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Who's modeling STEM for kids? A character analysis of children's STEM-focused television in the US

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ABSTRACT

Character portrayals are important to consider when investigating the effects of educational television on young viewers. When it comes to academic interests and career aspirations, children take cues from the media representations around them. This study is a content analysis of STEM-focused children's television shows, with attention to gender and race representation amongst the characters in those programs. Across 90 episodes of programs that claim to teach STEM to young children, 1,086 unique speaking characters were coded on demographics, physical attributes, centrality to the plot, and modeling of STEM behaviors and occupations. Following traditional industry trends, female and minority characters were underrepresented in these programs compared to population statistics. However, when it came to the centrality of their role and on-screen STEM engagement, characters were portrayed relatively equally regardless of their race or gender. This was true, especially, for characters depicted as children, but less so for adult characters, who followed more traditionally stereotypical trends. Findings align closely with prior character-focused content analyses, but also present some areas in which the industry may be moving towards more egalitarian practices.

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In recent years, there has been a noticeable increase in the number of television programs for young children that claim to teach STEM (science, technology, engineering, and math) or early STEM skills. This surge of STEM shows was likely spurred by policymakers calling for and supporting media producers to create more math- and science-focused television for children. For example, the U.S. Department of Education's Ready To Learn (RTL) initiative has provided millions of dollars for math and science programming since 2010, including math shows like *Odd Squad* and science shows like *Ready Jet Go!* (Lowenstein, Johnson, & Fragale, 2019). Because this is a relatively recent phenomenon, the body of research that formally investigates the content, features, and potential effects of these programs is still quite small compared to research on literacy programs, for example. One key mechanism through which television programs have effects on viewers is through the characters that present the content, especially when

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viewers identify strongly with the characters and/or perceive themselves as similar to the characters in some way (Moyer-Gusé, 2008). Given recent national and global efforts to diversify the STEM workforce to include more women and people of color, it is more important than ever to attend to the diversity of characters in television programs that are created, at least in part, to help achieve that goal. Thus, this study presents a content analysis of STEM television shows available to children today, with a focus on documenting the gender and race-ethnicity of characters featured in these programs.

Importance of STEM experiences in early childhood

The domains of science, technology, engineering, and mathematics – known collectively as STEM – are essential for preparing children for an increasingly technological global workforce. For example, the U.S. Department of Education predicted significant increases in the need for STEM-related jobs through 2020 (National Center on Education and the Economy, 2008; U.S. Department of Education, 2010). Yet, in recent years, children in the United States have continued to fall behind their international peers in both math and science (PISA). In addition to poorer performance on math and science assessments, American students show less interest in STEM learning compared to their international peers (President's Council of Advisors on Science and Technology, 2009). Critically, this is true not only for American children, but also for children in similarly industrialized countries, especially countries where quality of life is generally high and pressure to pursue specific careers is low (Stoet & Geary, 2018).

In addition to the overall performance in science and math, one area of particular concern is the underrepresentation of women and minorities in STEM career fields. For example, according to the U.S. Bureau of Labor Statistics, women account for only 30% of professional scientists and engineers, yet they make up 47% of the U.S. workforce. Similarly, while African Americans make up 11% of the total workforce, they account for only 5% of professional scientists and engineers. While there are many contributing factors to these disparities, media likely plays a central role by providing stereotypical role models and cultivating an acceptance of the status quo (Bandura, 1971; Gerbner, Gross, Morgan, & Signorielli, 1986).

Television as an agent of socialization

Decades of research on media effects have shown that television can and does shape viewers' attitudes and beliefs about themselves and the world (Dill-Shackleford et al., 2017; Gerbner, 1998), and that children are especially susceptible to this type of influence (Anderson & Pempek, 2005; Comstock & Scharrer, 2007). One of the ways television influences society is by displaying certain family roles, sex roles, race roles, job roles, and age roles (Dill-Shackleford et al., 2017; Greenberg, 1982). Regular exposure to these role portrayals alters our beliefs about how the world works and our assumptions about how we should behave. Several prominent theories from the fields of communication, social psychology, and cultural studies discuss this phenomenon and the underlying mechanisms behind it, including cultivation theory (Gerbner, 1998), social cognitive theory (Bandura, 2008), and encoding/decoding (Hall, 1973). What these theories have in common is the shared idea that sociocultural values are transmitted through the media and impact how we view ourselves and others (Reinhard, Olson, & Kahlenberg, 2017).

To help demonstrate these effects, many scholars have conducted content analyses to document the (often imbalanced and stereotypical) ways in which television portrays reality. Race-ethnicity of characters is one area where there have been consistent disparities documented over the last several decades (Behm-Morawitz & Ortiz, 2013). For example, in a content analysis of children's cartoons from the 1930s to the 1990s, Klein and Shiffman (2009) found that only 9% of characters in the study sample were racial minority group members, a significantly disproportionate percentage compared to the national average of 15% of the American populace averaged across the study period. The issue lies not only in the quantity of portrayals of minority characters, but also in the quality. Mastro and Greenberg (2000) found that in primetime television programming, African Americans,[1] in comparison to Whites, were shown to be more provocative and less professional in dress, more passive, and were judged as the laziest and least respected ethnic group. Similarly, in a content analysis of children's television programs across 24 countries, Götz and Lemish (2012) found that Black, Hispanic, and Asian characters were not only vastly underrepresented, they were also much more likely than White characters to be shown as "followers" rather than "leaders". These patterns of portrayals have been linked to negative effects in minoritized individuals such as lowered self-esteem in African American adolescents (Ward, 2004) as well as a devaluation of African Americans in society at large (Klein & Shiffman, 2009).

As with racial biases, content analyses have consistently found many gender biases present across all television genres, and especially in children's television programs (Signorielli, 1990). A report by the Geena Davis Institute on Gender in Media (Smith, Choueiti, Prescott, & Pieper, 2012) found that less than a third of all speaking characters in children's programming were coded as girls or women. Across all children's and family-oriented genres, not only do male characters usually outnumber female characters by a ratio of at least 2:1 (e.g. Aubrey & Harrison, 2004), but there are also clear and fairly consistent differences in the types of portrayals. Specifically, female characters are less likely to occupy leading roles or positions of responsibility and more likely to show affection and defer to male characters (Leaper, Breed, Hoffman, & Perlman, 2002; Sternglanz & Serbin, 1974; Streicher, 1974; Thompson & Zerbinos, 1995). Male characters, meanwhile, are more likely to engage in problem-solving activities, exhibit assertive behaviors, and show leadership; and are less likely to express emotions (Leaper et al., 2002; Sternglanz & Serbin, 1974; Streicher, 1974; Thompson & Zerbinos, 1995). There is evidence that these gender disparities have begun to lessen over time, especially in the last decade or two (Lemish, 2010; Lemish & Russo Johnson, 2019), and that programs are starting to feature more counter-stereotypical gender roles (Kahlenberg, 2017). Nevertheless, it is important to look at the effects of traditional patterns as their legacies have not dissipated entirely.

