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What Are My Children Watching? Analyzing the Scientific & Mathematical Questions of Preschool Television Shows Using Process Skills

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Abstract

In an effort to compare what process skills preschoolers were exposed to during an average episode of *Sid the Science Kid* and an average episode of *Team Umizoomi* 35 episodes of each were compared using T-test statistical analysis. The goal of this study was to analyze evidence of process skills in each episode: observing, inferring, classifying, measuring, predicting, and communicating and compare each math and science show and determine their differences in their use of inquiry to presentation science and mathematics content. Results demonstrated a significant difference between the two shows with preschoolers being exposed to observing and communicating when watching *Sid the Science Kid* and preschoolers being exposed to classifying and measuring while watching *Team Umizoomi*. In addition, it is worth mentioning that young children watching *Team Umizoomi* are experiencing more questions when compared with *Sid the Science Kid*.

Keywords

Mathematics, Science, Preschool

1. Introduction

What process skills are young children exposed to through television viewing? How do preschoolers internalize television experiences in terms of scientific and mathematical knowledge? How do these television experiences connect to young learners' curiosity as it pertains to science and mathematics? Studies on preschool television shows generally focus on parents' participation, parental engagement and parent involvement (Berger, 1995; Christenson & Hurley, 1997;

Hoover-Dempsey & Sandler, 1995) and the relatedness of these parental actions to better outcomes in education. However, few studies have examined the specific questioning techniques used in preschool science and mathematics shows and their connection to research-based frameworks such as process skills and inquiry-based learning. The purpose of this study was to analyze and compare the process skills and frequency of asking questions in two popular preschool television shows.

2. Shows Selected for the Study

We selected two currently popular shows that highlight science and math for this study because we were interested in identifying science and mathematics shows for this analysis, *Sid the Science Kid* and *Team Umizoomi*. We noticed that these shows both contained a high amount of science or mathematics content and included substantial amounts of questioning. *Sid the Science Kid* is a 30-minute PBS kids series that first debuted in 2008. Its main character, Sid, is an inquisitive preschooler (about four years of age) who asks questions about how things work and the world around him. He tries to answer these questions using the nature of science and basic science principles along with the help of his classmates (May, Gerald, and Gabriela) and his parents (Alice and Mort). Sid's curiosity in attempting to make sense of the phenomena around him is the very foundation of scientific exploration. *Team Umizoomi* is a series produced by Nickelodeon that first debuted in 2010. Unlike *Sid the Science Kid*, it does not have one main character, but rather a "team" of mini superheroes: Milli, her brother Geo, and a robot named "Bot". In each episode they solve problems and find solutions to challenges. We now discuss the mathematical and scientific inquiry built into each show.

2.1. *Sid the Science Kid*

Sid the Science Kid revolves around Sid and a specific question he asks to launch each episode. Sid wakes up each day with a question on his mind. He takes this question to his family first at breakfast. Then, as he prepares for school, he brings this question to the playground at pre-school where he begins formalizing his research into the actual exploration phase by creating a survey with his friends' responses. His teacher, Susie, is ready, willing and prepared to investigate whatever particular question he has on his mind for that day at school. At pre-school, the students investigate the question in the classroom or on the playground. After pre-school, his grandmother picks him up, reinforces what he has learned that day during the drive home—usually an answer to the question he began the day with.

An extensive variety of topics in the categories of earth, life and physical science have all been recorded over the 69 episodes using this framework. For example, topics relevant and developmentally appropriate to young scientists include: tools and measurement, changes and transformation, senses, health, simple machines, backyard science, weather, the body, force and motion, environ-

mental systems, light and shadow, technology and engineering, and living things. Each episode's conceptual content connects to the National Science Standards (National Research Council, 1996), Cognitive Learning Theory, and on the preschool science curriculum, Preschool Pathways to Science (Gelman, Brenneman, Macdonald, & Roman, 2010).

