Mixed Methods Study
of the Effects of The Cat in the Hat Knows a Lot About That!™ on Pre-School Children’s Perceptions of Science and Knowledge of the Nature of Science and Engineering

April 2020

THE UNIVERSITY OF RHODE ISLAND
About The University of Rhode Island

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Problem

Experiences that allow young children to actively participate in and develop understanding about science and engineering provide pathways for equitable opportunities and engaged citizenship (Lederman, 2013; Vincent-Ruz, & Schunn, 2018). In 2018, the average salary of a STEM (science, technology, engineering, math) related job was more than double that of a non-STEM related job (M = $84,880, M = $37,020 respectively)(US Bureau of Labor Statistics, 2019). People who are interested in STEM careers are more likely to make a reasonable salary and to find work and stay employed. Furthermore, understanding science and engineering is essential for all children, not just those going into STEM careers, to be active participants in our democratic society. Citizens should be able to critically interpret information, collaborate to solve unknown future challenges, and be able to make decisions based on evidence (Ratcliffe, & Grace, 2003). Recent research has posited that developing positive perceptions and knowledge about science and engineering is most effective in the earliest years of education, before stereotype threat negatively impacts academic experiences and children’s sense of belonging in the STEM community (Aldemir & Kermani, 2017; John, Sibuma, Wunnava, Anggoro, & Dubosarsky, 2018; Duschl, Schweingruber, & Shouse, 2007; Steele and Aronson, 1995).

Research on how digital technologies support STEM learning in early childhood education has expanded over the past decade. Questions have shifted from whether technology is beneficial in early childhood development, to how it can be best integrated into the learning experiences of young children (Parette, Quesenberry, and Blum, 2010; Kermani and Aldemir, 2015). Advocates argue that technology can be leveraged to widen educational opportunities, facilitate more student-centered learning, focus adaptive instruction on student need, and strengthen connections between school and home (Keengwe and Onchwari, 2009; Kermani and Aldemir, 2015; McClure, et al, 2017). However, several obstacles to effective media integration have been identified: insufficient or inequitable distribution of resources, inappropriate or ineffective uses of technology, parents and teacher attitudes and training, and a variety of broader perceived medical problems associated with digital technology (Blackwell, Lauricella, & Wartella, 2014; McClure, et al, 2017; Plowman and McPake, 2013). The purpose of this study is to add to the small but growing body of literature on the use of educational media in early childhood. The study seeks to understand the effects of free, accessible, and education-oriented multimodal media, used at both home and school, on young children's perceptions of science and their understanding of the nature of science and engineering.
Background

The CPB-PBS Ready To Learn Initiative created an ecosystem of educational materials including television programs, digital games, and real-world activities for young learners. As part of that ecosystem, The Cat in the Hat Knows a Lot About That™ multi-platform media was developed to provide foundational learning opportunities in science and engineering that prepare young children for success in school and life. The PBS Kids Personalized and Adaptive framework (see Figure 1) shows the child at the center of a playful learning ecosystem in which they socially construct their understanding through multimodal media integration into their daily routines. A university research team explored science and engineering outcomes for preschool children with diverse abilities, and from different demographics, who exist in the center of this playful learning ecosystem.

Figure 1

Playful Learning Ecosystem

Note. The child is featured in the center of a media rich home and school environment (PBS KIDS, 2018).

This report presents the findings of a multi-phase, mixed-methods study that occurred during the Spring of 2019. The study sought to uncover how preschoolers' perceptions of and knowledge about science and engineering change when they are
exposed to The Cat in the Hat Knows a Lot About That!

The Cat in the Hat Knows a Lot About That!™ Media Multi-platform Media

The Cat in the Hat Knows a Lot About That!™ video stories, digital games, and parent/teacher real-world activities were individually designed with specific learning goals and developed collectively for meaningful and impactful multimedia learning experiences (Sweetman, Mirkin, Lund, & Bishop, 2018). Each TV episodic story models an integrated approach to the NGSS three dimensions of science learning: (1) science and engineering practices, (2) disciplinary core ideas, and (3) cross-cutting concepts by having Nick and Sally engage in authentic problem-solving and phenomena-based investigations relevant to young children’s lives (NRC, 2012). Additionally, 90 second interstitials were developed to encourage children to try science and engineering activities at home and to develop science mindsets of curiosity, persistence, and creativity. The digital games, many of which use a responsive learning system (adaptivity) with multiple access points and forms of expression (personalization), provide opportunities for young children to engage in science inquiry and engineering design tasks that require children to use science knowledge and scientific thinking to interact with the characters and setting. Teacher and family real-world activities provide opportunities for children to apply what they learn from the videos and games into everyday life experiences. The suite of multimedia resources aims to instill a sense of excitement and provide foundational tools for learning about the natural and engineered world, to set children up to seek knowledge and develop understanding throughout their K-12 schooling. In addition, these multimedia resources strive to cultivate preschooler’s understanding that learning and doing science and engineering happen often, in many places, in many different ways, and for all people, including themselves.

Nature of Science and Engineering

The 2012 National Research Center (NRC) report entitled A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas, the 2013 Next Generation Science Standards (NGSS) include the nature of science (NOS) as a key component of 21st century science, technology, engineering, and math (STEM) education. The nature of science and engineering refers to the understanding of who engages in the practice of science and engineering, how it occurs, and the type of knowledge constructed (Lederman, 2013). It also addresses the values and beliefs associated with developing scientific knowledge as well as conceptualizations about science as a discipline (Ümran & Erdoğan, 2018). The NGSS standards recommend that students develop an understanding of science through learning experiences that include wondering, investigating, questioning, collecting data, and analyzing information. Recommendations also include that engineering
be embedded into a broader understanding of science so that children develop the knowledge and skills to ask questions and solve problems related to the natural and the human-made world (NRC, 2012). Therefore, the construct labeled throughout the study as ‘the nature of science and engineering’ includes (1) **who**: many people of varying ages, gender, race, and abilities participate in science and engineering, (2) **how**: that science and engineering are practiced, often collaboratively, using high and low tech tools to actively investigate and communicate about our natural and designed world, and (3) **what**: science and engineering include understanding of physical, earth, space, and life science as well as how the designed world is constructed and utilized.

**Perceptions of Science**

Perceptions of science have been correlated with interest in science, the development of science identity, and academic achievement (Hacieminoglu, 2016). Understanding young children’s perceptions of science provides further evidence as to their understanding of the nature of science and uncovers stereotypes (Mantzicopoulos, Patrick, & Samarapungavan, 2008; Shepardson, & Pizzini, 1994.). Additionally, their perceptions help educators and researchers understand how children see themselves within or outside of the science community (Zhai, Jocz, & Tan, 2014; Gee, 2001). In this study, the researchers built on the work of Farland-Smith (2012), and categorized children’s perceptions into three constructs (1) sensational (2) traditional and (3) contemporary. Sensational perceptions of science are unrealistic; scientists are seen as magical, evil, or superhuman. Traditional perceptions of science include an older man in a lab coat doing chemistry in a laboratory which have been evident in the research for the past six decades (Chambers, 1983; Farland-Smith, 2013). One of the greatest concerns of young children developing either sensational or traditional stereotypes is that they perceive science for ‘those people’ and ‘not for me’ (Gee, 2001; Stets & Burke, 2000). Media perpetuated the development of sensational and traditional science perceptions (Nisbet, et al.2002; Tan, Jocz, & Zhai, 2017). If children do not develop a positive science identity, they will likely eliminate science as a possible career (Gottfredson, 1988). Once a career has been eliminated children make daily decisions that move themselves farther from the career, ultimately contributing to the unbalanced gender and race participation in the science and engineering workforce (Coleman, 2019; Gottfredson, 1988). Contemporary perceptions of science indicate that people of all abilities, ages, races, and genders can and do participate in science, that science is conducted in real-world natural and engineered spaces, and that science and engineering is practiced as described by the NGSS (NRC, 2013). In this study the perception of science is operationalized as (1) **sensational**: magical, evil, or superhuman doing unrealistic activities, (2) **traditional**: man in a lab coat with a beaker, and (3) **contemporary**: diverse people doing active science in realistic settings using practices identified in NGSS.
Study Design and Methods

