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How the COVID-19 shutdown revealed the effectiveness of a northern Nigerian educational media program

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ABSTRACT

A team of researchers were investigating the impact of a Nigerian adaptation of *Akili and Me* when the COVID–19 pandemic struck. Schools shut down, interrupting the study's quasi-experimental intervention design. Post-school reopening, researchers recontacted 363 children (mean age = 5.1, SD = 1.1 years) who had provided data at baseline and had completed the intervention. The analyses revealed that during the shutdown, participating children watched *Akili and Me*, beyond the exposure experienced through the study intervention. Across viewing groups and including the control group, researchers found the children knew the program's characters using a program receptivity score. The researchers found no differences associated with study's initial group assignments. Those children who could name more *Akili and Me* characters performed significantly better on the outcomes of literacy, numeracy, shape, socio-emotional development, controlling for sex, age, baseline score, and group assignment. This study offers promising evidence that locally-produced educational media interventions can impact early learning skills, especially during a crisis when children rely on educational media for home learning.

IMPACT SUMMARY

Prior State of Knowledge: Previous research conducted in low- and middle-income countries offers evidence that when exposed to educational and entertaining media, young children show significant albeit small improvements in their knowledge and skills related to literacy, numeracy, socio-emotional development, and health and hygiene.

Novel Contributions: Our original plan was to examine learning from media through a school-based study. In Nigeria, the government shutdown schools because of COVID–19; we used this interruption as an opportunity to capture children's exposure to and impact of home-based viewing of educational media.

Practical Implications: Educational programs offering culturally-relevant content can affect preschool children's learning of content and skills. If school interruptions happen because of manmade or natural disasters, governments can disseminate quality educational programming to enhance children's learning while at home.

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Introduction

The 2030 Sustainable Development Goals developed by the United Nations include the ambitious target that all the world's children have access to quality early childhood development, care, and pre-primary education so that young boys and girls enter school ready to learn (United Nations, 2015). Early childhood programs are not only affordable, but also effective (Britto, 2017). Children who access pre-primary and early childhood education interventions gain skills in cognitive and language development, social competency, and emotional development, all foundational for school success as well as long-term societal outcomes (Barnett & Nores, 2015; Barnett, 2011; Lu et al., 2020; Yamano & Jayne, 2005). However, the most disadvantaged children of our world typically lack access to such programs. Data from 14 West and Central African countries reveal that 72% of children aged 36–59 months fail to attend any form of early education (UNICEF, 2017).

The COVID–19 crisis made the situation worse. An estimated 167 million preprimary-aged children from 196 countries were unable to attend in-person early childhood care and education between March 2020 and February 2021 (McCoy et al., 2021). Students in high-income countries (HICs) lost around six weeks of schooling, while those from low- and middle-income countries (LMICs) approximately four months (United Nations Educational, Scientific, and Cultural Organization et al., 2022).

During the COVID–19 pandemic, many countries and communities tried to reach children through educational media, which governments found to be cost-effective and efficient (Nugroho et al., 2020). Efforts to broadcast educational children's media increased worldwide as a substitution for in-person classroom-setting education. Over 90% of countries introduced some form of remote learning during the pandemic, delivering content through radio, television, and the Internet (United Nations Children's Fund, 2020). Countries in Africa used both radio and television to reach children, while countries in Europe and North America relied on digital technology (United Nations Educational, Scientific, and Cultural Organization, 2020). Throughout the world, educators and policy makers raised concerns over unequal Internet access (Manullang & Satria, 2020), fearing that children without reliable Internet would receive poorer quality education during the pandemic (Manullang & Satria, 2020; Nugroho et al., 2020). Additionally, most remote learning tools targeted primary and secondary school level students; few countries provided pre-primary school level remote learning opportunities (Nugroho et al., 2020; United Nations Children's Fund, 2020). Children in rural regions of low-income countries saw the fewest opportunities to access remote learning (United Nations Children's Fund, 2020).