Within each episode, show writers seem intentional not only in exploring science concepts but also Sid's questioning strategies. Sid embraces the idea of scientific process within the realm of scientific methods and spends his entire day zealously consumed with investigating a particular question. The producers in constructing his experiences conceptually and exploring them over time (a day- which is developmentally appropriate for a 4 year-old) increase opportunities for developing and discovering some "big ideas". For example, Sid may discover that some changes are reversible while others are not (i.e., "The Perfect Pancake" Episode) in which understanding of that irreversible transformation/heat is explored. According to the *Next Generation of Science Standards* (NGSS) (2013) the call for scientifically literate students and their understanding of the science processes such as the benefits of considering irreversible change can motivate young children who experience such pleasure and fulfillment of discovery with the hopes that they will want to savor it again and again. Early investment and exposure to science can inspire many years of discovery. In this way, the content in Sid is both meaningful and relevant to the everyday lives of young children. For example, a question about decay, "Why is my banana yucky?" was the basis for the "My Mushy Banana" Episode. In this way the science content is framed in relatable ways to its characters yet investigated through the nature of science, through posing questions, investigating objects and events that can be directly observed and explored.

2.2. *Team Umizoomi*

On the contrary, *Team Umizoomi* does not focus on conceptual exploration, but rather pits the four heroes, Milli, Geo, Bot, and the viewer, referred to as their Umifriend, through a puzzle-solving adventure. Each episode involves a crisis that *Team Umizoomi* must solve using mathematics, following a similar pattern. First, *Team Umizoomi* are playing together when something interrupts the scene. Often, this interruption takes the form of a guest character who introduces herself or himself through a song. Suddenly, a crisis emerges which can be simple (e.g. a bear covering himself in glue) or disastrous (e.g. a goblin stealing away a fairy's power). *Team Umizoomi* then assembles through an animated counting sequence, singing a song about using their math powers to solve the day. They then embark on the a series of adventures, with each adventure involving a series of 4 to 6 puzzles, each lasting about 4 minutes. The team usually asks the viewer to identify the challenge, gives 1 or 2 seconds of wait time, then agree. These challenges vary in their complexity and their incorporation of mathematics. They can involve reading and interpreting a chart, identifying colors, shapes, and numbers, counting up to 10, comparing numbers or objects, writing

and recognizing numbers, and recognizing and repeating a pattern. For the shapes puzzles, Geo uses his "Super Shapes" power to create, identify, find, and even split specific shapes into smaller shape. For the pattern puzzles, Dot invokes her "Puzzle" power, which makes her dress mimicking the pattern so that she and the viewer can discern specific detail in the pattern. For the counting puzzles, Bot invokes his "Belly Belly Screen" power by figuring a number that everyone (and the viewer) must count up to and then displaying it on his chest display. After all the puzzles have been solved, *Team Umizoomi* solves the crisis. This usually involves saving someone, which then launches a scene of thankfulness and celebration involving a song/dance called the "Crazy Shake", culminates in the gang jumping in the air and yelling, "*Team Umizoomi*!" Overall, the show is a fast-paced, colorful, and musical adventure in which the characters continually ask observation questions of the viewer.

Through this framework, an extensive variety of mathematics skills for children have been recorded over the 78 episodes of the show. For example, topics relevant and developmentally appropriate to young mathematicians include recognizing colors, shapes, and patterns, (recognizing small groups of numbers without counting), reading from a chart, counting, and joining and removing within 10.

The National Council of Teachers of Mathematics (NCTM) (2013) position brief on Mathematics in Early Childhood (2013) calls for preschool mathematics to be engaging and encouraging, developing children's confidence in their use and understanding of mathematics and creating positive experiences. Additionally, the NCTM (2000) Standards for Pre-K (2000) calls for mathematics instruction to be connect mathematical thinking to real-world curiosity, to develop children's natural inclinations to solve problems, and focus on reasoning abilities such as classifying and ordering, not just counting and number abilities. The preschool years calls for literate students who see mathematics actively existing in their world, excited to engage in thought-provoking opportunities and exploration. While the content in *Team Umizoomi* centers mathematical thinking on problem solving and reasoning through the short puzzles the team solves, the real-world connections and building off children's curiosity are often sacrificed for a skill-based task. For example, whenever Milli invokes her "Pattern Power", her dress magically appears with colors of pattern on it so she can use it to solve the larger pattern. Little discussion is made as to why this pattern has appeared, how a child might classify/order this pattern, or different strategies the team might have to solve this problem. Instead, Milli just continually repeats the pattern, asking the viewer to follow along. Unlike *Sid the Science Kid*'s emphasis on scientific inquiry in the real world, the mathematics content of *Team Umizoomi* is often framed as isolated skills involving repetition, unconnected a child's natural curiosity.