The research team conducted a multi-phase, mixed-methods research study to accomplish four objectives: (1) to understand how *The Cat in the Hat Knows a Lot About That!*™ multi-platform media affects preschoolers’ understanding of the nature of science and engineering, (2) to understand how *The Cat in the Hat Knows a Lot About That!*™ multi-platform media affects preschoolers’ perceptions of science and engineering, (3) to understand how moderating factors, including weeks with the intervention, gender, race, family income, and identified special needs influence the outcomes; and (4) to design valid research instruments to measure young children’s knowledge of the nature of science and engineering.

Multi-Phase Design

A two-phase, sequential mixed methods research design was used to develop instruments and collect qualitative and quantitative data to understand how a multi-platform media content based on *The Cat in the Hat Knows a Lot About That!*™ video stories impacted children’s perceptions and knowledge of the nature of science and engineering.

Table 1
Multiphase Study Design

<table>
<thead>
<tr>
<th>Phase</th>
<th>Goals</th>
<th>Primary Question</th>
<th>Analysis</th>
<th>Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase One: January - March, 2019</td>
<td>Design and testing of the assessment instruments</td>
<td>How do preschool students preparing to begin kindergarten in the fall demonstrate their perceptions of science and knowledge about the nature of science and engineering?</td>
<td>Usability testing and cognitive interviews</td>
<td>22 children from the two preschool classrooms and their teachers</td>
</tr>
<tr>
<td>Phase Two: March - June, 2019</td>
<td>Examine the effect of <em>The Cat in the Hat Knows a Lot About That!</em>™ multi-platform media on</td>
<td><em>How does exposure to The Cat in the Hat Knows a Lot About That!</em>™ affect children’s understanding of the nature of science and engineering and their</td>
<td>SW-CRT mixed methods intervention study using data collected 5 times over 9 weeks via the NOSES,</td>
<td>137 children, their caregivers, and their teachers from 13 classrooms</td>
</tr>
</tbody>
</table>
Phase One

The purpose of the first phase of the study was to design two measurement instruments (1) to assess preschooler’s understanding of the nature of science and engineering and (2) to understand their perceptions of science. Although instruments exist to measure the nature of science and perceptions of science in older children and adults, few assessments are available to inform early childhood educators, curriculum developers, and researchers of what children know and can do in these areas when entering school (Brenneman, 2011; Greenfield, 2015). Five specific steps were taken to develop valid and reliable assessment instruments (Radhakrishna, 2007). These steps and activities from phase one are described in Appendix A. This phase was completed during January - March, 2019. As a result, two tools emerged, The Nature of Science and Engineering Survey, NOSES, - a 23-item, picture-based survey instrument and the Digital Design a Scientist Test, D-DAST - a 7-item, picture-based avatar builder. These tools were then used in phase two of the study.

Phase Two

The purpose of phase two was to examine whether exposure to The Cat in the Hat Knows a Lot About That!™ video stories content, affected children’s understanding of the nature of science and engineering; and their perceptions of science. A stepped wedge random control trial design allowed for multiple assessment data to be collected at different periods in time to discover the threshold, or “the specific dosage level at which the intervention affects outcomes” (Wasik, Mattera, Lloyd, & Boller, 2013, p.8). The phase was conducted over a nine-week period from March to May, 2019. The remainder of the report shares the outcomes of phase 2 of the study.

Research Questions

The following research questions guided the second phase of this study:
1. *How does exposure to The Cat in the Hat Knows a Lot About That!™ content funded by the Ready To Learn grant affect children’s understanding of the nature of science and engineering?*
   
   a. *Does the number of weeks of intervention influence children’s understanding of the nature of science and engineering? If so, how?*
   
   b. *How does children’s gender, socio-economic status, race, and qualification for special education impact their understanding of the nature of science and engineering over time?*

2. *How does exposure to The Cat in the Hat Knows a Lot About That!™ funded by the Ready To Learn grant affect children’s perceptions of science?*
   
   a. *How does *The Cat in the Hat Knows a Lot About That!*™ multi-platform media influence children’s science identity?*

**Sampling and Recruitment**

Before beginning recruitment, the research team secured Institutional Review Board (IRB) approval from the university. Per IRB guidelines, the study was conducted in an ethical manner ensuring proper recruitment of teachers and families as well as anonymity of data (see Appendix B).

**Sample Size and Attrition**

The sample included 137 children between 45-71 months (mean of 60.42 months) in inclusive public preschool programs preparing to enter kindergarten the following year. Missing data due to children’s absenteeism during data collection is addressed in each analysis. Appendix C provides more details on the sample size and composition.

**Racial and Ethnic Composition of the Sample**

Racial and ethnic identities of children were collected from the family pre-survey. Figure 2 describes the composition of study participants. More detailed information by cluster can be found in Appendix C.
Figure 2
Racial Composition of the Sample of Children who Participated in Phase Two of the Study

Note. Demographics based on self-reported data from the family pre-survey.

Socioeconomic Status
According to the pre-survey data, family income levels varied among the participants (see Figure 3). Additional details by cluster can be found in Appendix C.
Students Receiving Special Services

According to the state’s public preschool model, approximately 49% of the children enrolled in the participating preschools are eligible to receive special services. Of families who responded to the pre-survey, only 33% reported that their child received special services. Previous research found that caregivers of children with disabilities are less likely to complete surveys or participate in research activities (Becerra et al., 2017). Additional details by cluster can be found in Appendix C.

Gender

There were 86 boys and 55 girls in the study. The unequal distribution of gender is likely due to the fact that boys are more likely to be identified with learning disabilities,

Note. Demographics based on reported household income data from the family pre-survey.
especially at a younger age (Skårbrevik, 2002). Additional details by cluster can be found in Appendix C.

Research Design

The intervention was implemented and the outcomes assessed using a stepped wedge cluster randomised trial (SW-CRT; Hussey & Hughes, 2007). A SW-CRT design was used to understand exposure time on the effectiveness of the intervention, to eliminate ethical concerns of withholding potentially beneficial materials from participants, and to overcome challenges of statistical power associated with smaller sample sizes (Brown & Lilford, 2006; Thompson, Fielding, Hargreaves, & Copas, 2017). SW-CRT places the randomization on the timing of the intervention rather than on the placement of the participant in a group (Brown & Lilford, 2006; Hussey & Hughes, 2007). Since the 137 preschool participants were already situated in classrooms, four clusters were created and then randomly assigned 2, 4, 6, or 8 weeks of intervention (see Table 2). Researchers visited the preschool classrooms to collect data five times, every other week for a nine week period, using three separate measures: (a) Draw a Scientist Test (DAST), (b) Digital Design a Scientist Test (D-DAST), and (c) Nature of Science and Engineering Survey (NOSES). Participating families and teachers completed pre and post-surveys as well as weekly media logs.