Stereotypically gendered portrayals on television have been shown to have behavioral and attitudinal effects on children. Signorielli and Lears (1992) found that 4th and 5th graders' television viewing was significantly related to their attitudes towards household chores being particularly male- or female-oriented. In other words, boys and girls who watched more television were more likely to say that washing the dishes, cleaning the house, and making the bed were "girl chores," and mowing the lawn, taking out the garbage, and helping with repairs were "boy chores." These beliefs also affected their behaviors, such that children who watched more television had a stronger relationship, on average, between stereotypical sex role attitudes and actually performing chores that matched their traditional gender category. In sum, there is strong evidence that if children only see representations of traditional roles and identities, they are likely to endorse traditional roles, stereotypes, and behaviors (Reinhard et al., 2017).

In addition to general attitudes about the roles of women and racial-ethnic minorities in society, research has demonstrated a relationship between television viewing and how children think about the *occupational* images they are exposed to on television. For example, in an early study on this topic, Jeffries-Fox and Signorielli (1978) found that middle school children who watched more television were more likely to want more glamorous and high-status jobs, like those most often portrayed on TV. Similarly, Signorielli (1993) found that high school students who watched more television aspired to high-status jobs that allowed them to make a lot of money, much like the TV characters they frequently viewed. Though most of these studies have focused on older children, a seminal study by Beuf (1974) looked at preschoolers' occupational aspirations in relation to the amount of television they viewed and found that children held sharply contrasting beliefs about which occupations should be held by men and which should be held by women. The more television the children watched, the more likely they were to apply stereotypes portrayed on TV to their own ideas about careers and household work roles.

Representations of STEM in children's television

While the evidence is clear that televised character portrayals affect our beliefs about the world and about ourselves, most prior research in this area has looked at adult-directed or family television programming, and when studies do focus on children's television they have tended to look at entertainment television or television for young audiences broadly. Because children's *educational* television has been known to stimulate interest in topics that young children might not otherwise encounter (e.g., Fisch & Truglio, 2001; Jennings, Hooker, & Linebarger, 2009; Wright et al., 2001), it is an important genre to focus on in the context of supporting children's interest in STEM. There is great opportunity for children to learn about various types of STEM careers and occupations through STEM-focused educational television. For example, a child growing up in a family with limited economic resources might have little opportunity to meet a computer scientist in real life, especially a female computer scientist given that they are so few in number. However, a television show that portrays a female computer scientist as a primary character would be an easy and accessible way to introduce many children to that career possibility.

Long, Boiarsky, and Thayer (2001) conducted one of the few existing content analyses of portrayals of scientists in children's educational television. They found that males and females were equally likely to be portrayed as scientists, but that male characters in these shows significantly outnumbered female characters. They also found that minority characters were significantly less likely than Caucasian characters to be labeled as scientists; minority scientists spent much less time on screen than Caucasian scientists; and there were significantly fewer minority characters than Caucasian characters in these shows. While this study represents an important building block in this area of research, it was very limited in scope in that the sample included only four television programs.

The current study

With the current study, we sought to replicate and expand upon the existing literature on portrayals of STEM in children's television. Given the national focus on increasing the participation of women and racial-ethnic minorities in STEM, our first goal was to quantitatively document the representation of gender and race that are present in STEM television programs. As Lemish (2010) points out, "head counting" is just the first step towards documenting diversity in television, but it is an essential one. While it is impossible to set a golden standard for the "perfect" ratio of female to male characters or White to non-White characters, we felt that comparing these proportions to actual U.S. population statistics would at least provide a useful benchmark.

> RQ1: What is the representation of gender and race in STEM television shows for young children in the U.S., and how does it compare to the U.S. population?

We also consider age as a potential moderating variable that may affect the patterns of gender and race portrayals. Prior studies have shown that representations of gender and race are not always equal across different age groups of characters. A recent report on the characters in children's programs in Canada and the U.S. found that the gender ratio of male to female characters was roughly equal for youth characters, but that males significantly outnumbered females when looking at adult characters (Lemish & Russo Johnson, 2019). This same pattern has been found in earlier studies (e.g. Götz & Lemish, 2012), and so we felt it important to look at gender and race not only as independently operating variables, but also in interaction with character age.

> RQ2: Are the patterns of gender and race portrayals in STEM television shows moderated by age of character?

Moving beyond head counting, another primary goal of this study was to look at the nature of the characters' involvement, and particularly their STEM engagement in these programs. As many prior content analyses have shown (e.g. Aubrey & Harrison, 2004; Götz & Lemish, 2012), looking at the qualities and characteristics that characters portray is a critical part of understanding the sociocultural values that are transmitted to viewers. As an important extension to the existing literature, for this study, we conceptualized participation in STEM in a very holistic way. Prior studies have looked specifically at characters portrayed as "scientists" (Long et al., 2001; Steinke & Long, 1996). However, STEM skills, especially for young children, encompass much more than science as traditionally conceptualized (i.e. in a lab, wearing a lab coat, handling beakers and pipettes). Foundational building blocks of STEM include problem solving, scientific inquiry, and early math skills (Center for Children and Technology, 2014; NGSS, 2015), and so it is important to look for all of these types of behaviors as portrayed by characters in STEM shows.

> RQ3: (a) What types of STEM activities are modeled by characters in STEM TV shows, and (b) are there differences by gender, race, or age in who models these behaviors?

Lastly, because these shows are in large part designed to increase participation in STEM careers, we also thought it important to investigate what types of STEM careers were portrayed within the programs. Educational television has been shown to increase children's awareness of topics that they might not otherwise be introduced to (Fisch & Truglio, 2001), and vicarious exposure can be highly effective in lieu of real-world exposure (Graves, 1999). Therefore, we sought to document the extent to which these shows may or may not be exposing children to a variety of STEM career possibilities.

RQ4: (a) What types of STEM occupations are depicted in STEM shows for young children, and (b) are there differences by gender, race, or age in who portrays these STEM occupations?