3. Theoretical Framework

Effects of Television on Children's Development

Sid the Science Kid has been shown to engage preschool children and their adult

caregivers, helping children ask questions related to concepts from each episode after watching (Gorman Research Group, 2009), and developing the scientific talk of low-income children (Penuel et al., 2010). Findings from a study focused on *Sid the Science Kid* by the Author (2015) about the use of process skills suggest preschoolers are exposed to observation and predicting most often while watching the television show, and are exposed to an average of fifteen questions per thirty-minute episode. The explicit and implicit use of the word scientist (an average of five times per episode) might actually help young children visualize themselves as scientists.

4. Process Skills

A fundamental aspect of inquiry-based science and mathematics teaching at the preschool level involves structuring a child's ability to explore answers to his or her own questions. The process skills framework (observing, inferring, classifying, measuring, predicting, and communicating) helps young learners organize their curiosity in a way that connects to science and mathematical curiosity. Here, we detail each process skill and how it relates to preschool science and mathematics.

4.1. Observation

Observing in science is the most essential science skills for young children, yet it often underutilized in the classroom setting. Young kids are natural scientists and so exploring with their eyes in common occurrence. They are curious of their surrounding environment and new phenomena they experience. Children experience the world around them through their senses so it is likely that observations can be made through seeing, hearing, smelling, touching and tasting. In this way scientific exploration happens almost naturally in science for young learners. For young children, observing in mathematics involves seeing the numbers, patterns, and relationships within the "play" they are engaged with.

4.2. Inference

Inferring in science is a logical thinking process that explains relationships between reason or cause and effect. Young children develop an explanation that is based on their experiences which is supported by valid observations. Gradually, children learn to think critically, to reflect logically, and find relationship between evidence and explanation carefully in science. In mathematics, inference involves recognizing repeated patterns or phenomena within the models they are playing with.

4.3. Classification

Classifying in science is very common and is considered the inevitable process of organizing objects into groups based on observable properties. Most often, with young learners those fall into two categories common characteristics and distinguishing characteristics. For example, young children can collect leaves from

outside and they begin to sort the leaves based on their likeness and differences. A visible classification system, based on observations is appropriate skill for young learners in science. In mathematics, classification is form of mathematical reasoning involving ordering and sorting numbers, shapes, or groups.

4.4. Measurement

In science, using different measurement tools such as rulers, caliper, balances, and scales is common for young learners as they stimulate the perceptual development of young children. Knowing how to measure and what tools to measure with are important skills for young children. Young child should be given many opportunities to measure with many different tools and science is a natural fit for such experiences. In mathematics, measurement also involves the use of appropriate tools, units, techniques, and formulas to quantify the world.

4.5. Prediction

In this process of predicting, young children anticipate what will happen in any given situation based on their experiences. When children observe an event, they may infer a pattern, and predict an outcome. All scientific methods are based on the idea of exploring if a prediction turns out to be accurate. However, the most learning occurs when what thinks will happen, does not happen as the result of a scientific investigation. In mathematics, prediction is a constant of problem solving, in which young children continually create new strategies or adapt older strategies, using prediction to monitor and reflect upon their problem solving process.

4.6. Communication

Communication is important to inspire new understandings, to exchange experiences, and often to share results. Young children communicate their understandings in a variety of ways appropriate for their developmental levels which include but are not limited to writing words or a sentence, painting pictures, making drawings and diagrams. In mathematics, communication normally refers involves explaining mathematical thinking coherently and clearly to peers and adults using pictures, diagrams, or words. Communication also refers to ways children can use mathematical representations to organize, record, and share mathematical thinking and ideas.

