad* episodes and accompanying activities (two at-home episodes and activities for Case 1: Patterns, and three at-home episodes and activities for Case 2: Skip Counting & Fact Families). The at-home activities were aligned and sequenced with the in-class activities such that a concept would first be introduced in the classroom and then be reinforced and further practiced at home. For each at-home episode and activity, parents were encouraged to co-view an *Odd Squad* episode with their child. The co-viewing experience could be shared among parents, children, siblings, extended family members, and friends. After watching the *Odd Squad* episode together, parents were encouraged to follow a detailed activity guide that was related to the episode. The activity guide included a description and explanation of the mathematics content and vocabulary that were used in the episode in order to empower parents to feel comfortable engaging with the mathematics content with their child. The activity guide also included a list of suggested questions and accompanying answers that parents could ask their child about the mathematics content in the episode. For example, in an episode related to skip counting, parents might ask their child, “Why do you think the agents count by 10’s instead of by 1’s?” Lastly, the activity guide provided a short mathematics activity that parents could complete with their child in order to further practice the mathematics content. For example, in the same episode related to skip counting, parents might skip count with their child by counting by 10’s to determine the number of fingers

² These detailed episode descriptions and screenshots were particularly important for families who did not speak English at home, as it allowed parents to access the storyline and mathematics content of each *Odd Squad* episode.

and toes in their household, or by using piles of nickels and dimes to practice counting by 5's and 10's. Each at-home episode and activity took approximately 30 minutes to complete: 15 minutes to co-view the *Odd Squad* episode, and 15 minutes to complete the questions and suggested activities in the activity guide.

Parents and children were also encouraged to use the *Odd Squad* online games at home, provided they had access to the Internet and access to a compatible device (e.g., computer, tablet, smartphone). Children were encouraged to log in to their PBS KIDS *Odd Squad* agent profile while playing the games so that their in-game progress at school and at home could be linked. Parents were encouraged to either co-play the games with their child (sitting side-by-side and playing the games together), or to engage in conversations around game play after their child had played the game. Descriptions of each game, including game objectives and screenshots, were provided in the Parent Binder, in addition to tips that parents could use to support their child through game play.

Study Design and Methodology

The study explored whether the use of the OSM intervention in class and at home impacted elementary-age students' mathematics learning, specifically in the domains of Numbers and Operations and Algebraic Thinking. In addition, the study examined the advantages of transmedia-based learning in the elementary school classroom. The study used a single-subject design that allowed all participating school sites, teachers, and students to take part in the intervention. The study took place in spring 2015 in elementary school classrooms around the San Francisco Bay Area.

Participants

Four first-grade teachers from around the San Francisco Bay Area and their classrooms (n = 83 first-grade students and their families) participated in the study. All participants were recruited from elementary schools serving low-income communities, and all participants in the study received the *Odd Squad Math* intervention.

Instruments

The following instruments were used to collect data during the study:

Student Verbal Mathematics Assessment

Students were assessed using a one-on-one verbal mathematics assessment. The items included in this assessment were selected or adapted from the TEMA-3. The TEMA-3, or the Test of Early Mathematics Ability, third edition, is a test of children's informal and formal mathematics knowledge, developed by Western Psychological Services. The TEMA-3 is a standardized, nationally normed achievement test (Ginsburg & Baroody, 2003). The test is designed for use with children ages 3 years and 0 months through 8 years and 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. Researchers selected and adapted a subset of items from the TEMA-3 that are aligned to the domains of Numbers and Operations and the skill of skip counting that were focused on in the intervention. Students were assessed using this verbal mathematics assessment both before and after participating in the intervention.

Student-Written Mathematics Assessment

Students were assessed using a researcher-developed mathematics proximal assessment both before and after participating in the intervention. The pencil-and-paper assessment was administered to students either at the class level or in small groups, with the test administrator (the teacher or a teaching assistant) reading assessment instructions aloud to students. The proximal assessment addressed the domains of Numbers and Operations and Algebraic Thinking. The assessment was not a timed test, and no precise time limits were imposed on students being tested.