Method

Sample

The sample for this content analysis was collected in two parts. First, as part of a larger study, we identified 20 programs targeted at children aged 3- to 6-years that mentioned STEM curricula in the tag line, program/episode descriptions, or other marketing materials. These programs were selected based on a Nielsen list of all children's shows aired in the United States on broadcast or cable channels between January 2013 and August 2014 and recorded between January 2013 and August 2014 (Beaudoin-Ryan, Lovato, Olsen, & Pila, 2016). Then, to update that original sample, we added in any new STEM shows for preschoolers that aired between August of 2014 and October of 2016. Additionally, because of the increase in use of streaming platforms by households with children (Whitney, 2016), we included any shows that fit the original age and content criteria but were available on streaming platforms such as Amazon Video, Netflix, or Hulu. From these two expansion criteria, 10 additional shows were identified, resulting in a final list of 30 programs (see Appendix A).

For each of the 30 programs, three episodes were selected using simple random sampling from the latest available full season (as of the fall of 2014 for the original 20 programs; fall of 2016 for the additional 10 programs), resulting in a final sample of 90 episodes. Episodes ranged in length from 11 minutes to 22 minutes. Importantly, if an episode contained two separate narratives (e.g. one 22-minute episode comprised of two separately-titled 11-min story arcs) only the first narrative of each episode was coded. Given that characters would be coded for their STEM participation, it seemed most appropriate to compare only one individual story arc to another.

Coding

Three undergraduate student coders were trained for this project. All coders participated in the same training process and watched the same training material (non-sample episodes of the shows in the sample). Inter-rater reliability was established at Kappa ≥ 0.7. Twenty percent of the sample was double coded. Every character that appeared on screen during an episode was coded across the 16 codes that are described below. Table 1 presents reliability statistics for all variables.

Character attribute variables. Were created to capture the physical and/or demographic representation of each character in the episode. These categorical variables included: gender (male, female), age (baby, child, teen, adult, elderly adult), type of filming (animated, live action, puppet), type of being (human/humanoid, animal, robot, nature object, vehicle, monster, inanimate object), and race/ethnicity (White, Black,

Table 1. Reliability statistics for all variables.

Variable	Kappa
Speaking vs. Non-Speaking Character	0.95
Character Attributes	
Gender	0.93
Age	0.86
Animated or Live	0.97
Type of Being	0.97
Race/Ethnicity	0.91
Role	0.65
STEM Participation	
Active/Passive Learning	0.78
Teaching	0.75
Questioning	0.81
Making Observations	0.74
Investigating	0.90
Problem Solving	0.83

Asian, Hispanic/Latino, Native/Indigenous, Middle Eastern, multi-racial). We created an ordinal variable for the character's centrality to the plot (1 = walk-on character, 2 = minor/supporting character, 3 = major character, 4 = protagonist). Coders used visual and auditory information present in the episode to code each of these variables. For variables that were difficult to code based solely on information in the episode (e.g. race/ethnicity), coders were instructed to look up information in the program description on the show's website or on the Internet Movie Database (IMDB). Each variable included an "other/unsure" option for situations where the code could not be determined, as well as a "group" option (e.g. for a chorus of puppets and live action characters or a crowd of children and adults). There was also an "irrelevant" option for variables that only applied to humans (e.g. race/ethnicity would be coded as irrelevant for an animal character).

STEM participation variables. Were created to further investigate each character's role in the episode and how much they engaged with the STEM content that the episode presented. Five variables were created to capture specific STEM-related actions and activities (according to NGSS) that a character might engage in during an episode: *teaching* (i.e. explaining STEM-related facts and/or information to other characters who are less knowledgeable), *questioning* (i.e. asking questions to find out STEM-related information), *making observations* (i.e. making observations that lead to the discovery of new STEM information), *investigating* (collecting and/or analyzing data as a practice of scientific inquiry), and *problem solving* (i.e. when a character faces a problem and subsequently designs, tests, compares, or communicates a solution to that problem). These variables were coded on a scale from 0–2, where 0 meant the character did not engage in the activity at all, 1 meant the character engaged in that activity once or twice during the episode, and 2 meant the character engaged in that activity three or more times during the episode. Across these five variables, we also coded how actively or passively the character was engaged with STEM content throughout the episode. This *active/passive learning* variable was measured on an ordinal scale ranging from 0 (i.e. no active learning, only passive learning) to 4 (e.g. only active learning, no passive learning).

Occupations. If a character was portrayed as having any type of occupation or career, this was noted in the coding document. The initial, specific occupation recordings were later coded as either STEM or non-STEM occupations by cross-checking our list of occupations with a list of STEM occupations provided by the U.S. Bureau of Labor Statistics. Occupations that were explicitly included on the Bureau of Labor Statistics list were coded as "STEM occupations." Occupations that were not explicitly on the list, but that involved STEM skills and/or content knowledge (e.g., doctor) were coded as "borderline-STEM." All other occupations were coded as "non-STEM." We coded both 'real' occupations (e.g., an adult character who works as a doctor) and "pretend" occupations (e.g., a child character who, during part of an episode, pretends to be a doctor).

Results

Datasets

A total of 1086 character entries were coded from the 30 shows across 90 episodes (3 episodes per show). From this master dataset, we created two separate datasets – *Unique Characters* dataset and *Character Behaviors* dataset – that were used for different parts of the analyses.

The *Unique Characters* dataset contained 168 characters and was used to answer RQ1. In order to investigate the representation of different races and genders on screen, we needed a dataset that would account for the fact that main characters tend to have repeated appearances across episodes. Therefore, we filtered down the master dataset so that each character would be listed only once. Of those 433 characters, a large majority were one-off, guest-type characters. Because repeat characters are more likely to have an effect on viewers through the development of parasocial relationships over time (Calvert & Richards, 2014), we further filtered the list to include only characters that appeared in at least two of the three sampled episodes, resulting in the final 168 characters. This Unique Characters dataset includes only the character attribute variables because they could be collapsed across the three episodes for each show, whereas STEM participation variables could differ across each episode.

The *Character Behaviors* dataset includes all 761 individual speaking characters from the full data set and is used to answer RQs 2–4. In order to move beyond character representation to consider characters' on-screen actions, we needed a dataset that would capture all of the STEM behaviors that occur across the 90 episodes in the sample. This Character Behaviors dataset includes a separate entry for each episode that a character appears in (i.e., each character had either one, two, or three entries). Group characters were excluded from this dataset because it was not possible to analyze their behaviors by individual character attributes. Similarly, non-speaking characters were excluded because they were inherently not involved in STEM actions. Table 2 gives a comparison of the two focal datasets to the full dataset in regard to some of the basic demographics of the characters.