Table 2

Stepped Wedge Cluster Randomized Trial Model

<table>
<thead>
<tr>
<th>Time period: every two weeks</th>
<th>Time period 1</th>
<th>Time period 2</th>
<th>Time period 3</th>
<th>Time period 4</th>
<th>Time period 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cluster 1</td>
<td>Control (n=30)</td>
<td>Intervention (n=32)</td>
<td>Intervention (n=32)</td>
<td>Intervention (n=34)</td>
<td>Intervention (n=33)</td>
</tr>
<tr>
<td>Cluster 2</td>
<td>Control (n=24)</td>
<td>Control (n=27)</td>
<td>Intervention (n=25)</td>
<td>Intervention (n=28)</td>
<td>Intervention (n=24)</td>
</tr>
<tr>
<td>Cluster 3</td>
<td>Control (n=36)</td>
<td>Control (n=38)</td>
<td>Control (n=37)</td>
<td>Intervention (n=38)</td>
<td>Intervention (n=39)</td>
</tr>
<tr>
<td>Cluster 4</td>
<td>Control (n=22)</td>
<td>Control (n=23)</td>
<td>Control (n=22)</td>
<td>Control (n=22)</td>
<td>Intervention (n=19)</td>
</tr>
</tbody>
</table>

Note. Sample sizes based on number of children who completed the NOSES during that data collection period.
Intervention Description

During the intervention, each participating child received two identically configured Kindle Fire HD8 Kids tablets (one for home and one for school) provisioned with The Cat in the Hat Knows a Lot About That!™ multi-platform media: 41 video story videos and interstitials from The Cat in the Hat Knows a Lot About That!™ and five games from The Cat in the Hat Builds That!™ app. All content was downloaded onto the tablets to allow offline use and avoid internet access challenges. In addition, the teachers received printed lessons from the PBS Learning Media Website and everyday physical materials listed on the lesson instructions (see appendix D). The teachers were encouraged to spend 30 minutes per week engaging their students in the classroom activities. Caregivers also received printed resources from PBS Learning Media to support real-world activities that could be used at home. The caregivers were encouraged to allow their children access to the tablet as often as they would typically let their child interact with digital media and to engage with their children in the available real-world activities if time permitted.

Research Instruments

Three different instruments were used at each of the five data collection periods. The research team visited the preschool classrooms and worked one on one with the participating children using iPads to administer the Digital Design a Scientist Test (D-DAST) and Nature of Science and Engineering Survey (NOSES). The classroom teachers administered the Draw-a-Scientist-Test (DAST) and scribed children’s explanations of their pictures.

Nature of Science and Engineering Survey (NOSES)

The Nature of Science and Engineering Survey, NOSES, was designed by the research team to collect evidence about young children’s understanding of the nature of science and engineering. The picture based survey had 23-questions with multiple picture responses and the respondent was prompted to choose all that apply (see Figure 4). Only 20 of the 23 items were scored. Two questions (like to eat, and like to play) were included in the beginning of the survey to teach preschoolers how to use ‘the all that apply’ feature. These questions were not scored in the assessment. One question asked the participants about who behaves like scientists and engineers. The children were able to pick from a variety of characters from educational based animated shows. The researchers wanted to see if the preschoolers associated Nick and Sally with science and engineering but did not include it in the final scoring.
The children could choose as many images as they felt answered the question.

The 20 scored questions included 84 pictures that were coded as either accurate (2 points), inaccurate (-2 points), or neutral (0 points) to calculate a composite score for the child's overall understanding of the nature of science and engineering. Total scores could range from -40 to 88.

**Draw A Scientist Test (DAST)**

The DAST was developed by Chambers in 1983 based on the seminal work of Mead and Metraux (1957). Chambers posited that the DAST was an appropriate tool to assess perceptions of scientists in young children as well as people with significant language and learning barriers. Hillman, Bloodsworth, Tilburg, Zeeman, and List (2014) recommended incorporating interviews when using the DAST with young children to gain more accurate information. Therefore, each week, the classroom teacher provided the children with paper and crayons which included Crayola Multicultural Crayons™ to draw a scientist or engineer. Once completed, the teachers asked the children to describe their drawings using the prompt, “tell me about your drawing,” and scribed their responses. Directions and
proper protocol for the DAST administration and transcription were provided to the teachers (see Appendix E).

After each data collection period, a member of the research team typed the teacher’s scribed notes into a spreadsheet for qualitative analysis. Employing a modified version of the DAST Rubric created by Farland-Smith (2012), one researcher from the team examined the Appearance, Activity, and Location drawn by the child, and then coded these three elements as either sensationalized = 1, traditional = 2, or contemporary = 3 (see Appendix F). Figure 5 illustrates examples of how Appearance might be coded.

**Figure 5**

* Coding for Appearance.

<table>
<thead>
<tr>
<th>Dependent Variables</th>
<th>Sensationalized (1)</th>
<th>Traditional (2)</th>
<th>Contemporary (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>APPEARANCE</strong></td>
<td>Male or female who resembles a monster (e.g., crazy hair, odd appearance, cape)</td>
<td>Standard-looking white male or standard-looking scientist unable to determine gender. This scientist clearly lacks any references that are bizarre (e.g., humpback).</td>
<td>Female, person of different ethnicity, child*, or two or more scientists</td>
</tr>
</tbody>
</table>

*modified from Farland-Smith, 2012

Note. Examples of sensationalized, traditional, and contemporary perceptions of scientists based on the DAST rubric.

**Digital Design a Scientist Test (D-DAST)**

The Digital Design a Scientist Test (D-DAST) was developed to collect further evidence about the preschoolers perceptions of science and to support the findings on the DAST, particularly to address the concerns of the researchers at the onset of the study about challenges in interpretation of preschoolers drawings. The D-DAST had seven items and took the preschoolers under one minute to complete. The D-DAST was created using Typeform, a web-based survey platform and presented to the participants on an IPad. The children designed their own computer based ‘scientist’ image by choosing from a series of mostly picture options (see Figure 6): gender (male/female), skin color (light/dark), clothing (lab coat/ shirt), hair types (sensational/normal), glasses/no glasses, tools (hand lens, beaker, computer), and backgrounds (lab, playground, dungeon).
Note. Examples of the different choices that the children could make when completing the D-DAST. Each choice built on the previous one.

Once the data had been collected, each choice was coded as either sensational, traditional, or contemporary on a 1-3 scale with 1 being sensational, 2 being traditional, and 3 representing a contemporary perspective. This coding resulted in the assignment of a composite score for the D-DAST that was calculated by adding up the points associated with each interaction. For example, a lab coat would be coded as traditional and receive 2 points and everyday clothing was contemporary and worth 3 points. Higher composite scores were associated with more contemporary perspectives of science. D-DAST scores could range from 11 to 21.

Pre and Post Teacher and Parent Surveys
Each teacher was asked to complete a pre and post survey in addition to weekly media logs. The pre-survey (87% response rate, N=11) collected demographic data and
asked about the teachers’ current use of digital media with their students. Post-surveys (92% response rate) asked teachers to rate *The Cat in the Hat Knows a Lot About That!*™ multi-platform media and their perceptions of students' feelings towards the media. Teachers also reported on how *The Cat in the Hat Knows a Lot About That!*™ multi-platform media resources helped to support their science instruction and likelihood of continued use of lessons (See Appendix G). The weekly media logs were available for teachers to record the time and types of *The Cat in the Hat Knows a Lot About That!*™ multi-platform media instruction implemented in the classroom.