Mathematics Assessment Resource Service (MARS) Assessment

The Mathematics Assessment Resource Service (MARS) assessments are performance-based tasks that require extended open responses from students. The tasks assess math concepts and skills that correspond to the core ideas taught at each grade level. The tasks also assess the mathematical processes of problem solving, reasoning, and communication. The MARS tasks are scored using a detailed, point-scoring rubric. Each task is assigned a point total that corresponds to the complexity of the task and the proportional amount of time that the average student would spend on the task in relation to the entire exam. The combination of open tasks and weighted rubrics provides a rich picture of students' performance, including their problem-solving approaches, strategies to find solutions, explanation of thinking, and justification of their findings. A subset of tasks related to the domains of Numbers and Operations and Algebraic Thinking was selected for use in the study. Students were assessed using this subset of MARS tasks both before and after participating in the intervention.

Student Mathematics Vocabulary Assessment

Students were assessed using a researcher-developed mathematics vocabulary assessment both before and after participating in the intervention. The one-on-one assessment was administered to individual students to assess students' mathematics vocabulary. Students were required to verbally provide definitions of mathematics-related words (e.g., pattern, conjecture) that were emphasized in *Odd Squad Math* intervention. Researchers used a detailed rubric to evaluate the quality of the students' definitions and scored the items correct, incorrect, or partially correct.

Teacher Interviews

After participating in the intervention, classroom teachers participated in a teacher interview. Teachers were asked to elaborate on how the *Odd Squad Math* intervention was incorporated into their regular classroom environment, how their students responded to the content, whether they felt the content helped to support their students' learning in mathematics, and whether they felt the content helped to develop their students' mathematical practices.

Parent Survey

Before and after participation in the intervention, parents of participating students were asked to complete a short parent survey. The survey included items related to parents' awareness of children's mathematical development and to parents' support of their child's mathematics learning in their home environment. The survey also collected demographic information from parents, and was available for parents to complete in both English and Spanish.

Parent Focus Groups

After participating in the intervention, parents were invited to participate in a brief focus group at their child's school. In the focus group, parents were asked to elaborate on how the *Odd Squad Math* episodes, activities, and online games were used in the home environment, how their child responded to the content, and whether they felt the intervention helped them to support their child's learning in mathematics and increased their awareness of their child's learning in mathematics. Focus groups were conducted in either English or Spanish, depending on parents' language preference, and were facilitated by a WestEd researcher. Each focus group lasted 20–30 minutes.

Data Analysis

Data from the student mathematics assessments were scored and cleaned by researchers. A series of paired t-tests were used to analyze changes in the mean from pre- to post-test on students' overall mathematics achievement and their achievement on sub-categories of mathematics.

Researchers used a combination of grounded theory (Strauss & Corbin, 1998) and established methods for coding qualitative data (Miles & Huberman, 1994) to identify and categorize factors that participants described regarding the study's research questions. Throughout the process, researchers used peer debriefing and auditing to check codes and concepts. Identified codes and concepts were further sorted to generate categories. Categories were further reduced to produce study findings.

Results

Four first-grade teachers and their classrooms ($n = 83$ first-grade students) participated in the study. With the exception of one teacher who skipped one hands-on activity, the teachers used all episodes, games, and activities as recommended in the OSM intervention. Pre- and post-assessment data were collected for all 83 students who participated in the study.

Students' Knowledge and Skills in Mathematics

Students' outcome data were collected through a series of assessments focusing on Numbers and Operations and Algebraic Thinking, which covered the following sub-categories of mathematical knowledge and skill: counting, pattern recognition, simple addition and subtraction, fact families, and vocabulary. Over the course of the *Odd Squad* intervention, students' overall knowledge of mathematics in the domains of Numbers and Operations and Algebraic Thinking increased significantly (Pre-test mean = 42.80, Post-test mean = 48.70, $p < 0.001$). In terms of sub-categories of mathematical knowledge, students showed significant and positive changes in the mean score from pre- to post-test on their knowledge of skip counting (Pre-test mean = 10.92, Post-test mean = 13.61, $p < 0.001$), pattern recognition (Pre-test mean = 9.49, Post-test mean = 10.12, $p < 0.002$), and simple addition and subtraction (Pre-test mean = 18.72, Post-test mean = 20.95, $p < 0.001$). Table 3 shows gains in students' knowledge in mathematics.