We know that educational technology can deliver entertaining and educational messages stimulating learning, including among those children living in vulnerable and resource-poor communities (Olumorin et al., 2018; Watson & McIntyre, 2020). The media effects literature now extends beyond the U.S. borders and the global co-productions of *Sesame Street*, with studies on other efforts and programs. Even after short interventions, children who watch and are receptive to educational media perform statistically better on tasks related to school success than their peers exposed to regular programming (Cole & Lee, 2016; Borzekowski, 2018). Media interventions can improve young children's foundational skills in literacy and numeracy skills (Borzekowski, Lando, et al., 2019; Borzekowski, Singpurwalla, et al., 2019; Cole & Lee, 2016; Borzekowski & Macha, 2010; Borzekowski, 2018; Mares & Pan, 2013). Researchers

have also found that media can improve children's social skills, health knowledge, cultural awareness, and reduce gender stereotypes (Cole & Lee, 2016; Borzekowski et al., in press).

Several theories provided guidance for why educational media can affect young audiences. Experiments in the 1960s contribute to Albert Bandura's social cognitive theory, which show that children are capable of repeating social behaviors they have learned through observation even when the demonstrations are delivered through film (Bandura & McDonald, 1963). Producers of educational programs use social cognitive theory, developing aspirational characters in familiar environments who model behaviors. This theory suggests that viewers will try to take on the modeled behaviors, especially if the behaviors were rewarded on screen. Accordingly, producers developed the sub-Saharan program *Akili and Me*, where short videos offer recognizable characters who model children's foundational skills in educational, social, and health practices. It is expected that children who are exposed to such content will be able to imitate the skills observed through the program.

More effective educational media interventions offer young viewers recognizable characters in familiar settings (Borzekowski, Lando, et al., 2019; Fisch, 2000). Research on wishful identification suggests that children observe and imitate that which they see (Bandura, 2001; Bussey & Bandura, 1999; Cohen, 2001). Children adopt modeled behaviors into their own behavioral repertoires, especially if they understand, like, and admire particular characters (Bussey & Bandura, 1999). Learning is enhanced when children can identify with media characters and their narratives (Hoffner & Buchanan, 2005; Reeves & Nass, 1996). Successful educational programs reflect the culture and experiences of the target audience; it is not enough to overdub characters' dialogue in the local language and assume that children will not notice that the characters and settings are dissimilar to what they know. When learning material is embedded into the narrative structures that children recognize, there are greater opportunities for learning (Borzekowski, Lando, et al., 2019; Fisch, 2000; Hoffner & Buchanan, 2005).

An additional theory provides insight into this study and findings. Bronfenbrenner's ecological model offers a way to think about the ways educational media influence children's development (Bronfenbrenner, 1974; Jordan, 2004; McHale et al., 2009). Nested systems interact to affect children's skills and relationships, with media use and messages contributing at different levels (Jordan, 2004; McHale et al., 2009). Media can shape the individual, where the young audience member may be exposed to messages that affect his or her learning and skills as well as identity development. Media also can influence interpersonal ties and connections to social institutions. Lastly, children's media use can influence beliefs around one's place within the larger society by influencing attitudes around and engagement with society's politics, economies, and culture (McHale et al., 2009). The study described in this paper shows how media can play a role in individual's lives as well as within society. Our original research question was: In what ways is differential exposure to *Akili and Me* content associated with changes in Nigerian children's knowledge and skills related to literacy, numeracy, socio-emotional strategies, and health? We were confident that greater exposure to targeted content would result in gains in related outcomes; however, we were unsure which content areas would have the least or greatest gains.

The intended study and the COVID–19 interruption

This study began as an evaluation of a Hausa adaptation of *Akili and Me*. Targeting children ages 3- to 6-years-old, *Akili and Me* is an animated cartoon series designed to support development of school readiness skills. The production company Ubongo first created this program in Dar es Salaam, Tanzania in 2016. In 2019, the Ubongo management and production teams initiated work in Nigeria. Production for the Nigerian adaptation involved translating old and generating new material in the Hausa language. Additionally, the program introduced two new animated characters Hauwa and Musa, who wear local clothing (*riga da dankwali* for girls and *taguwa da hula* for boys).

Using a quasi-experimental design, the research team set out to explore Nigerian children's exposure to and reception of the adapted content. The original study's objective was to see if there were differential gains, depending on what the children watched. Children would only see certain content (literacy, numeracy, socio-emotional strategies, and health) and researchers would see if there was more improvement for the assigned content area. Prior to this study, it was unlikely that the participating children would even know *Akili and Me*, as it was not yet on broadcast television in this region. Using a quasi-experimental study design, the team intended to collect pre- and post-intervention data collection after a school-based media exposure intervention. Over a 12-week intervention period, researchers would control children's exposure to the specific *Akili and Me* content. The team randomly assigned children into groups, where they would only see certain content on their viewing day. Then COVID–19 happened.