The caregivers were also asked to complete pre and post surveys and media time logs. The pre-survey (78% response rate) asked demographic questions and assessed the exposure to media at home, specifically how many hours per day children engage in digital game play and/or television viewing. The post-survey (36% response rate) asked caregivers to report how the resources supported their confidence level in teaching their children about science and engineering and to rate *The Cat in the Hat Knows a Lot About That!*™ app, video stories, and family activities (see Appendix H).

**Analysis & Results**

This section presents the results of phase two of the study. First, quantitative data from the NOSES instrument and the parent pre-survey and qualitative data from a survey prompt on the family time log to share experiences with the *The Cat in the Hat Knows a Lot About That!*™ multi-platform media content were used to answer the research questions about outcomes associated with the nature of science and engineering. Next, results from the DAST and D-Dast were used to report about the children's perception of science and scientists. Finally, qualitative data from parent and teacher surveys were used to understand how the media supported (or did not support) the development of a positive science identity.

**Research question 1: How does exposure to *The Cat in the Hat Knows a Lot About That!*™ content funded by the Ready to Learn grant affect children's understanding of the nature of science and engineering?**

Preschool children significantly increased their understanding of the nature of science and engineering after engaging with *The Cat in the Hat Knows a Lot About That!*™ multi-platform media content. The mean scores for all participants at each data collection period were plotted on a line graph to visually understand how the NOSES scores changed over time. Figure 7 shows that the overall mean scores increased at every data collection period.
The intervention effect on children’s understanding of the nature of science and engineering was first examined by making pre-post comparisons using a paired t-test. Scores from the first data collection - prior to any children receiving the intervention, were compared to the fifth data collection - when all of the children had received the intervention. Only children who had the first and last data points were included in the calculations (n=96). There was a statistically significant difference: NOSES 1 (M = 27.60, SD = 17.044) and NOSES 5 (M = 36.06, SD = 17.228), t(95) = 4.193, p ≤ .005. A Cohen’s effect size value (d = 0.49) suggested a moderate effect.

To more accurately assess the change over time of the control group and intervention group, mean scores were plotted prior to and post implementation on a line plot (See Figure 8). The intervention group scores at all data collection periods were higher and increased at a greater rate than the control group scores. Secular changes in the outcome caused by external influences such as changes in the way that teaching is delivered or learned knowledge and skills from the assessment are common in repeated
measure designs (Song & Ward, 2015). Thus, calendar time may be associated with the outcome in addition to its association with exposure to the intervention and so is a potential confounder (Hemming, Haines, Chilton, Girling, & Lilford, 2015). An underlying upward secular trend is evident in the line plot since both the control and the intervention scores increased over time.

**Figure 8**
Comparing Mean NOSES Scores of Children During Control Periods to Intervention Periods

To account for the upward secular changes in the data, the researchers analyzed the intervention effect using a linear mixed model with a random effect for each cluster. Additionally, for the SW-CRT, a fixed effect for time representing each step was employed (Hussey & Hughes, 2007). The confidence interval was adjusted for multiple comparisons using Bonferroni. Only participants who had at least 4 of the 5 possible data points were included in the analysis (N=116). After controlling for the secular trend, the results showed that the intervention had a significant effect (F= 5.468; P=.020).
The multiple methods of analysis provide evidence that *The Cat in the Hat Knows a Lot About That!*™ multi-platform media significantly increased preschoolers’ understanding of the nature of science and engineering.

**Weeks of Intervention**

Research Question 1a. *How does the number of weeks of intervention influence the outcomes of nature of science and engineering?* was explored using a paired sample t-test for each cluster. The dropline plot shows the difference in scores by cluster from data collection time 1 to data collection time 5 (figure 9). While the scores between clusters were not significantly different at the start of the study, clusters one, two, and three all had meaningful changes with *p* values under .1 (*p*=.013, *p*=.093, and *p*=.001 respectively), whereas; cluster four did not have a significant change (*p*=.861). This indicates that more than 2 weeks of experience with *The Cat in the Hat Knows a Lot About That!*™ multi-platform media is needed for the media’s content to impact outcomes associated with children's understanding of the nature of science.

**Figure 9**

*Comparison of NOSES Scores at the First and Last Data Collections for Each Cluster*

Qualitative data captured from parent media logs were analyzed to better understand the experiences of the children who had the longest intervention period (8 weeks), in relation to the NOSES scores. Figure 10 shows the change in mean NOSES scores.
over time in conjunction with caregivers comments on the weekly time logs. At first children shared content from the videos and games with others in their family, and then they began to apply the knowledge to real-life situations and engage in scientific practices such as asking questions. A few caregivers, and only those whose child had the intervention for 8 weeks, indicated that they were ready for new or additional challenges. Although interesting trends arose, additional research exploring how time with *The Cat in The Hat Knows a Lot About That!*™ multi-platform media impacts children’s abilities to apply learning to new scenarios and to engage in science and engineering practices is necessary to generalize to the larger population.

**Figure 10**

*Change in Mean Scores Combined with Qualitative Data*

![Figure 10](image)

*Note. Comments from parents via the media logs and post-survey helped to explain the change in scores over time.*

Research question **1b. How does children’s gender, socio-economic status, race, and qualification for special education impact their understanding of the nature of science and engineering over time?** was explored first for differences at the start of the study through a linear regression and then through visual analysis using line plots.

**Gender**

Gender was the only confounding variable in which there was a significant difference (p<.001) at the first data collection period (prior to any intervention). Girls NOSES scores (M=36.00; SD=15.05) were significantly higher than boys (M=22.68;
SD=16.31), $p < .0001$. Figure 11 displays a line plot of mean scores between boys and girls from the beginning of the study to the final data collection period. By the end of 9 weeks of the study the difference was no longer significantly different.

**Figure 11**
*Line Plot Comparing Boys and Girls Over Time*

---

**Socio-economic Differences**

An interesting pattern emerged from the SES data analysis; children from lower income groups had greater gains in scores over time (see Table 3).

**Table 3**

*Family Reported Income and Percent Change In NOSES Scores*

<table>
<thead>
<tr>
<th>Income Level</th>
<th>Percent change in scores</th>
<th>Mean Pre-Intervention Score</th>
<th>Mean Post-Intervention Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than $24,999</td>
<td>12.3%</td>
<td>20.0</td>
<td>35.7</td>
</tr>
</tbody>
</table>
Income groups were dichotomized into low income (<$50,000) and not low income (>=$50,000). The mean line plot shows that children from low income families made greater gains than their more affluent peers (see Figure 12).

**Figure 12**

*NOSES Scores by Income Over Time*

<table>
<thead>
<tr>
<th>Income Group</th>
<th>Percentage</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>$25,000-$49,999</td>
<td>8.6%</td>
<td>33.0</td>
<td>44.0</td>
</tr>
<tr>
<td>$50,000-$74,999</td>
<td>7.2%</td>
<td>32.1</td>
<td>41.3</td>
</tr>
<tr>
<td>$75,000+</td>
<td>5.3%</td>
<td>28.5</td>
<td>34.2</td>
</tr>
</tbody>
</table>

*Note.* Line plot comparing NOSES scores from children from households whose income was less than $50,000 per year and children from households whose income was greater than $50,000 per year.