Table 3. Gains in students’ early mathematical knowledge.

Measure	N	Mean (SD) Pre	Mean (SD) Post	t	df	p-value
Knowledge of mathematics in the domains of Numbers and Operations and Algebraic Thinking (overall)	83	42.80 (12.03)	48.70 (11.33)	-8.78	82	<.001
Skip counting	83	10.92 (4.15)	13.61 (4.59)	-7.40	82	<.001
Pattern recognition	83	9.49 (2.43)	10.12 (1.90)	-3.26	82	.002
Simple addition and subtraction	83	18.72 (7.09)	20.95 (6.17)	-5.07	82	<.001

In addition to the above sub-categories of mathematical topics, the *Odd Squad* intervention also introduced another important mathematical knowledge: fact families and vocabulary.³ Analysis of the fact families item from the post-assessment indicates that more students were able to partially understand the concept of fact families (Pre = 22 percent vs. Post = 47 percent) and fewer students completely failed the item (Pre = 66.3 percent vs. Post = 48.2 percent). No student was able to verbally explain the meaning of fact families in pre-assessment. However, 10 students were able to either partially explain the meaning of fact families (8.4 percent) or fully explain the meaning (3.6 percent) at post-assessment.

Students also improved in their understanding of vocabulary words that were emphasized by *Odd Squad*. For instance, about 16 percent of students could explain the meaning of sphere in the pre-assessment, whereas the majority of students could either partially explain the meaning (27.7 percent) or fully explain the meaning (30.1 percent) at post-assessment. Across all math vocabulary words, the percentage of students who provided incorrect definitions decreased at post-assessment, while the percentage of students who provided correct definitions increased at post-assessment. These changes were statistically significant. However, the majority of students still struggled with the vocabulary words “conjecture” and “fact families.” Table 4 below provides the results for students’ mathematical vocabulary score analysis.

Table 4. Changes in students’ mathematical vocabulary.

Vocabulary Word	Incorrect (%)		Partially (%)		Correct (%)		p-value
	Pre	Post	Pre	Post	Pre	Post	
Pattern	50.6%	34.9%	10.8%	24.1%	38.6%	41.0%	0.037
Conjecture	100.0%	92.8%	-	6.0%	-	1.2%	0.044
Sphere	84.3%	42.2%	7.2%	27.7%	8.4%	30.1%	<0.001
Rearrange	96.4%	78.3%	-	-	3.6%	21.7%	<0.001
Fact families	100.0%	88.0%	-	8.4%	-	3.6%	0.005

³ Fact families are sets of related equations that illustrate the relationship between addition and subtraction or multiplication and division. For example, the equations $2+3=5$, $3+2=5$, $5-3=2$, and $5-2=3$ are all part of the same fact family.

Results of Qualitative Data Analysis

Qualitative analysis of teacher interview and parent focus group data produced findings related to *Odd Squad Math*'s effect on students' mathematics knowledge and skills, and findings related to the advantages of using the OSM transmedia intervention in the classroom and at home.

Findings Related to Odd Squad Math's Effect on Students' Mathematics Knowledge and Skills

Analyses of the qualitative data — teacher interviews and parent focus groups — suggest that OSM supported student mathematics learning. In particular, teachers mentioned that OSM supported mathematics learning for their grade level, especially in the areas of patterns and skip counting. Approximately one third of the parents who took part in OSM home activities mentioned that OSM supported their children's learning of patterns, skip counting, addition, subtraction, and mathematics vocabulary.

Findings Related to Learning About Patterns

All teachers participating in the intervention reported that *Odd Squad* content supported learning in the mathematics topic of patterns. Teachers said OSM content related to patterns helped students deepen their understanding of pattern recognition and connect the concept of patterns to their school's mathematics curriculum. Typical comments from participating teachers include:

They were able to try different types of patterns, like the moo-moo [in OSM]. The one with animal sounds. They were able pick up that kind of pattern. They keep connecting, like in the [patterns] the *Odd Squad* [episode] "Dance Like No One's Watching," up-down-left-right, to other math problems.

They made games in different types of patterns. They [saw] a pattern can be not just color and shape, which is what they're used to, but it can also be sound, it can also be something that you tap. It can be something that repeats over and over again. The definition of a pattern was the biggest gain that they made.