On 23 March 2020, the Nigerian government responded to the COVID–19 pandemic by locking down the entire country. Children in Kano State were out of school from March 2020 through January 2021. In this northern Nigerian region, there were no expectations that primary school children would continue formal studies and the online learning experienced by primary school children in high-income countries was unavailable. During this time, however, the Nigerian government partnered with international and domestic organizations to develop and roll out remote-learning programs for children through media platforms including television, radio, and the internet. Although without a formal structure, age-appropriate lessons and content were made available; the Ministry of Education put out announcements through radio and newspaper encouraging but not compelling parents and guardians to have their children access the available resources. The government was aware that the Ubongo production company was almost ready to launch educational media in Hausa, and requested the company release the materials given the emergency situation. In Spring 2020, *Akili and M*e became available on Kano's Free-To-Air (FTA) TV station (AREWA24), which households could have at affordable rates. Additionally, Ubongo promoted ways that children could access *Akili and Me* through the internet and social media without charge, although households would still need a device, internet plans, and wifi. With these things in place, children could watch and download episodes through Facebook, YouTube, and broadcast websites.

Methods and materials

The following paragraphs describe the intended study. Both the Kano State Ministry of Education and the University of Maryland's Institutional Review Board reviewed and

approved this study's procedures and instruments. Additionally, the Kano State Qur'anic and Islamiyya Schools Management Board monitored the study's implementation. Other than informing the review boards of the change in data collection timing, there were no other changes to the originally-stated procedures.

Procedures

For this work, we convened a multi-country team, with child development, research, and media experts from the United States, Nigeria, and Tanzania. The principal investigator and in-country director led extensive and multi-session in-person trainings of 16 local researchers, two for each school. It was critical that the team of researchers deliver the protocols in a consistent and ethical manner. Training included lessons about research conduct with children (a vulnerable population), appropriate interview techniques, validity of measurement instruments, and consistency for scoring protocols.

The in-country project director recruited eight Quar'anic and Islamiyya schools in Kano State, Nigeria. It was felt that the structure of such schools, in contrast to public schools, would allow for the consistent delivery of the study protocols. In both settings (private versus public schools) in northern Nigeria, the majority of schools lack trained and qualified teachers, as well as locally-produced teaching aids. Interventions and studies that empower schools with educational media are rare in these communities (Asiabaka & Mbakwem, 2008). When offered the opportunity to be part of the proposed study, the administrators were eager to participate. The Nigeria team, in partnership with the Kano State Ministry of Education (through the Quranic and Islamiyya Schools Board), developed a set of criteria for screening and selecting the intervention schools.

When the research team recruited and selected schools, administrators needed to commit to participation throughout the entire study period, facilitation and collection of parental consent forms, and security of the project equipment. Additionally, schools needed to have a large number of 3- to 6- year-olds so that the team could work with 50 children per school, aiming for a total sample of 400 children.

Prior to data collection, the team obtained active parental consent and active participant assent. From among those providing consent and assent, the team randomly selected 50 children to be part of the study. Baseline data collection happened in December 2020, when researchers worked one-on-one with the children, conducting a 20-minute interview in Hausa.

At each of the eight schools, the research team randomized the children, creating five different groups with ten children per group. Each group watched 20 minutes of video programming twice on a given day, with the following viewing schedule:

Group 1, Mondays, *Akili and Me* literacy;

Group 2, Tuesdays, *Akili and Me* numeracy;

Group 3, Wednesdays, *Akili and Me* health content;

Group 4, Thursdays, *Akili and Me* socio-emotional content; and

Group 5, Fridays, other children's programming (this group served as the control group).

Across the study sample, there would be around 80 children in each group.

The prescribed viewing occurred in a designated room that was not the children's classroom. The team collected attendance, and great efforts were made to avoid

contamination between groups. We wanted children only exposed to the content for their assigned group. The donated equipment included a 32-inch LG brand TV set and was identical across schools and viewing groups.

To reduce bias and ensure effective compliance of the methodology during viewing sessions, the in-country project hired and trained field assistants for each school. These field assistants were responsible for playing the appropriate videos and capturing attendance data. Research project leaders made unscheduled visits during the intervention to verify adherence to the research protocol. There was limited teacher involvement; if the teachers knew the study and intervention content, they might alter their classroom lessons and affect children's learning.