Table 2. Comparison of the three datasets across major demographics.

Dataset	All Characters	Gender		Age		Race	
		Male	Female	Adult	Child	White	Minority
Unique Characters	168	96	63	35	67	47	22
Character Behaviors	761	425	288	198	249	207	104
Full Dataset	1,086	496	334	246	293	237	105

Analysis plan

To investigate the representation of gender and race on children's STEM TV shows (RQ1), we ran descriptive analyses with the Unique Characters dataset, and then ran binomial tests to see how these data compare to the U.S. population using 2015 U.S. Census data (United States Census Bureau, 2015). To investigate age as a potential moderating factor (RQ2), we then ran descriptive statistics and binomial tests to further look at gender and race by age of character. Because there were very few characters coded as babies (0), teens (5), or elderly adults (2), we looked at child versus adult for the age analyses.

Then, to investigate what types of STEM engagement activities were modeled and whether there were differences by gender, race, or age in who modeled them (RQs 3a and 3b), we used the Character Behaviors dataset to run chi-square tests, t-tests, and one-way analyses of variance (ANOVAs) to compare genders, races, and age groups on the STEM engagement variables. Finally, to answer the question of what types of STEM occupations were portrayed and by whom (RQs 4a and 4b), we used the Character Behaviors dataset to report frequencies of various STEM occupations and descriptive statistics by gender, race, and age. All analyses were run using SPSS Version 24.

Character representation (RQs 1 and 2)

Gender

Of the 168 characters in the Unique Characters dataset, 57% were male, 38% were female, and 5% were coded as "other". Excluding characters coded as other, a binomial test indicated that the proportion of female characters of.42 was lower than the expected .51, $p = .000$ (1-sided), suggesting that female characters were underrepresented compared to the U.S. population.

Gender by age. When looking only at the 67 child characters in the sample, representation of genders was actually quite balanced, with 51% being male and 49% being female (expected value .51 female, n.s.). However, the same was not true for adults. Of the 35 adult characters, 60% were male and 40% were female. A binomial test indicated the proportion of adult female characters was lower than the expected value of .51, $p = .016$ (1-sided).

Race

Of the 90 human characters (race/ethnicity was not coded for non-human characters), 52% were White, 19% were Black, 17% were coded as "unsure", 4% were Asian, 4% were Hispanic, 2% were coded as "other", and 1% were of mixed race/ethnicity. No Native American or Middle Eastern characters appeared in our sample.

There were some significant differences compared to population estimates (United States Census Bureau, 2015). We used binomial tests to compare White characters to characters that represent a race/ethnicity that is underrepresented in STEM fields (i.e. Black, Hispanic/Latino, Native American, and Mixed race, hereafter referred to as "minority characters"). A binomial test indicated that the proportion of minority characters of .24 was lower than the expected .35, p = .019 (1-sided). Looking at each racial group separately, Hispanic/Latino characters seemed to be driving this difference. Binomial tests indicated that the proportion of Hispanic characters of .04 was lower than the expected .18, p = .000 (1-sided). Interestingly, White characters also seemed to be underrepresented. A binomial test indicated that the proportion of White characters of .52 was lower than the expected .61, though only with marginal significance, p = .075 (1-sided). This was likely due to the large number of racially ambiguous characters that were coded as "unsure" for their race – 17% of all human characters in the Unique Characters dataset.

Race by age. The underrepresentation of Hispanic/Latino characters held true for both child and adult characters. For the 54 child characters, a binomial test indicated that the proportion of Hispanic characters of .06 was lower than the expected .18, p = .008 (1-sided). The proportion of White children of .50 was also slightly lower than the expected .61, though only with marginal significance, p = .060 (1-sided). Amongst the 24 adults, no group was significantly lower than expected; however, a binomial test revealed that the proportion of Hispanic/Latino characters was marginally lower than expected (observed = .04, expected = .18, p = .056. 1-sided).

Characters' on-screen actions (RQ 3)

Character role

Before examining specific STEM behaviors, we looked for differences by race and age in character role, i.e. their centrality to the narrative and educational content. Chi-square analyses of character role scores showed no significant differences between the different race groups in our sample. There was a marginally significant difference for gender; the trend suggests that male characters are more likely than female characters to be protagonists (i.e. a character role score of 4), $X^2(1, N = 713) = 3.64$, p = .056. There was also a significant relationship between age and being a major character (i.e. a character role of 3 or 4), such that child characters are more likely to be major characters in shows than adult characters, $X^2(1, N = 447) = 68.67$, p = .000.

STEM participation

In order to look specifically at the characters' STEM-related behaviors, we first examined the characters' overall levels of active vs. passive learning of STEM content, and then examined the specific STEM behaviors that the characters demonstrated, i.e. teaching, questioning, making observations, investigating, and problem solving. For those five specific STEM behaviors, a Principle Components Analysis in SPSS revealed two components; teaching loaded as one component, and the other 4 behaviors loaded together. Therefore, we summed questioning, making observations, investigating, and problem solving into a composite STEM Engagement variable.

Active/passive learning. Child characters were significantly more active in their learning (M = 1.78, SD = 1.53) than adult characters were (M = .38, SD .97), t(424) = 11.76, p = .000. Comparisons across races and genders did not produce significant differences, except when considering only adults. White adults were significantly more active in their learning (M = .58, SD = 1.15) than minority adults were (M = .18, SD = .58), t(108) = 2.49, p = .014. This again suggests that while children of different races and genders exhibit similar levels of learning and engagement behaviors on-screen, the same may not be true of adults.

STEM engagement. Children displayed significantly higher STEM engagement (M = 2.61, SD = 1.97) than adults did (M = .88, SD = 1.29), t(430) = 11.16, p = .000. Here again, comparisons across races and genders did not produce significant differences, except when considering only adults. White adults displayed significantly higher STEM engagement (M = 1.08, SD = 1.63) than minority adults (M = .53, SD = .78), t(109) = 2.40, p = .003. This was driven by two of the four STEM engagement variables: questioning and problem solving. There were no differences across race, gender, or age for making observations and investigating.

Teaching. Adult characters were found to have significantly more teaching moments (M = .58, SD = .82) than child characters (M = .40, SD = .63), t(364) = 2.53, p = .012. No significant differences were found in comparisons across races and genders.

Further analyses of STEM participation by race

In answering RQ1, we learned that many of the characters in our sample (17%) were coded as “unsure” for their race. Therefore, in an effort to go beyond simply comparing White characters to minority characters, and to investigate this relatively large group of racially ambiguous characters further, we ran several one-way ANOVAs to look for any differences in portrayals of these specific groups along our STEM behavior variables.