All teachers mentioned that they found the OSM content related to pattern recognition vocabulary to be valuable. The following comment quotation represents participant teachers' views..

The vocabulary was great. The vocabulary that we used for patterns, what a pattern is, and how you conjecture, helped them tremendously. Now they have that math vocabulary.

All teachers mentioned that the hands-on activities also supported learning. One teacher in particular mentioned that she and her class appreciated the hands-on activity called "The Patternista."

It was the activity "The Patternista" where they had to start their pattern and then ask their partner to finish it. That was good. You could tell the ones that didn't know how to do a pattern. I had to go back and re-teach. And you could see the ones that could do the pattern, and they were able to apply it. They absolutely loved [the activity]. We couldn't finish it the first day, and they asked me, "When do we get to finish it?"

One teacher felt that OSM supplemented her curriculum by providing a review of pattern recognition for her students. She said her students had studied pattern recognition earlier in the year and that OSM provided a useful review of the concept.

The kids . . . knew how to create different kinds of patterns and how to name those patterns. I think they were excited to put it into a [new] context when they were watching the video. “Oh, I get what it is. It’s black-white-black-white pattern. That’s an ABAB pattern.” It was . . . a good final review of something we did a few months ago.

Findings Related to Learning About Skip Counting

All teachers reported that *Odd Squad* content supported learning in the mathematics topic of skip counting.

In terms of the skip counting work, it [supports] what we are working on now. . . . It’s always good for kids to see something in multiple, different contexts to see how it applies. In that sense, they learned how they could apply this [skip counting] to another context.

Several teachers mentioned that the visual media included in the transmedia materials helped students to visualize the concept of skip counting and the benefits of using skip counting.

And I think the visual of being able to see, here are these 10 things and now I’m counting that as 10. Here’s another 10 things. And I think reinforcing the efficiency of skip counting in different ways was definitely valuable. . . . This was the one thing that made a difference.

Several teachers said they expanded on the OSM materials to help students use skip counting rules with new problems.

[The materials were] super effective. They were able to skip count by twos, skip count by fives, skip count by tens. We even tried three. I said, “Okay, let’s see what happens. I want to see if you really get it.” We skip counted by threes, and even my [students] that struggled got it.

Findings Related to Learning About Fact Families

Two teachers mentioned the content on fact families helped their students grow in this area. In particular, one teacher reported that several students in her class made significant leaps in understanding conceptual mathematics by interacting with the materials.

I had three kids who just took it to a whole other level. Students have to understand [the math] conceptually in order to do this [fact families]. They were able to understand that if they mixed up the numbers again, they can get a fact family. As long as they are “true.” And you know what? They [the students] were “true.” Usually, my experience with fact families is students will memorize, they’ll say, $9 + 2$ is 11, $2 + 9$ is 11, $11 - 9$ is 2, $11 - 2$ is 9, but they don’t really understand what they’re doing. If I take that [memorization] away, they don’t understand arranging. [Using OSM], I took that away, and they were able to rearrange the numbers.

Potential to Support the Standards of Mathematical Practice

Analysis of teacher interview data showed that three of the four participating teachers reported that the OSM’s narrative-based structure supported learning in specific areas of the Standards of Mathematical Practice. These teachers mentioned that *Odd Squad*’s plot device of showing examples of children constructing and testing arguments, listening and responding to the theories and perspectives of others, and persevering to solve complex problems could be framed to support teaching around the Standards of Mathematical Practice.

We’ve had a pretty concerted effort to focus on the SMPs this year, and we name them for students. Our kids are doing a lot of problem solving and focusing on being really precise on their work right now. I think that they drew on that when they were doing some of the [OSM] problems.

I think in terms of those videos, I saw modeling of perseverance and we talked about that. I'd pause the video and talk about that, "He doesn't quit trying to go through all the different booby traps." And I think that the kids probably noticed. I was really explicit about naming this, "Oh, look at how they are doing it."

I think that's one of the biggest things with the math practices, is really changing practice to show multiple different ways in which to do something and really talking about their thinking and the justification that's behind it. In "Who's the Thief," I saw the critical thinking they had to do. So when you're looking at the centigurp activity, we didn't just do it by the 10s, we did it in different ways.