**Race and Ethnicity**

Children's race and ethnicity identified by caregivers on the pre-survey was dichotomized into those who were identified as white and those who were not. A line plot shows the group means did not differ throughout the study (see Figure 13).
**Figure 13**

*Comparison of Mean Scores on the NOSES for Children Who Were Identified as White and Children Who Were Not Identified as White*

*Children Receiving Special Services*

Children who received special services, as reported by their caregivers on the pre-survey, were compared with children who did not receive special services. Group mean scores were plotted on a line plot graph (Figure 14). Although children receiving special services scored lower than their typically developing peers, they had similar increases in their understanding of the nature of science over the course of the research.
Note. *Children receiving special services followed a similar learning path as their peers.*

**Question 2: How does exposure to The Cat in the Hat Knows a Lot About That!™ funded by the Ready to Learn grant affect children’s perceptions of science?**

The research team conducted analysis using data from the D-DAST and the DAST to examine how the intervention affected children's perceptions of science. The analysis of the data from the D-DAST was limited in the number of questions (7) and the range of scores (11-18). A mixed model that accounted for cluster and time found a positive but non-significant change in children’s perceptions of science and scientists (df 35.78; f 1.44; p .238). The DAST provided more detailed information about the children's change in their perceptions of science and engineering. The descriptive data below showed that children did increase their contemporary perceptions and decreased their sensational or traditional perceptions for all three constructs over the course of the study. Additionally, a two-way
contingency table analysis was conducted to evaluate whether perception of science and engineering changed from Time 1 (pretest) to Time 5 (posttest).

**Activity (What scientist do)**

Activity significantly differed from Pretest to Posttest, Pearson $\chi^2 (3, N = 199) = 13.746, p = .003$. During the first data collection period, only 23.58% of the children described contemporary activities such as testing a theory or planning an experiment. However, at the fifth data collection, 55.88% of the children described contemporary activities (see Figure 15).

**Figure 15**

*DAST Activities*

![Preschooler’s Perceptions of What a Scientist Does](image)

Note. Children described more contemporary activities by DAST 5.

**Location**

Location significantly differed from Pretest to Posttest, Pearson $\chi^2 (3, N = 199) = 18.849, p = .001$. Over the course of the intervention, contemporary depictions of where science and engineering take place nearly doubled. At the first data collection period, 14% of children placed their scientist or engineer in a realistic everyday setting. By the fifth data collection period, 32.4% of the locations in the drawings could be described as contemporary (Figure 16).
Note. Children identified more contemporary locations in their drawings between the first and last data collection periods.

Appearance

Appearance did not significantly differ from pretest to posttest, Pearson $\chi^2 (3, N = 199) = 5.668, p = .129$. The DAST data from the pretest initially showed similar proportions of traditional (41%) and contemporary (46%) depictions of the appearance of scientists and only 13% of children demonstrated sensationalized perceptions. However, by the end of the study the majority of children drew contemporary scientists while traditional and sensationalized depictions decreased (see Figure 17).
Note. A high percentage of children described contemporary appearances on the first DAST and then increased that percentage by the last.

Gender

Participant gender also played a role in explaining children’s increase in contemporary perceptions of science. The data show that prior to any intervention boys drew significantly more male scientists than females whereas, girls drew almost equal numbers of male and female figures. However, after everyone received the intervention girls depictions of female scientists increased significantly (paired samples T-Test results t=-2.98, df 43, p=.005).
Figure 18

Gender of the Scientists in the Drawings

Note. More girls drew female scientists or engineers by the last data collection period.

Science Identity

The qualitative data from parent post surveys were analyzed using a lean coding method described by Creswell and Poth (2018). Statements from the post survey from an open-response question, “How did your child interact with The Cat in the Hat Knows a Lot About That!™ multi-platform media at home?” were categorized into three initial codes (behaviors, attitudes, and expressions). From the initial codes, 13 expanded codes were extracted. The expanded codes were then categorized into three final codes (transfer of The Cat in the Hat Knows a Lot About That!™ multi-platform media, family engagement, and nature of science). The coding procedure illustrated by Figure 20 provides representative examples of each expanded code and shows the relationship between the codes and the theme of science identity.
Multiple caregivers reported that their children incorporated science and engineering practices into their daily lives, and that children incorporated characters from The Cat in the Hat Knows a Lot About That!™ into their play experiences. Caregivers described children’s behaviors and attitudes that demonstrated an understanding of the nature of science and engineering after engaging with The Cat in the Hat Knows a Lot About That!™ multi-platform media content. The reports showed that children displayed a sense of pride and accomplishment when sharing information about their science and engineering learning from The Cat in the Hat Knows a Lot About That!™ Together, the codes describe positive science identity constructed through everyday experiences with media that encourages STEM learning and social interactions between children and their families (Chafel, 2003).

**Figure 19**

Examples of Caregiver Comments for Each Coded Category
Discussion of the Study Findings

The findings from this study suggest that exposure to *The Cat in the Hat Knows a Lot About That!*™ multi-platform media at home and school develops children’s understanding of the nature of science and engineering and supports contemporary perceptions of science and a positive science identity. Developing a deep understanding of the nature of science and engineering allows people to more critically engage in and interpret information about the world in which they live (Lederman, 2013). When preschoolers understand the nature of science and engineering they are better able to answer their own questions and solve problems and will be better able to engage critically in their formal K-12 science curriculum.

Science identity is constructed through everyday experiences and social interactions (Dou et al., 2019; Gee, 2001). Prior research has shown that consistent access to science instruction in a collaborative classroom can help build positive science identity as students actively construct meaning from learning experiences (Buck, Cook, Quigley, & Lucas, 2014; Emdin, 2011; Ferrini- Mundy, 2013). Children with contemporary perceptions, a strong science identity, and understanding of the nature of science and engineering are more likely to feel included in and believe they can be successful in science and engineering endeavours.

The findings from this study support the recommendations from the National Science Teaching Association (NSTA) position statement for early childhood science education which articulates that young children require multiple, varied, and prolonged opportunities to engage and explore science; and that young children require sustained engagement with concepts over extended periods of time (NSTA, 2014). In the current study, children began to increase their understanding of the nature of science and engineering over time; interestingly children needed more than two weeks to demonstrate significant growth. Furthermore, caregivers reported interest and engagement with different modes of the multi-media; digital games, episodes, or real-world activities. Learning through a multi-platform media approach provides different access points for children to learn and develop interest in new concepts and ideas over time (Kennedy, Thomas, Meyer, Alves, & Lloyd, 2014; Kennette & Wilson, 2019).

Finally, this research indicates that high-quality, free multi-platform media experiences at home and school increases access and provides a more equitable route for children of all backgrounds to encounter science and engineering in a meaningful way. The data shows that children with disabilities learned at an equivalent rate as their peers. Multiple meta studies found similar patterns when comparing special and typical students in inclusion classrooms, reporting a small to moderate effect over time (Bakken, 2016). Providing children from under-resourced communities, who have not previously had access to science and engineering experiences of their peers, to learning through media may help create a more diverse STEM workforce. STEM fields are negatively impacted by
the lack of diverse perspectives necessary to create solutions to global problems of today and in the future. Research has identified a lack of understanding of who participates in science, technology, engineering, and math careers and how those careers are practiced as areas which impact the lack of interest in continuing through the STEM pipeline (Coleman, 2019; Dou et al., 2019; Farland-Smith, 2012; Koballa, & Glynn, 2013; Reid, 2014). Additionally, positive perceptions of and attitudes towards science influence the development of science identity, an essential construct for persistence in STEM career pathways (Dou et al., 2019).