A one-way ANOVA showed that the effect of race was significant in active learning, F(4, 367) = 3.95, p = .004. A Tukey post-hoc test revealed that characters coded as “unsure” were significantly more active in their learning (M = 1.91, SD = 1.61) than White characters (M = 1.09, SD = 1.43, p = .005) and Asian characters (M = .63, SD = 1.01, p = .011). Significant results showing the effect of race in active learning were also found amongst adults, F(4, 118) = 2.87, p = .026, and amongst children, F(4, 194) = 4.98, p = .001. With adults, a post-hoc Tukey test revealed that adults coded as “unsure” were significantly more active in their learning (M = 1.67, SD = 1.51) than Hispanic adults (M = .00, SD = .00, p = .038) and Black adults (M = .22, SD = .64, p = .022). With children, a post-hoc Tukey test revealed Asian children were significantly less active in their learning (M = .67, SD = 1.05) than Black children (M = 2.07, SD = 1.49, p = .012) and children coded as “unsure” (M = 2.58, SD = 1.39, p = .000). Children coded as “unsure” were also significantly more active in their learning than White children (M = 1.72, SD = 1.48, p = .035).

A one-way ANOVA also found a significant effect of race on questioning, F(4, 367) = 3.07, p = .016. A Tukey post-hoc test revealed that characters coded as “unsure” asked significantly more STEM-related questions (M = .60, SD = .65) than White characters (M = .31, SD = .55, p = .016). Race also had a significant effect on questioning among children, F(4, 194) = 2.66, p = .034. A Tukey post-hoc test showed only a marginally significant difference, with children coded as "unsure" asking more questions (*M* = .84, SD = .64) than White children (*M* = .48, SD = .65, *p* = .060).

Taken together, these results show that characters coded as "unsure" for race were more STEM engaged than at least one other group across two variables: active learning and questioning. Excluding characters of "unsure" race, there was close to no difference in performance of STEM behaviors between other races across all variables.

Portrayals of STEM occupations (RQ 4)

In the Character Behaviors dataset of 761 characters, only 217 (29%) characters were portrayed as having an occupation. Using a list of STEM occupations provided by the U.S. Bureau of Labor Statistics, we found that 30 of the 217 characters (14%) held STEM occupations. The STEM occupations that came up in our sample were: animal expert, marine biologist, information technology officer, engineer, zoologist, astronomer, inventor, and scientist. Twenty-three characters held borderline-STEM occupations (i.e. occupations that require STEM skills and/or content knowledge, but were not explicitly included on the Bureau of Labor Statistics' list). These included doctors, nurses, mechanics, paleontologists, ophthalmologist, archaeologists, and inventors. The remaining 164 occupations were not related to STEM and ran the gamut, from racecar drivers and bakers to fictional or pretend occupations, such as superheroes and "backyard explorers."

STEM occupations by age, gender, and race

Of the 53 characters who held either a STEM or borderline-STEM occupation, the majority were adults (45%). The second largest age group was "other" (32%), which reflects how it was often difficult to ascribe an age to a non-human character. Children made up 13% of occupations, and elderly adults made up 9%. There were no babies or teenagers that held occupations.

Looking at gender, we found that the overwhelming majority of characters with STEM or borderline-STEM occupations were male (77%). Females made up 21% of characters with these occupations and characters coded as "other" made up 2%.

The breakdown of STEM and borderline-STEM occupations by race was confounded by the inclusion of non-human characters, who had their race coded as "irrelevant"; they made up 40% of characters with STEM-related occupations. If they are excluded we find that 81% of STEM or borderline-STEM occupations were held by White characters. The remaining 19% of occupations were held by three Black characters (6%), two characters coded as "unsure" (5%), and one Hispanic character (2%).

Discussion

This study investigated the landscape of character portrayals on STEM-focused television programs for young children. We identified a sample of 30 STEM television shows that are available to children in the U.S. today via broadcast, cable, or streaming and randomly selected three episodes from the most recent season of each. From these 90 episodes, 1,086 characters were identified and coded for their character attributes and STEM participation across the episodes. From that full dataset of 1,086 characters, the 761 individual speaking characters were analyzed for their demographic representation and their modeling of STEM behaviors.

Our first research question focused on the representation of gender and race in these STEM television programs, and how that compares to the U.S. population. Overall, female characters were significantly underrepresented in our sample. This is a classic industry shortcoming that has been documented in many content analyses across decades of television studies (e.g., Götz & Lemish, 2012; Jeffries-Fox & Signorielli, 1978; Lemish & Russo Johnson, 2019; Long et al., 2001; Signorielli, 1990). However, our second research question added more nuance to this finding; when it came to child characters, as opposed to adults, female characters were represented in relatively equal numbers to male characters. This finding, which aligns with other recent studies such as Lemish and Russo Johnson's 2019 report, is encouraging because literature on identification and perceived similarity suggests that children are most likely to be influenced by characters whom they perceive to be like them (Hoffner & Buchanan, 2005); it seems likely that child characters would be perceived as more similar to viewers than adults.

When examining race/ethnicity in children's STEM shows in comparison to population statistics, we found that the race/ethnicity groups that are underrepresented in STEM fields (i.e., Black, Hispanic/Latino, Native American/Indigenous, and Mixed race) were significantly underrepresented in our sample. The lack of Hispanic/Latino characters was the main driver of this results, which falls in line with other studies that have found Hispanic characters to be especially underrepresented (Götz & Lemish, 2012). Interestingly, White characters were not overrepresented. An important note here is that in our analysis, we included a category called "racially ambiguous/unsure," which was used both for characters that were an ambiguous shade of tan and for human characters that were animated in non-human skin tones (e.g., the pink, orange, and purple characters on *Sid the Science Kid*). This category could not be directly compared to any U.S. population statistics, but we did document a relatively large percentage of these racially ambiguous characters. This finding makes sense in light of other recent research on the "browning" of American culture, which documents the use of these racially ambiguous characters as a marketing strategy (Aldama, 2020; Leon-Boys & Valdivia, 2020).