I would say it's [OSM is] math practices. . . . It's not like math skills where you learn how to count. It's thinking. It's definitely mathematical practices.

Parents Noticed Their Children Improving on Target Mathematics Content

The majority of parents participating in focus groups at the end of the study mentioned they noticed their child practicing and improving in mathematics during the study. Domains of mathematics most often mentioned by parents were addition, subtraction, and mathematics vocabulary. A subgroup of parents mentioned additional mathematics topics, including pattern recognition and skip counting.

A typical quotation was from a father who said his two older daughters had watched *Odd Squad* episodes and played *Odd Squad* games with his son, who is a study participant.

[OSM] is helping my son, who is just beginning to learn math. My older girls are twins and they have been teaching him math in reference to what they've seen in [*Odd Squad*]. They teach him and they have fun.

Another parent said she saw her child learning mathematics, including mathematics vocabulary.

The sing-a-long songs helped him to learn words, the numbers, and the colors.

About one quarter of parents mentioned they noticed their children learning patterns and skip counting.

My son is working on 10s. He didn't know them before, and he's better at counting the numbers by 10s, and to get to 50, or even up to 70.

Both of us tried the games and watched all of the episodes. The games are really interesting. It [*Odd Squad*] has a lot of information for learning. It's good for children. There are games for learning how to count by 5s, 10s, 20s. And my daughter learned a lot.

She did learn. For all the games, you have to find a clue, or a pattern, and it makes them think, it makes their mind work, and it's good because they're in a stage in which they're making discoveries, and learning how to solve problems.

Parents Mentioned They Created Other Learning Activities to Support the OSM Content

Qualitative data analysis suggests that a subset of parents who used OSM materials took ideas from the *Odd Squad* materials to create their own ways to support their child's learning. Below is a typical quotation from a parent.

We worked with him with sticks — I don't know what they're called in English. They're little sticks, and they have 10 [in a bunch], and he was using those to count by 10s. Those sticks have like 10 squares. When they were counting by 10s on *Odd Squad*, I integrated that.

Qualitative Findings Related to the Advantages of Using *Odd Squad Math*

Results of qualitative data analysis suggest that *Odd Squad Math* motivated students to engage deeply in mathematics content and that the transmedia aspects of the intervention provided teachers with new tools to engage students and to reach all types of learners.

Exciting Storyline Spurred Engagement in Mathematics

OSM involves episodes, games, and activities that include a fast-paced, playful narrative domain that draws students into storylines. OSM invites students to be a part of the *Odd Squad* team and to help solve “cases” that involve using mathematics. In interviews and focus groups teachers and parents often mentioned that these engaging aspects of OSM boosted students’ interest in mathematics and in solving mathematics problems.

All teachers reported that the intervention was highly engaging for students and contributed to their enthusiasm for engaging in and learning mathematics. The quotations below are typical of teachers’ comments during their interviews.

Highly, highly engaged. They loved the centigurps, the fuzzy little centigurps. The number lines were good. The videos were fantastic. We still watch *Odd Squad* on YouTube. They really reacted, and I can see that their math knowledge grew too. The conceptual math knowledge grew.

[They were] very engaged. They are sad that *Odd Squad* is going away. Every single activity was engaging. The episodes, hands-on [activities], and they loved the centigurps games.

[The content] is age appropriate and it was highly engaging. It was fantastic. There’s not a dull moment. They are loving it. I think it will be with them for life.

All of the teachers in the study mentioned that the *Odd Squad* plot device of making viewers and players part of the *Odd Squad* problem-solving team brought a strong motivational factor to mathematics learning during the intervention.

Any time they were putting on their badges, it was like, “Okay, now we get to solve some math problems.”

That [OSM] activity at the beginning, of just getting to make their badges . . . I think it helped solidify kind of an identity for them, which I think helped in engaging and tying things together.

It was nice to put it into the context of “You’re being part of the *Odd Squad* and you’re having to [solve cases].” We took a picture of our “*Odd Squad*” where we all had our little badges. They got into it. At this age they are so into character things.

Particularly first grade, I think it’s such a great imagination type of thing. They get to be *Odd Squad* detectives, and doing things like that. They loved it.