The results of this study provide critical contributions to a relatively sparse body of literature related to preschool science and the use of media with early learners. Multi-platform media content that is thoughtfully and intentionally designed with specific learning goals has the potential to reach more children and have positive impacts on their understanding, perceptions, and identity of science and engineering. Media is a tool for teaching and learning that can transcend home and school and can have great impact in early childhood education. Though many debates exist around the role of “screen time” and media with preschool children, they rarely account for how digital tools can enhance the learning opportunities for children who may not otherwise have access to physical resources and experiences. Language about the media’s role in education at home and school needs to shift away from time on screens and focus on, instead, the qualities of active media integration. Research that highlights the benefits will support implementation efforts and encourage teachers, administrators, and policy-makers to reconsider the role of media in early childhood classrooms.

Limitations

By incorporating both quantitative and qualitative data from multiple sources and adhering to the tenets of mixed-methods research, the team endeavored to mitigate threats to validity and fidelity (Creswell & Plano Clark, 2011). Despite these efforts, a few limitations are acknowledged:

- Two of the instruments were designed for the study. Further investigation into criterion validity and reliability should be completed for future use of the instruments.
- The clusters in the SW-CRT design differed slightly in size and demographics. Hussey and Huges (2007) warn that this could introduce bias into the results.
- As corroborated by Dusenbury et al. (2003), self-reported data can introduce challenges of fidelity. The pre-survey data from the children’s caretakers, likely under represents the number of children who received special services and the number of children who were situated in families that made less than $50,000 a year.
Implications for Practice and Future Research

These findings suggest that *The Cat in the Hat Knows a Lot About That!*™ multi-platform media does indeed create positive learning opportunities for preschool children. Future studies should build on these efforts while also considering the following:

- The data indicated that while intervention impacts are evident within the first two weeks, more than four weeks of intervention may be needed to more accurately measure outcomes.
- Digital data analytic tools such as the PBS KIDS Learning Analytics Platform can provide a more detailed indication of the effects of time on the intervention and the outcomes.
- For children in under-resourced communities and those who may have limited social, physical, or cognitive capabilities, the media might have introduced activities that could not otherwise be available. Future studies should examine the effects of novel virtual experiences on under-represented groups.
- Future research has the potential to not only further address a gap in the literature related to how preschool children engage in science (Bustamante et al., 2017) but also gaps in equitable access to resources and digital technologies (Daugherty et al., 2014; Magnuson & Duncan, 2006).
- Young children are playing and learning in an increasingly digital world. Educating them on how to engage with and learn from multi-platform media will support their current and future play and learning experiences. Changing the conversations from ‘screen time’ to ‘learning through educational media integration’ may help parents and educators understand the beneficial roles media can play in children’s learning.
References


Link to Appendix

For further information on the research designed assessment tools please contact Dr. Sara Sweetman at sara_sweetman@uri.edu.
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Appendix A - Phase One Instrument Development

Five specific steps were taken to develop valid and reliable assessment instruments (Radhakrishna, 2007). The first step in creating a valid and reliable instrument is to examine the proposed research, the participants, and the literature to understand how, who and what is being measured. The researcher conducted a thorough literature review on the Nature of Science, the inclusion of engineering with science, young children’s perceptions of scientists, and science and engineering assessments for young children. Furthermore, two classroom teachers, separate from the larger phase two sample, were interviewed to better understand the experiences and abilities of children ages 4-6 with technology in the classroom. Findings from the literature review justified the importance of assessing young children’s understanding of the nature of science and engineering and their perceptions of scientists and highlighted the need for quantitative measures that are easily implemented and preschool accessible.

Step two and three involve questionnaire conceptualization and format and data analysis considerations. During this step the researchers used the literature to write questions and create scales. The literature, though, could not provide all the answers to the researchers’ questions, such as how long will the children attain a picture survey test? How many picture choices are too many for 4-6 year olds? Will preschoolers understand directions like “all that apply”? How many children would be appropriate to test at one time? These questions needed to be addressed to create a valid measure.

Field testing and expert review were used to establish validity. Establishing validity is step four of Radhakrishna, (2007) instrument development model. Pretesting the instruments with an independent sample of 23 preschoolers helped identify potential problem areas, such as survey length, and reduced measurement error. The research team tested and revised the instrument on four separate occasions. Field notes from these trials provided feedback as to the ease with which the instrument could be used in the field, the optimal number of children to take the assessment at one time (1 child), the children’s response latency (fast), and how long children would attend to the assessment (<10 minutes). The researchers also interviewed the children while testing the instrument to understand their choices. Cognitive interview questions such as “Why did you choose that option?” and “Tell me more about what you think about” helped the researchers to refine instrument items to better capture preschoolers’ ideas as well as increase the face validity of the D-DAST and NOSES instruments. In addition, the items for the NOSES and D-DAST assessment, as well as the mechanisms for scoring each instrument, were sent out to a panel of three expert reviewers to ascertain whether the items within each instrument accurately represented the constructs being measured. The reviewers’ feedback was discussed among the research team and incorporated into the final draft of the assessment instruments. As a result of field testing and expert review the researchers were confident of the instruments’ content and face validity.

The final step laid out by Radhakrishna is to establish reliability. The research team intended to use a test-retest reliability measure during phase one. The challenge in working with such young children to establish validity created a situation in which too many instrument adjustments were made between each field test; therefore the results could not be compared. The research timeline dictated the need to start Phase Two prior to establishing reliability.
Data from the preschoolers who completed the assessments at data collection period one and two (2 weeks apart) and did not receive any intervention were included in a test retest reliability. The NOSES had 77 participants and was significant at the p<.001 and a correlation of .638. The researchers felt the reliability was sufficient considering the nature of assessment with young children, including those with special needs. The D-Dast had 84 participants that completed the assessment at times one and two without an intervention. The correlation was significant at the 0.01 level yet had a pearson reliability score of .388. The researchers used the D-Dast primarily qualitatively to support the findings from the DAST. Further adjustments to the survey could be considered for future use to increase reliability (Nunnally, 1978).

![Sequence for Questionnaire/Instrument Development](image)

*Figure 1: Radhakrishna’s process for developing valid and reliable assessments (2007, p. 1).*

Appendix B - Recruitment Procedure

Steps Taken for Recruitment of Participants:

(1) First, administrators from 12 local public school districts were contacted via phone call and email about their interest in the study.
(2) The first 5 districts whose superintendent, preschool principal, or early learning director responded with approval were sent consent forms and recruitment flyers to the individual classroom teachers.
(3) Thirteen of the possible seventeen teachers returned their permission forms.
(4) Finally, all families from the 13 classrooms were sent printed recruitment flyers explaining the study and a consent form in both Spanish and English.
(5) One hundred and forty one of the possible 179 children's caregivers signed and returned the permission form. One hundred and thirty seven of the children were able to successfully complete the assessments and had more than one data point over the five time periods.
(6) All participating teachers and children were given coded name tags. The codes were used to collect data while visiting the schools.
(7) Before beginning the study, the research team met with the teachers and families in person to explain the details of the research and answer any questions.