In the case of children's television, this overrepresentation of racially ambiguous characters may reflect how producers of these shows are attempting to address the call for increased diversity in children's programming – by including many characters with racially ambiguous skin tones, and many non-human skin tones such as purple and green. Some might interpret this trend as an improvement in diversity as far as including more non-white characters. However, it is yet unclear whether this is an effective way of addressing the need for representation and the fact that children of all races should be able to see characters on screen who actually look like them. It may be that children of different races see a racially ambiguous character and project their own race onto that character, as it seems producers are hoping is the case. However, it may be that, for the majority of children, these racially ambiguous characters still look like an "other" and do not in fact provide on-screen role models that children can see themselves in. In taking a grounded approach to defining "quality children's television" by interviewing 135 children's media professionals, Lemish (2010) wrote as a guiding principle that producers should: "Develop programs that allow children to hear, see, and express themselves, as well as their culture language and life experiences in ways that affirm their personal identity, community, and place" (p. 21). In line with that definition, it seems that these racially ambiguous characters may not be cutting it. However, as Mares, Sivakumar, and Stephenson (2015) describe, our understanding of the effects of educational television on children's racial/ethnic attitudes is quite limited. More work is needed on children's perceptions of character race and ethnicity to disentangle these possibilities.

To address our third research question, we examined whether the STEM behaviors modeled by characters differed based on character race, gender, or age. There were very few differences in character role or STEM behaviors by gender. This finding maps well onto Long, Boiarsky, and Thayer's (2001) analysis of counter-stereotypes in science education television. They found that although male characters largely outnumbered female characters, males and females were equally likely to be portrayed as scientists. Similarly, in the present study, we found that although female characters were underrepresented, they were equally as likely as their male counterparts to be portrayed exhibiting STEM behaviors like making observations and problem solving. Our findings, however, depart from Long et al. (2001) findings when it comes to race. In their study, minority characters were much less likely to be labeled as scientists and were given much less time on screen. In the present study, we did not find many differences in character role or STEM behaviors by race. This may reflect some improvement in portrayals of race in STEM TV over the last 15 years. Future research should continue to investigate these patterns.

Here again, age was an important moderator of these race and gender patterns. Child characters were treated significantly more equally in terms of race and gender differences in STEM engagement than adult characters. It is important to consider the implications of these differential patterns. Children as young as age three understand that different people have different domains of expertise (Lutz & Keil, 2002). Research suggests that preschool-aged children find adult informants more knowledgeable about certain things, like food, while they find child informants more knowledgeable about other things, like toys (VanderBorght & Jaswal, 2009). And, in the context of educational television, research has shown that children learn better from characters who they trust to be expert informants in that particular domain of learning (Schlesinger, Flynn, & Richert, 2016). Therefore, it is important for programs to show that these adult "experts" are just as diverse as the children learning from them.

Finally, our fourth research question asked what types of STEM occupations were being portrayed in children's STEM TV. We found that 29% of the characters in our sample were portrayed as having some type of occupation or, in the case of the child characters, pretending to have an occupation. However, only 14% of the occupations portrayed were STEM occupations, and these were quite limited in scope; only eight unique STEM occupations were portrayed. While this does not necessarily present a problem in the industry, it does seem like a missed opportunity that media producers might want to capitalize on given the wide reach of these programs. There are several potential strategies here that are already being utilized by a few of the programs. *Ready Jet Go!*, for example, introduces the viewers to Astronomer Amy, a real-life scientist, at the end of every episode. Or, more directly incorporated into the storyline, one of the main characters in *Wild Kratts*, Aviva, is a biomechanical engineer who programs their ship and power suits. Future research might look more closely at these portrayals to investigate whether young viewers are able to make the connection that these are real occupations that they could one day pursue.

Limitations

Though this study provides an important update to our literature on representation in children's television, it is certainly not without its limitations. First, looking at the sample, the inclusion criteria were quite broad and subject to program creator claims; programs needed only to self-identify as aiming to teach STEM. After completing the coding process, it was clear to the coders that some of these programs included drastically more educational content than others. Future work might investigate quality of STEM content in addition to character portrayals in order to see if there is any relationship between the educational quality of programs and how well they represent diverse characters. Another potential issue is that both our sample selection and analysis procedure were very U.S.-centric. It is important to note that many television programs created in the U.S. are designed for a global market, and therefore, our comparisons to the U.S. population may not be particularly enlightening in countries that have drastically different racial/ethnic makeups. It is our hope that studies like this will be replicated and extended across the globe. Finally, content analyses represent a first step in understanding media effects by identifying patterns and trends that might lead to effects (Jordan, Kunkel, Manganello, & Fishbein, 2010). Future studies should extend this line of research to investigate the impact of these portrayals on children's learning of and/or attitudes towards STEM.

Implications and conclusions

Despite these limitations, this study has important implications for researchers and media producers alike. There is prior evidence that studies such as this one can in fact have tangible effects within the media industry. The Geena Davis Institute on Gender and Media conducted a survey of all TV and film executives who had attended their research presentations and symposia on gender disparities in children's programming. Over two-thirds of respondents reported that they had utilized information they learned from the research in two or more projects. When asked what they had changed about the projects, over a quarter of respondents reported having changed the "aspirations or occupations of female characters" (Smith, 2012). This suggests that the industry is open to taking suggestions by researchers and implementing them into their programs. Likewise, in an interview study with 135 media professionals, Lemish (2010) found that overall, producers of children's television wanted to contribute to the creation of more high-quality, diverse, and inclusive content and were interested in collaborating with academic researchers to do so. Many did speak of the financial constraints to making such changes; the consensus was that "the best way to promote change is to show that there is profit in it" (p.172). Therefore, an important next step in order for this line of research to be relevant to producers is to demonstrate that authentically diverse STEM programming is appealing to mass audiences.

In terms of research implications, there have been only a few content analyses of television for young children that have focused on representations of gender and race, especially when it comes to programs that are labeled as "educational." Within the children's media literature, studies of gender, and especially of race tend to focus on programs that are popular among adolescents, and the existing analyses of programs for younger children have tended to focus, for example, on Disney films or cartoons in general (e.g. Leaper et al., 2002). Educational television, however, is a particularly popular genre for children who have yet to enter formal schooling, which is also an opportune time, developmentally-speaking, to begin to expose them to early STEM topics (Brenneman, Stevenson-Boyd, & Frede, 2009). That coupled with the fact that, as discussed earlier, racial and gender biases are in place by the age of six (Baron & Banaji, 2006; Bigler, Averhart, & Liben, 2003; Liben, Bigler, & Krogh, 2001), suggests that educational television for young children is an important genre to focus on when looking at the media's influence on our STEM workforce. Especially now that we are seeing more and more STEM-focused programs become popular, this type of work can really help us understand the potential effects, both direct and indirect, that these programs may have on our future STEM workforce.