They were highly engaged and they were very excited about getting their own badges and getting to participate. I think a lot of them already knew *Odd Squad*, so I think it was exciting to have something they knew and their personal interest being brought into the classroom time.

Anytime we said, “Today we’re doing an *Odd Squad* challenge,” there was a lot of cheering and excitement. They really took it on.

Several teachers mentioned that they used the *Odd Squad* theme to motivate students in other content areas in addition to math.

[We were] reading nonfiction to find information. This time, I kept going and said, “Okay *Odd Squad*, let’s go do [this]!” So they were detectives that time . . . They’re *Odd Squad*. I think that’s important. A different way to get them to be motivated enough to really be invested into solving something.

The engagement was really high. I could literally take any lesson and say, it’s an *Odd Squad* lesson, they would be excited by that name. I think in terms of triggering their interest, I think that was helpful.

Transmedia

Qualitative data analysis suggests that the intervention’s transmedia content, including a storyline and academic content that are connected across multiple platforms and environments, has added educational value to the OSM learning environment. Teachers reported that the combination of episodes, digital games, and hands-on activities allowed their students to make useful connections and reinforce their mathematics learning through different media.

I think that [the transmedia aspect] definitely helped. I think because they had already played a little bit of the computer game and they’d seen the episode, when they were doing the hands-on, they had a lot of context for how could we count the items.

The hands-on [educational support materials]. . . they really liked “Who’s the Thief.” So again, when they felt like they were in the case, like that one where someone stole something and you have to figure it out. That’s when they were the most engaged.

The online games were very good [quality]. Code Breaker was amazing. Because it gave them different patterns to have to work through: number patterns, shape patterns. All different kinds of patterns. And they got more complex, which is good.

You need all of the components of it. It reinforces what they are supposed to be learning and hopefully gives them a different way [to access content]. So I think all three components are important.

Three teachers mentioned that the use of digital media helped them reach different types of learners in their classes.

I think the different modalities for them [are helpful]. For instance, I have one kid that . . . does a lot of [digital] stuff at home. He can do videos and stuff. It was good to get him . . . so he can play those games that are educational. With the transmedia he was glomming onto the definitions and things. That was great.

One teacher said she grew in her ability to use transmedia in the classroom. She mentioned the importance of setting the narrative stage by starting a lesson or unit showing an episode, then moving into other activities.

I think a lot of [transmedia] is to reference back to it [the narrative] and you know, that’s your “aha” grab for them to be interested in it [the content]. So I think that doing the videos is important as your intro and then doing the activities.

Teachers Would Use Odd Squad Math Again to Augment Their Math Lesson Plans

All teachers reported they would continue to use *Odd Squad* resources in the classroom in the coming school year. Below are several quotations that were typical of teacher comments during their interviews.

I'm going to be trying to do this next year. Combine it with cooperative group problem solving. It will be . . . our *Odd Squad* unit. I'm planning to introduce it at the beginning [of the year]. I need to look and see all the [*Odd Squad*] videos online that I can get to too. I know there are two other games.

I would use the activities again. Like I said, here is something . . . that's super fun and also aligned to what we're doing. I think it would be really cool to have more of these things that are aligned to all the things we do in first grade. It could be like a culminating activity of the unit, like we get to search for a centigrup. That sort of thing, which I think is really fun, and I'm all for them having fun.

I will actually use it [*Odd Squad*] next year. I can find it on the PBS website and use the episodes there. So I think it'll be a great way to introduce math into the kids next year, and make them little *Odd Squad* [agents].

Results of Qualitative Data Analysis Related to Use of OSM in the Home

Analysis of parent focus groups and teacher interviews produced findings related to families' use and satisfaction with the OSM intervention results. Approximately 80 percent of participating families used OSM during the intervention. About 80 percent of families watched all of the episodes included in the home component of the intervention, and about half of these families used the other components along with the episodes. Data suggest that parents appreciated OSM and that teachers felt the home component of the intervention was useful.

Parents Appreciated Odd Squad Math

Parents reported they had positive experiences with their children when engaging with the OSM activities at home. Parents said that they were impressed with the mathematics content and felt that it was teaching meaningful mathematics concepts to their children.