Neither the participating teachers nor the caregivers received compensation for their participation, although they were informed that they would be able to keep their tablets, and teaching materials after completion of the study.
Appendix C - Phase Two Sample and Cluster Demographics

The sample included 137 children preparing to attend kindergarten in the fall of 2019 who were currently in inclusive preschool classrooms associated with the public school system.

**Ages of the Children**

Both the mean and media age of the children was five years old. The ages of the children ranged from 45-71 months and a mean of 60.42 months. Figure 1 illustrates the distribution of ages amongst the children in the sample.

![Figure 1. Age of Participants in Months. Calculated from birth dates provided on the pre-survey.](image)

The sample size was distributed across clusters as follows: Cluster 1, n=35; Cluster 2, n=31; Cluster 3, n=44; Cluster 4, n=27.

**Composition of clusters:**

Since children were situated in classrooms and in public schools, each cluster had some differences in their demographic characteristics, as presented in the four tables below.
Gender split by cluster

### Children's Gender

**Cluster 1**
- **Gender of Cluster 1**
  - Male: 55.5%
  - Female: 44.5%

**Cluster 2**
- **Gender of Cluster 2**
  - Male: 67.7%
  - Female: 32.3%

**Cluster 3**
- **Gender in Cluster 3**
  - Male: 60.5%
  - Female: 39.5%

**Cluster 4**
- **Gender of Cluster 4**
  - Male: 55.5%
  - Female: 44.5%

Racial/ Ethnic Composition by cluster

### Racial Composition of Clusters

**Cluster 1**
- **Racial Composition**
  - White: 32.0%
  - Mixed: 8.5%
  - Hispanic or Latinx: 20.0%
  - Black or African American: 8.0%
  - Native American: 0.5%
  - Asian or Asian American: 6.0%
  - Other: 17.5%

**Cluster 2**
- **Racial Composition**
  - White: 23.1%
  - Mixed: 76.9%
  - Hispanic or Latinx: 0.0%
  - Black or African American: 0.0%
  - Native American: 0.0%
  - Asian or Asian American: 0.0%
  - Other: 0.0%

**Cluster 3**
- **Racial Composition**
  - White: 23.1%
  - Mixed: 76.9%
  - Hispanic or Latinx: 0.0%
  - Black or African American: 0.0%
  - Native American: 0.0%
  - Asian or Asian American: 0.0%
  - Other: 0.0%

**Cluster 4**
- **Racial Composition**
  - White: 70.2%
  - Other: 29.8%
Household Income by cluster

Students receiving special services by cluster
Appendix D - Intervention Materials

Teacher Materials
Each teacher who participated in the study received the following materials as part of the intervention.

Student Tablets:
- Kindle Fire HD 8 Kids Tablet
- Each teacher received one tablet for each participating child as well as 1-3 extras depending on the size of the class
- The tablets contained The Cat in the Hat Builds That!™ app as well as 41 videos from The Cat in the Hat Knows a Lot About That!™.

iClever Kids Headphones:
- Each teacher received two sets of headphones
- Purchased headphones with tangle-free cord and volume control for safety

Lesson Materials:
The researchers printed out all of the materials to support the following lesson plans from the PBS Learning Media website:
- Building Bridges
- Floats Your Boat
- Good Vibrations
- Pulling Together

Books Identified by the Lesson Materials:
- A Book of Bridges: Here to There and Me to You - Cheryl Keely
- What Floats in a Moat? - Lynne Berry
- Oscar and the Snail: A Book About Things That We Use - Geoff Waring
- Why Do Moving Objects Slow Down? A Look at Friction - Jennifer Boothroyd

Supplemental Materials to Support Real World Activities Listed in the Lesson Materials:
- Aluminum Foil
- Cardboard for ramps
- Modeling Clay
- Pipe cleaners
- Masking Tape
- Glitter Pom Poms
- Magnifying Glass
- Markers
- Wax Paper
- Popsicle Sticks
- Assorted Rubber Bands
Parent Materials

At the welcome meeting to begin the study, each family received a Kindle Fire HD 8 Kids Tablet containing *The Cat in the Hat Builds That!*™ app as well as 41 videos from *The Cat in the Hat Knows a Lot About That!*™. Additionally, the researchers provided print-outs to support the following real-world activities from the PBS Learning Media:

- Daring Designs Challenge
- Measuring This and That
- Stick Puppet Shadow Play
- The Cat in the Hat Pinwheel Activity
- What Floats Your Boat?

As an example, Figure 1 shows the directions page from *Stick Puppet Shadow Play* and one of the figures to be used as a shadow puppet. The researchers provided the parents with these materials printed on thick paper. By providing these resources to the families, the research team hoped to facilitate and encourage their use with the children.

![Figure 1. Sample Parent Resources. The parents received printed copies of the resources from the PBS Learning Media web site.](image)
Appendix E- DAST Teacher Directions

Draw a Scientist

(1) Have materials available
   ● White copy paper
   ● Multicultural crayon
   ● Colored crayons
   ● A pen for the teacher to record the students’ thinking

(2) Tell students: “Draw a picture of a scientist or engineer doing work. Tell an adult about your picture.”

(3) Record the students' ID number and what they say about their drawing on the back of the paper.
   Questions/ Prompts you can ask:
   ● How old is your scientist/ engineer?
   ● Is you scientist/ engineer a girl, boy, woman, or man?,
   ● What color is your scientist/ engineer’s skin?
   ● Tell me what your scientist/ engineer is doing.
   ● Tell me where your scientist/ engineer is.

(4) Make sure all papers have ID numbers and place the paper in the folder.

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Appendix F- DAST Rubric

The researchers modified the original DAST rubric from Farland-Smith (2012) as described below. In addition to removing some of the criteria from the rubric, the researchers changed one of the ratings. In the original rubric, Farland-Smith listed (a) Can’t be Categorized, (b) Sensationalized, (c) Traditional, and (d) Outside of Traditional. This last criteria was recoded as Contemporary.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Can’t be Categorized</th>
<th>Sensationalized</th>
<th>Traditional</th>
<th>*Contemporary</th>
</tr>
</thead>
<tbody>
<tr>
<td>APPEARANCE</td>
<td>Examples:</td>
<td>Male or female who resembles a monster, <em>or who has clearly geeky appearance</em></td>
<td>Standard-looking white male or standard-looking scientist unable to determine gender. This scientist clearly lacks any references that are bizarre.</td>
<td>Female, person of different ethnicity, child, or two or more scientists.</td>
</tr>
<tr>
<td></td>
<td>- No Scientist</td>
<td>(example: crazy hair, odd appearance, cape).</td>
<td>(example: humpback).</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Historical Figure</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- *reflects teacher or student</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Difficult to discern</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LOCATION</td>
<td>Difficult to discern</td>
<td>Resembles a basement, cave, or setting of secrecy and/or horror. Often elaborate, with equipment not normally found in a laboratory.</td>
<td>Traditional lab setting-a table with equipment in a normal-looking room.</td>
<td>Anywhere other than a traditional lab setting.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(example: beakers without bubbles).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACTIVITY</td>
<td>Difficult to discern</td>
<td>The scientist’s work is either magical or destructive, or embellishes the drawing with a storyline that is about spying, stealing, killing, or scaring. Often science done unrealistically under hazardous conditions.</td>
<td>“The scientist is studying or is trying to…” but caption *or drawing does not show HOW the scientist is studying or researching.</td>
<td>“The scientist is studying…” and the caption or drawing shows HOW the scientist is doing this. Indicates that the student is portraying the type of work that a scientist might actually do with the tools needed. *tools may include literacy component for example science notebook or books.</td>
</tr>
<tr>
<td>(with support or without support from caption)</td>
<td></td>
<td>(example: destructive, toxic potions, or explosives).</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Score | 0 | 1 | 2 | 3

Figure 1. Modified DAST rubric based on the work of Farland-Smith (2012). * indicates a modification.
Appendix G - Teacher Survey Data

Pre and post-surveys collected data from participating teachers about their prior experience and comfort-levels, technology and media use, as well as their perceptions of The Cat in the Hat Knows a Lot About That!™ media after the conclusion of the program.