4.7. Questioning

Wynne Harlen (2001), in her chapter, "The Right Question at the Right Time", (2001) reminds us that when children ask questions, they indicate they want to know, and when they want to know, they are interested (p. 34). Questions help generate children's interest in science and mathematics if they are allowed to investigate and answer their curiosities. The NGSS and NCTM Standards for Pre-K provide the support and structure for developing this frame of mind and approach to answering questions and solving problems. Preschoolers' questions are often the same big ideas that scientists investigate. In mathematics, ques-

tioning is usually the heart of the problem solving process, connecting children's natural curiosity and exploration to ways they can use mathematics to actually solve a problem.

5. Research Question

We were curious about the connections to research-based science and mathematics inquiry found in children's shows that purport to focus on early- childhood science and mathematics. Particularly, we focused on how each show presented process skills and questioning in the context of scientific and mathematical inquiry. The goals of this study were: 1) To analyze process skills; observing, inferring, classifying, measuring, predicting, and communicating within each episode; 2) To evaluate the number of questions asked within an episode; 3) Compare across two popular shows. The research questions were: 1) How often would preschoolers be exposed to process skills (observing, inferring, classifying, measuring, predicting, and communicating) while watching each episode? 2) Was one process skill explicit more than the others or were they all portrayed equally? 3) How many questions would preschoolers be exposed to during each episode? 4) How did the exposure of process skills compare between *Sid the Science Kid* and *Team Umizoomi*?

Our study used quantitative methods to analyze process skills in each episode: observing, inferring, classifying, measuring, predicting, and communicating and compare each math and science show and determine their differences in their use of inquiry to presentation science and mathematics content.

6. Method

A Process Skills Inventory (Appendix A) was created based on the description of process skills in the textbook *Teaching Science to Every Child*, by Settlage & Southland (2007). One of the researchers served as the coder and used the Process Skills Inventory to code thirty-five episodes of *Sid the Science Kid* and thirty-five episodes of *Sid the Science Kid*. Every time evidence of a visual representation of each process skill was displayed in either TV show episode it was counted and recorded on the Process Skills Inventory. Likewise, the number of questions included in each episode was tallied and recorded on the Process Skills Inventory. Once all episodes had been watched of each show (*Sid the Science Kid* and *Team Umizoomi*) the mean for each individual process skill (observing, inferring, classifying, measuring, predicting, and communicating) was calculated. A similar process ensued with the number of questions per episode. Then, the mean scores of the two shows in these areas were compared using an independent T-test.

7. Results

Results for each category will be discussed for each independently as episodes were scored using the Process Skills Inventory. Results for the first question, How often would preschoolers be exposed to process skills (observing, inferring,

classifying, measuring, predicting, and communicating) while watching each episode, are shown in Table 1. When comparing the process skills between the two shows, four of the process skills (classifying, measuring, communicating and observing) were statistically significant because the p value < 0.05. Results demonstrated that preschoolers being exposed most often to observing and communicating when watching *Sid the Science Kid* and preschoolers being exposed most often to classifying and measuring while watching *Team Umizoomi*. In question two we asked, was one process skill explicit more than the others or were they all portrayed equally? The table below indicates that there is a difference between the process skills, for example, for *Sid the Science Kid*, the biggest range in the means was between measuring (0.40) and observing (20.63). In the case of *Team Umizoomi*, the biggest range in the means was between communicating (1.51) and observing (15.57).

The third question we asked was how many questions would preschoolers be exposed to during each episode? Table 1 displays the mean number of questions asked in a 30 minute episode for each show. The number of questioning is also statically significant with a p value or 0.05, with *Team Umizoomi* asking more questions when compared with *Sid the Science Kid*.

Our last question looked at how the process skills compared between *Sid the Science Kid* and *Team Umizoomi*? When comparing the process skills between the two shows, four of the process skills (classifying, measuring, communicating and observing) were statistically significant because the p value < 0.05. However, the results demonstrated a significant difference between the two shows with preschoolers being exposed to observing and communicating when watching *Sid the Science Kid* and preschoolers being exposed to classifying and measuring while watching *Team Umizoomi*. However, these process skills were divided between each show, with *Sid the Science Kid* having a statistically significant higher mean in observing and communicating and *Team Umizoomi* having a statistically significant higher mean in classifying and measuring. The remaining process skills, inferring and predicting were statistically different. The number of questioning is also statically significant with a p value or 0.05, with *Team Umizoomi* asking more questions.