At first, I thought they were cartoon, but they aren't. They're to inform you of math; what it is that they need to do, how to do it.

When we started to watch, I listened to the vocabulary and saw that was good for your children. And the themes that aren't inappropriate for their age. My son likes it and I feel that it's helping him do something good, not just filling his head.

At the beginning when we were getting to know it, my husband was there. When the video started, I said, "What does this have to do with math?" And so they started to play and the girl started to ask questions about adding. And my husband said, "There is the math. Look how they're discussing things and agreeing." Then I understood.

Parents reported that engaging in the OSM episodes and activities together with their children inspired meaningful dialogue and that they were able to learn from OSM alongside their children.

It's good because, if we watch it together, maybe the child doesn't understand something, and I do, and I can explain, or try to because sometimes they understand more than me, and they explain.

Parents expressed that the presentation of the *Odd Squad* content was quite engaging to their children.

We watched the episodes and we talked a bit about the papers [Episode Guide]. . . . [Our son] focused since it's something that he's interested in, because it is like a cartoon. [*Odd Squad*] captures his attention and so he's noticing what [the math] is.

Several parents mentioned that while using OSM with their children, they saw their children successfully learning through play. These parents reported realizing that learning through play was an effective way for their children to gain an understanding of and solidify new math concepts.

It gives us the idea of learning by playing. It's good to watch the episodes. When we're talking about the [math] topic, he remembers, "Oh! In *Odd Squad* they said this, this, and this." So, he's remembering. He's capturing the ideas.

We [realized] that they can learn equally when they're playing.

Overall, parents expressed that OSM was a very positive experience for their children and had lasting positive effects on them. Parents reported that as a result of participating in the OSM program, their children learned how to problem solve in a new way.

I like the way that they teach. They teach us, because I was there, how you should use your intelligence, how you should resolve problems. It was very interesting. The truth is that my son was very happy.

[After the program] she [my daughter] thinks before she acts, before she does something, something that she's doing whether it's good or bad.

Parents reported that their children will continue engaging with *Odd Squad* in the future in place of other television programming they previously chose to watch.

We did the episodes on the DVD, but then I found it on the KQED. And I found it two times. She really liked to watch it. Before that we were watching cartoons or something. And now she knows exactly what time it's [*Odd Squad*] on TV.

I think it will be a program that I can incorporate at home so that he can have the enrichment that can help him at school.

Teachers Felt the Home Components of OSM Were Useful

All teachers mentioned that they liked the idea of having families involved in the intervention. Teachers commented that by including families in OSM, students became more involved in the *Odd Squad* narrative and the mathematics content.

[Parent involvement] is very helpful. It builds the knowledge that they need to make their skills grow and to make their thinking grow. And students are getting it [the mathematics] from all angles.

Suggestions from Participants About Improving OSM

Themes and findings emerged from interview and focus group qualitative data analysis that may be useful in improving the OSM intervention. Findings include those related to organizing the structure of the intervention, and making changes to how parents learn about and use the home component of the intervention.

Suggestions About Organizing Content to More Explicitly Support the Standards for Mathematical Practice

Teachers saw promise in using *Odd Squad Math* to support student learning related to the Standards for Mathematical Practice. In addition, they said the OSM intervention could be enhanced with some changes and additions. Suggestions included:

- Adding connections between activities so that they build off of each other.
- Designing activities such that students might work for several days to solve one problem or case.
- Providing explicit guidance for teachers on how to incorporate the Standards for Mathematical Practice into their use of *Odd Squad* transmedia content.

Suggestions About How Best to Help Families Connect Home and Classroom Content

Though most families viewed *Odd Squad* episodes and used the episode guides, only about 40 percent used the other supplementary home materials. Teachers emphasized in their interviews that increased parent involvement in the OSM program could enhance the impact on students. Some teachers suggested that parent involvement could be enhanced by formally introducing families to OSM and explaining how families can best participate.