Pre-Survey Data
Teacher Demographics
Eleven of the 13 teachers who participated in the study completed the pre-survey. Of the 11 teachers, all identified as White (Non-Hispanic) and 10 identified as female with one preferring to self-define. The teachers all possessed a certification in early childhood education. The teachers had an average of 13.7 years of teaching experience, ranging from 3 to 31 years, and an average of 12 years of teaching preschool, ranging from 1 to 25 years (See Figure 1).

Figure 1. Teaching Experience.
Teacher Media Use Prior to the Program
Nine of the teachers responded to these questions and reported that students spend little to no time with digital media and technology as shown by Figure 2. The majority of teachers reported that the students experience less than 10 minutes of video and/or technology each week.

![Figure 2. Teacher reported media and technology use. Data based on teacher pre-surveys.](image)

Post-Survey Data
Teacher Perceptions of The Cat in the Hat Knows a Lot About That!™ Materials
All but one teacher responded to the post-survey (N=12), which asked the teachers to rate The Cat in the Hat Knows a Lot About That!™ media as well as the individual lesson plans. All of the teachers positively rated The Cat in the Hat Knows a Lot About That!™ app, videos, lesson activities, and materials (See Figure 3). Additionally, teachers reported that they would be likely or very likely to use the individual lesson plans in the future.
The Cat in the Hat Knows a Lot About That!™ multiplatform media supported teachers' feelings of preparedness to teach science in preschool. Teachers were asked: "After using the Cat in the Hat lessons and activities, how prepared do you feel about teaching science to preschool children?" Response options included extremely prepared, more prepared than before, prepared - about the same as before, less prepared than before, or not at all prepared. 91% of teachers in the study reported feeling more prepared or extremely prepared to teach science.

Teachers spent more time with the media than they reported spending with media on the pre-test. In addition to the time viewing videos reported in figure 4, all teachers provided time for the children to play on the mobile app during center time (eight teachers reported allowing their students access to the mobile app 2-3 days a week and the remaining five teachers allowed access
to the mobile app 4-5 days a week).

![Bar chart showing time students spent watching Cat in the Hat videos each week.]

**Figure 4. Amount of time teachers spent showing *The Cat in the Hat Knows a Lot About That!* videos.**

While teachers still reported concerns for using media in the classroom, they also provided positive feedback about their experiences. In response to the prompt, “Do you have any feedback you would like to provide about the materials?” teachers reported:

“As an educator, the lessons and resources provided in the units enabled all students to participate and engage in. The family letters provided in each unit is a great way to collaborate with families and allowed me to inform families what we are learning about in the classroom and ideas what they can do at home with to support their learning. Our class enjoyed the Classroom Collection Box. During group time, students would share the items they brought in. “

“The children really enjoyed the Cat in the Hat videos and app. They started using vocabulary from the videos in the classroom.”

“The children were very excited to do the experiments each week as well as use the tablets. Including the families in providing materials for the activities kept them involved...they were so interested in the experiments and asked their children many questions about it.”

“My students enjoyed doing more of the hands-on activities vs. using the tablets. However, it seemed like they used the tablets alot at home because they were familiar with the games and concepts. In a classroom setting I felt a little guilty for having students use the tablets and they would get into a "technology zone", but we used them in small increments.
Appendix H - Family Survey Data

Pre and post-surveys collected data from participating families about their technology and media use, their comfort with teaching science to their children, as well as their perceptions of *The Cat in the Hat Knows a Lot About That!*™ media after the conclusion of the intervention.

Pre-Survey Data

**Reported Exposure to Media and Technology**
The survey asked families about their media and technology usage before gaining access to *The Cat in the Hat Knows a Lot About That!*™.

**Daily Exposure to Media (n=103)**
As illustrated by Figure 1, over half of the families reported that their child spends less than an hour per day playing games on a mobile device or computer.

![Figure 1. Amount of time spent playing games on a mobile device or computer.](image)

Families indicated that their children spent more time watching TV than playing games or interacting on a device or tablet. As illustrated by Figure 2, the majority of the children spend at least an hour watching TV each day.
Figure 2. Amount of time spent watching TV per day.

**Exposure to The Cat in the Hat Builds That!™ app (n=112)**
The pre survey inquired whether or not the children had ever played *The Cat in the Hat Builds That!™* app prior to the start of the intervention. Very few families reported that their child had played with the app (see Figure 3).

![Figure 3. Count of the number of families reporting whether their child played with The Cat in the Hat Builds That!™ app prior to the start of the intervention program.](image-url)
Post-Survey Data

**Parent confidence in teaching science and engineering (n=51)**
The majority of parents reported that they feel as confident and prepared, or more confident and prepared, to teach their children about science and engineering after completing the intervention program (Figure 4).

![Figure 4. Caregiver confidence about teaching science and engineering to their children.](image)

**Parent perceptions about The Cat in the Hat Knows a Lot About That!™ content (n=51)**
The post-survey asked parents to compare *The Cat in the Hat Knows a Lot About That!*™ media to other educational apps and video content. Parents generally had positive perceptions of *The Cat in the Hat Builds That!*™ app and *The Cat in the Hat Knows a Lot About That!*™ video content (see Figure 5).
Figure 5. Caregivers’ perceptions of how much their child enjoyed and learned from playing games in The Cat in the Hat Builds That!™ app.

Similarly, parents largely reported that their child enjoyed and learned from engaging with The Cat in the Hat Knows a Lot About That!™ videos (Figure 6).

Comparing Cat in the Hat Builds That!™ to other educational apps.

When asked to compare the app to other educational apps that their children might play, parents rated The Cat in the Hat Builds That!™ more positively (see Figure 7). Over 75% of caregivers indicated that the app encouraged home and school connections either a fair amount or a lot; 63% percent of parents indicated that the app supported their child’s learning style or differences either
a fair amount or a lot when compared to other apps; and over 80% reported that the app taught their child problem solving skills either a fair amount or a lot.

Figure 7. Parent comparisons of The Cat in the Hat Builds That!™ app to other educational apps.

Comparing The Cat in the Hat Knows a Lot About That!™ to other educational videos.

Caregivers positively rated The Cat in the Hat Knows a Lot About That!™ video content when comparing it to similar educational videos: 61% of caregivers indicated that the videos encouraged home and school connections either a fair amount or a lot; 51% percent of parents indicated that the app supported their child’s learning style or differences either a fair amount or a lot when compared to other apps; and over 75% reported that the app taught their child problem solving skills either a fair amount or a lot (See Figure 8).

Figure 8. Comparison of The Cat in the Hat Knows a Lot About That!™ to other educational videos.