Overall, our findings suggest that today's STEM television landscape still includes many traditional shortcomings as far as character representation, but also a few emerging strengths. With greater understanding of the patterns of race and gender portrayals in television for young children, and the subsequent effects of such portrayals, we can move towards the creation of STEM television programs that have wide-reaching impact on all children's interest in STEM and beliefs about who participates in STEM careers.

Note

1. In literature on race and ethnicity, there are many different labels and terms used to describe various groups (e.g. Black versus African American), and little consensus on which terms are most appropriate. Therefore, throughout this paper, when reviewing prior literature, we use the labels that the authors of the original studies used in their writing.

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References

Aldama, F. L. (2020). Latinx pop cultural studies hoy! *The Oxford Handbook of Latino Studies*. 383.

Anderson, D. R., & Pempek, T. A. (2005, Jan). Television and very young children. *The American Behavioral Scientist*, *48*(5), 505–522.

Aubrey, J. S., & Harrison, K. (2004, May). The gender-role content of children's favorite television programs and its links to their gender-related perceptions. *Media Psychology*, *6*(2),111–146. .

Bandura, A. (1971). *Social learning theory*. Morristown, NJ: General Learning Corporation.

Bandura, A. (2008). Social cognitive theory of mass communication. In J. Bryant & M. B. Oliver (Eds.), *Media effects: Advances in theory and research* (3rd ed., pp. 94–124). Florence, KY: Routledge.

Baron, A. S., & Banaji, M. R. (2006). The development of implicit attitudes. *Psychological Science*, *17*(1), 53–58.

Beaudoin-Ryan, L., Lovato, S., Olsen, M., & Pila, S. (2016). STEM curriculum standards on children's TV: A content analysis of science and math programming for children on U.S. television. In *SRCD Special Topic Meeting on Technology and Media in Children's Development*, Irvine, CA.

Behm-Morawitz, E., & Ortiz, M. (2013). Race, ethnicity, and the media. In *Oxford handbook of media psychology* (pp. 252–266). New York, NY: Oxford University Press.

Beuf, A. (1974). Doctor, lawyer, household drudge. *Journal of Communication*, *24*(2), 142–145.

Bigler, R. S., Averhart, C. J., & Liben, L. S. (2003). Race and the workforce: Occupational status, aspirations, and stereotyping among African American children. *Developmental Psychology*, *39*(3), 572.

Brenneman, K., Stevenson-Boyd, J., & Frede, E. C. (2009). *Mathematics and science in preschool: Policy and practice*. Issue: Preschool Policy Matters.

Calvert, S. L., & Richards, M. N. (2014). Children's parasocial relationships. In A. Jordan & D. Romer (Eds.), *Media and the well-being of children and adolescents* (pp. 187–200). New York, NY: Oxford University Press.

Center for Children and Technology. (2014). *Next generation preschool science*. Retrieved March 10 from http://cct.edc.org/projects/next-generation-preschool-science

Comstock, G., & Scharrer, E. (2007). *Media and the American child*. Academic Press. http://site.ebrary.com/lib/northwestern/docDetail.action?docID=10185955

Dill-Shackleford, K. E., Ramasubramanian, S., Behm-Morawitz, E., Scharrer, E., Burgess, M. C., & Lemish, D. (2017). Social group stories in the media and child development. *Pediatrics*, *140* (Supplement 2), S157–S161.

Fisch, S. M., & Truglio, R. T. (2001). *"G" is for growing: Thirty years of research on children and Sesame Street*. Mahwah, NJ: Lawrence Erlbaum.

Gerbner, G., Gross, J., Morgan, M., & Signorielli, N. (1986). Living with television: The dynamics of the cultivation process. In J. Bryant & D. Zillmann (Eds.), *Perspectives on media effects* (pp. 17–40). Hillside, NJ: Lawrence Erlbaum.

Gerbner, G. (1998). Cultivation analysis: An overview. *Mass Communication & Society*, *1*(3–4), 175–194.

Götz, M., & Lemish, D. (2012). Gender representations in children's television worldwide. In M. Götz & D. Lemish (Eds.), *Sexy girls, heroes and funny losers: Gender representations in children's TV around the world*. (pp. 9–48). Peter Lang. doi:10.3726/978-3-653-01426-6/3

Graves, S. B. (1999). Television and prejudice reduction: When does television as a vicarious experience make a difference? *Journal of Social Issues*, *55*(4), 707–727.

Greenberg, B. S. (1982). Television and role socialization: An overview. In D. Pearl, L. Bouthilet, & J. Lazar (Eds.), Television and behavior: Ten years of scientific progress and implications for the eighties (Vol. II, pp. 179–190). Rockville, MD: National Institute of Mental Health

Hall, S. (1973). Encoding/decoding in television discourse, reprinted in Hall et al. (eds.) Culture, Media. *Language*.

Hoffner, C. A., & Buchanan, M. (2005, November). Young adults' wishful identification with television characters: The role of perceived similarity and character attributes. *Media Psychology*, *7*(4), 325–351.

Jeffries-Fox, S., & Signorielli, N. (1978). Television and children's conceptions of occupations. In H. S. Dordick (Ed.), *Proceedings of the sixth annual telecommunications policy research conference* (pp. 21–38). Lexington, MA: Lexington Books.

Jennings, N. A., Hooker, S. D., & Linebarger, D. L. (2009). Educational television as mediated literacy environments for preschoolers. *Learning, Media and Technology*, *34*(3), 229–242.

Jordan, A., Kunkel, D., Manganello, J., & Fishbein, M. (2010). *Media messages and public health: A decisions approach to content analysis*. New York, NY: Routledge.

Kahlenberg, S. G. (2017). Quantification of gender: Gender counter-stereotypes across disney and nickelodeon networks using content analysis. In C. D. Reinhard & C. J. Olson (Eds.), *Heroes, heroines. and Everything in Between: Challenging Gender and Sexuality Stereotypes in Children's Entertainment Media* (pp. 211–232). London, UK.

Klein, H., & Shiffman, K. S. (2009, Feb 4). Underrepresentation and symbolic annihilation of socially disenfranchised groups ("out groups") in animated cartoons. *Howard Journal of Communications*, *20*(1), 55–72.

Leaper, C., Breed, L., Hoffman, L., & Perlman, C. A. (2002). Variations in the gender-stereotyped content of children's television cartoons across genres. *Journal of Applied Social Psychology*, *32*(8), 1653–1662.

Lemish, D. (2010). *Screening gender on children's television: The views of producers around the world*. New York, NY: Routledge.