Conclusion and Recommendations

Research has shown that early mathematics achievement is a strong predictor of later mathematics and overall academic achievement (Burchinal et al., 2011; Duncan et al., 2007; Jordan, Kaplan, Ramineni, & Locumiak, 2009). Additionally, it has been shown that students from low-income communities consistently under-perform in mathematics compared to their middle-income peers in elementary, middle, and high school (NCES, 2011; Rosenquist, Henrick, & Smith, 2015). As technologies and educational digital media become more available to schools serving low-income families, educators are exploring how digital tools and resources can support mathematics learning. The current study indicates that transmedia resources, such as *Odd Squad* television episodes, educational online games, interstitials, and hands-on activities from PBS KIDS, show promise in enhancing mathematics achievement for students in schools serving low-income families. Additionally, the current study provides valuable information about how children use and learn in transmedia environments that involve home and classroom learning components. Overall, results of the study indicate that OSM is an innovative, fairly easy-to-implement intervention that can be a positive addition to the first-grade classroom. In addition, the study reinforces the learning benefits of transmedia storytelling and collections of connected media. Results of the current study suggest that OSM should be refined and tested again in a rigorous research study involving a larger sample and a comparison or control group. Additionally, new transmedia interventions should be designed and tested in diverse elementary school settings.

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Appendix: Odd Squad Math Cases

ODD SQUAD CASE #1: PATTERNS

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CASE AT-A-GLANCE (SUGGESTED PACING GUIDE)

Day	Classroom Component	At Home Component
Day 1	Agent Briefing – Full Episode (10 mins) <i>Dance Like Nobody’s Watching</i>	
Day 2	Online Game – Computers or Tablets (20 mins) <i>Code Breaker</i>	At Home Case – Full Episode (10 mins) & Parent Co-Viewing Activity (15 mins) <i>Totally Odd Squad</i>
Day 3	Agent Training Video – Short Video (2 mins) <i>Training Video #1624: How to Deal with a Spider-Cat Bite</i>	At Home Case – Full Episode (10 mins) & Parent Co-Viewing Activity (15 mins) <i>A Case of the Sing-Alongs</i>
Day 4	Agent Activity – Hands-on Activity (30 mins) <i>Patternista</i>	

Learning Objectives – Student will be able to:

- Identify and extend color, picture, sound, or number patterns
- Use algebraic thinking and reason inductively by looking for patterns
- Make sense of problems and persevere in solving them (mathematical practice)
- Construct viable arguments and critique the reasoning of others (mathematical practice)
- Look for and express regularity in repeated reasoning (mathematical practice)

Vocabulary:

- Pattern
- Conjecture

**ODD SQUAD CASE #2:
SKIP COUNTING & FACT FAMILIES**



**CASE AT-A-GLANCE
(SUGGESTED PACING GUIDE)**

Day	Classroom Component	At Home Component
Day 1	Agent Briefing – Full Episode (10 mins) <i>The Trouble with Centigurps</i>	
Day 2	Online Game – Computers or Tablets (20 mins) <i>Catch the Centigurps</i>	At Home Case – Full Episode (10 mins) & Parent Co-Viewing Activity (15 mins) <i>Picture Day</i>
Day 3	Classroom Activity (25 mins) <i>Fact Families</i>	
Day 4	Agent Activity – Hands-on Activity (30 mins) <i>The Case of the Centigurps</i>	At Home Case – Full Episode (10 mins) & Parent Co-Viewing Activity (15 mins) <i>O Games, Part 1</i>
Day 5	Agent Training Video – Short Video (2 mins) <i>Odd Squad Odd Report: Raining Cats and Dogs</i> Agent Activity – Hands-on Activity (20 mins) <i>Odd Squad Hundreds Chart</i>	At Home Case – Full Episode (10 mins) & Parent Co-Viewing Activity (15 mins) <i>O Games, Part 2</i>
Day 6	Agent Training Video – Short Video (2 mins) <i>Odd Squad Odd Report: Giant Sighting</i> Agent Activity – Hands-on Activity (15 mins) <i>Odd Squad Number Line</i>	

Learning Objectives – Student will be able to:

- Skip count by 2’s, 5’s, and 10’s
- Understand subtraction as an unknown addend problem
- Determine the unknown whole number in addition or subtraction number sentences
- Make sense of problems and persevere in solving them (mathematical practice)
- Look for and make use of structure (mathematical practice)
- Look for and express regularity in repeated reasoning (mathematical practice)

Vocabulary:

- Sphere
- Rearrange
- Fact families