Table 1. Comparison of process skills.

	Sid			Umizoomi			
	N	Mean	Std. Deviation	N	Mean	Std. Deviation	Sig. (2-tailed)
Question	35	14.49	6.118	35	25.17	8.269	0.000
Observing	35	20.63	12.076	35	15.57	6.437	0.033
Inferring	35	2.40	1.866	35	3.14	2.451	0.158
Classifying	35	2.31	4.276	35	10.66	7.207	0.000
Measuring	35	0.40	1.439	35	10.83	10.115	0.000
Predicting	35	10.31	8.408	35	9.14	10.236	0.603
Communicating	35	7.60	3.875	35	1.51	3.033	0.000

8. Discussion

We found significant differences in the character of process skills and questions within each show. First, we should acknowledge the limitations of this analysis. Both shows are very different and espouse different philosophies towards children's programming. *Sid the Science Kid* is sponsored by Public Broadcasting System and the National Science Foundation. *Team Umizoomi*, on the other hand, is owned by the Viacom subsidiary, Nickelodeon, which is a for-profit children's television station. It was not created through a public research grant. Comparing the metrics of both these shows in terms of their educational validity is somewhat skewed because both shows have vastly different origins. However, our criteria for focusing on both of these shows is in the fact that they are both easily accessible to young children.

Using a threshold of $p < 0.05$, we find statistical significance in the process skills of classifying, communicating, observing and measuring. These shows, while tackling separate content areas, are generally the same when it comes to the other process skills inferring and predicting yet different in the other process skills. So why was observing so different between the two shows? First, *Sid the Science Kid* situates scientific thinking in the real world, asking children to observe and notice the world around them. However, *Team Umizoomi* sets its mathematical puzzles in isolation, where there are no observable phenomena for a child to engage. The process skill of observing is clearly evident in *Sid the Science Kid* because he is noticing and experiencing his world and he bring the viewers along. Therefore, it is no surprise that communicating was also more prevalent in *Sid the Science Kid*, because Sid is in fact communicating his experiences with the audience. In terms of classifying and measuring, it appears that more opportunities exist for our preschools to experience those by watching *Team Umizoomi*. *Sid the Science Kid* is connected to a scientific process, in which measurement is a tool to verify or compare data. In *Team Umizoomi*, measurement is often a form of counting non-standard units, devoid of context beyond the particular puzzle at hand. In terms of classifying, *Team Umizoomi* simply offers more opportunities for its audience to classify a variety of objects, including shapes and other objects.

As Table 1 illustrates more questions were asked in the *Team Umizoomi* episodes versus *Sid the Science Kid*. While this quantifiable evidence can be demonstrated, we wonder if the level of questions are the same between the two episodes? In hindsight, it may have been more beneficial for us to analyze the types of questions asked in each television show than simply the number of questions. While asking questions and finding answers are both important aspects of scientific and mathematical thinking, the quality of the question asked is more important than the quantity.

These results show the vast difference in popular preschool television shows. Where *Sid the Science Kid* uses inquiry in a way that helps children explore their own scientific curiosity, *Team Umizoomi* relies on isolated puzzles that do little to help children connect mathematical curiosity to the world around them. Both

shows are popular with children and parents, but only one of them seems to have any connection with inquiry-based learning.

9. Conclusion

We were curious about the connections to research-based science and mathematics inquiry found in children's shows that purport to focus on early-childhood science and mathematics. Particularly, we were looking for evidence of what our children were watching? It appears to be pretty clear that if preschoolers are watching *Sid the Science Kid* they are exposed to observing and communicating and if they watch *Team Umizoomi* they are exposed to classifying and measuring. It may be wise for parents to allow children to watch both these shows as to provide a robust experience of process skills followed up by conversations of both scientific and mathematical inquiry.

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