Lemish, D., & Russo Johnson, C. (2019). *The landscape of children's television in the US & Canada*. Center for Scholars and Storytellers. https://static1.squarespace.com/static/5c0da585da02bc56793a0b31/t/5cb8ce1b15fcc0e19f3e16b9/1555615269351/The+Landscape+of+Children%27s+TV.pdf

Leon-Boys, D., & Valdivia, A. N. (2020). The location of US Latinidad: Stuck in the Middle, disney, and the in between ethnicity. *Journal of Children and Media*, 1–15. doi:10.1080/17482798.2020.1753790

Liben, L. S., Bigler, R. S., & Krogh, H. R. (2001). Pink and blue collar jobs: Children's judgments of job status and job aspirations in relation to sex of worker. *Journal of Experimental Child Psychology*, *79*(4), 346–363.

Long, M., Boiarsky, G., & Thayer, G. (2001, July 1). Gender and racial counter-stereotypes in science education television: A content analysis. *Public Understanding of Science*, *10*(3), 255–269.

Lowenstein, D., Johnson, P., & Fragale, M. (2019). Ready to learn and public media: Improving early learning outcomes for America's children. In S. Pasnik (Ed.), *Getting ready to learn*. New York, NY: Routledge. doi:10.4324/9780203701973

Lutz, D. J., & Keil, F. C. (2002). Early understanding of the division of cognitive labor. *Child Development*, *73*(4), 1073–1084.

Mares, M.-L., Sivakumar, G., & Stephenson, L. (2015). From meta to micro: Examining the effectiveness of educational TV. *American Behavioral Scientist*, *59*(14), 1822–1846.

Mastro, D. E., & Greenberg, B. S. (2000, Dec 1). The portrayal of racial minorities on prime time television. *Journal of Broadcasting & Electronic Media*, *44*(4), 690–703.

Moyer-Gusé, E. (2008). Toward a theory of entertainment persuasion: Explaining the persuasive effects of entertainment-education messages. *Communication Theory*, *18*(3), 407–425.

National Center on Education and the Economy. (2008). *Part 1: The Nature of the challenge now*. Washington, DC; Author.

NGSS (2015). *About the standards development process*. Achieve, Inc. Retrieved March 10 from March 10 http://www.nextgenscience.org/about-standards-development-process

President's Council of Advisors on Science and Technology. (2009). *Prepare and inspire: K-12 education in science, technology, engineering and math (STEM) education for Americans' future*. Executive Office of the President, Office of Science and Technology Policy. http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-stemed-report.pdf

Reinhard, C. D., Olson, C. J., & Kahlenberg, S. G. (2017). *Introduction: Looking Past Stereotypes of Gender Identity and Sexuality in Children's Media*. London, UK: Lexington Books.

Schlesinger, M. A., Flynn, R. M., & Richert, R. A. (2016, July 2). US preschoolers' trust of and learning from media characters. *Journal of Children and Media*, *10*(3), 321–340.

Signorielli, N. (1990). Children, television, and gender roles. *Journal of Adolescent Health Care*, *11*(1), 50–58.

Signorielli, N. (1993). Television and adolescents' perceptions about work. *Youth & Society*, *24*(3), 314–341.

Signorielli, N., & Lears, M. (1992). Children, television, and conceptions about chores: Attitudes and behaviors. *Sex Roles*, *27*(3–4), 157–170.

Smith, S. L. (2012). *Impact Study*. Geena Davis Institute on Gender in Media. https://seejane.org/wp-content/uploads/geena-davis-institute-gender-in-media-impact-study-2013.pdf

Smith, S. L., Choueiti, M., Prescott, A., & Pieper, K. (2012). *Gender roles & occupations: A look at character attributes and job-related aspirations in film and television*. Los Angeles, CA: USC Annenberg School for Communication and Journalism.

Steinke, J., & Long, M. (1996). A lab of her own?: Portrayalsof female characters on children's educational science programs. *Science Communication*, *18*(2), 91–115.

Sternglanz, S. H., & Serbin, L. A. (1974). Sex role stereotyping in children's television programs. *Developmental Psychology*, *10*(5), 710–715.

Stoet, G., & Geary, D. C. (2018). The gender-equality paradox in science, technology, engineering, and mathematics education. *Psychological Science, Advance Online Publication*, 0956797617741719. doi:10.1177/0956797617741719

Streicher, H. W. (1974). The girls in the cartoons. *Journal of Communication*, *24*(2), 125–129.

Thompson, T. L., & Zerbinos, E. (1995). Gender roles in animated cartoons: Has the picture changed in 20 years? *Sex Roles*, *32*(9–10), 651–673.

U.S. Department of Education. (2010). *Transforming American education: Learning powered by technology (U. D. o. Education, Ed.)*. Office of Educational Technology. http://www.ed.gov/sites/default/files/netp2010.pdf

United States Census Bureau. (2015). *American community survey*. https://www.census.gov/acs/www/data/data-tables-and-tools/data-profiles/2015/

VanderBorght, M., & Jaswal, V. K. (2009). Who knows best? Preschoolers sometimes prefer child informants over adult informants. *Infant and Child Development*, *18*(1), 61–71.

Ward, L. M. (2004). Wading through the stereotypes: Positive and negative associations between media use and black adolescents' conceptions of self. *Developmental Psychology*, *40*(2), 284–294.

Whitney, D. (2016, October 21). Kids Drive Parents' Use Of More Streaming Services. MediaPost. https://www.mediapost.com/publications/article/287388/kids-drive-parents-use-of-more-streaming-services.html

Wright, J. C., Huston, A. C., Murphy, K. C., St. Peters, M., Piñon, M., Scantlin, R., & Kotler, J. (2001). The relations of early television viewing to school readiness and vocabulary of children from low-income families: The early window project. *Child Development*, *72*(5), 1347–1366.

Appendix

Appendix Complete List of Programs in the Sample

Program	Season
Annedroids	3
Blaze and the Monster Machines	1
Blues Clues	6
Boj and Buddies	9
Bubble Guppies	14
Cosmic Quantum Ray	1
Curious George	9
Cyberchase	9
Dino Dan	2
Dinosaur Train	2
Doki	1
Dora the Explorer	7
Earth to Luna!	2
Go, Diego, Go!	4
Mickey Mouse Clubhouse	5
Monster Math Squad	2
Nature Cat	3
Octonauts	2
Odd Squad	1
Peep and the Big Wide World	1
Peg + Cat	1
Ready Jet Go!	3
Sesame Street	45
Sid the Science Kid	2
Team Umizoomi	4
The Cat in the Hat Knows A Lot About That!	2
The Magic School Bus	4
Thomas Edison's Secret Lab	2
Tumble Leaf	2
Wild Kratts	2