The intervention lasted 12 weeks, starting the second week of January 2020 with completion by March 2020, immediately preceding the school shutdown. The team was to collect post intervention data in April 2020, recontacting those children who provided data at baseline. As it turned out, the follow-up data collection did not occur until Spring 2021 after the COVID−19 school shutdown and community lockdown restrictions were lifted. Instead of doing data collection immediately after the intervention, a whole year had passed. Unfortunately, we did not change our follow-up instrument. We did not ask questions about what children did during the school shutdown nor do we know if and how children accessed educational material, including *Akili and Me*.

The main difference in the study's original and post-COVID design involves the type and ways children were exposed to educational media. In the original design, researchers would control the specific *Akili and Me* content available through a quasi-experimental design, with those in the control group having no exposure at all. During the COVID−19 school shutdown and community lockdown, the Nigerian government reached out to educational production companies. The World Bank's EdTech team compiled a list of educational television programs and created a rapid reaction advice note on how to best use such programming during school closures (World Bank 2020). The list included Ubongo, and the Nigerian government reached out to the production team to release all the available Hausa versions of *Akili and Me* through television and internet platforms. The broadcast shows included the complete episodes and not the study-edited versions of *Akili and Me*; children could see all the different content which researchers had tried to control to children in the specific and assigned groups.

As result of government and broadcast promotional efforts, we assume that children from this study mainly watched *Akili and Me* through promoted television programming. It is possible that a small fraction of the participating children also gained exposure through online videos and lessons. Whereas researchers could deliver measured exposure to the educational media content during the original intervention study, they could not constrain children's home-viewing and access to the *Akili and Me* material over the school shutdown and lockdown period. Our follow-up data collection, revealed through children's ability to name characters (receptivity), shows that participating children including the set who were part of the control group, were now familiar with *Akili and Me*. We assume that children would have seen all the different content areas.

Measures

Dependent variables

To assess children' early learning knowledge and skills, the team adapted and used the *International Development and Early Learning Assessment* (IDELA) (Pisani et al., 2015; Raikes, 2016). The organization Save the Children developed IDELA as a "rigorous, holistic, yet feasible and reliable international instrument for measuring early learning and development of children 48 to 72 months" (Pisani et al., 2015, p. 20). This open-source tool is easily adapted across different cultural contexts and requires few materials (e.g., pencil, blank paper, small items for counting.) Our team has successfully used adaptations of the IDELA instrument, working with preschool children in India, Tanzania, Rwanda, and Haiti (Borzekowski, Lando, et al., 2019; Borzekowski, Singpurwalla, et al., 2019; Borzekowski et al., in press; Borzekowski, 2018). For the study in northern Nigeria, we modified the picture cards so that the images featured local contextual cues.

Our instrument assessed seven early childhood constructs, including literacy, numeracy, shape recognition, color recognition, English language knowledge, socio-emotional skills, and health knowledge. Below, we offer more detail on each.

Researchers presented questions and each correct item was worth one point towards a summed score, unless otherwise specified. The Literacy construct included identifying (8 items) and naming letters (8 items), for a total possible score of 16 (Cronbach's alpha 0.81 at baseline and 0.88 at post-intervention). For the Numeracy score, children identified and named numbers and counted in Hausa and English. There were 22 items; the baseline Cronbach's alpha was 0.88 at baseline and 0.90 at post-intervention). To assess children's shape knowledge, participating children named and identified a triangle, circle, square, and rectangle. Shape knowledge had a possible score ranging from 0 to 8; the Cronbach's alpha was 0.56 at baseline and 0.78 at post-intervention. Color knowledge involved children identifying and naming five colors (blue, red, yellow, green and black); the Cronbach's alpha was 0.58 and 0.75, at baseline and post-intervention, respectively. English language knowledge involved children saying and identifying eight words from images (hands, legs, nose, wash, jump, small, draw, and run). Children could get a possible score from 0 to 8; the Cronbach's alpha was 0.42 at baseline and 0.75 at post-intervention.

We assessed socioemotional skills by presenting children with images and narratives of familiar situations, such as needing to share a toy or being unable to do a physical activity. Children had to identify emotions felt by characters in the situations (7 items) and strategies (5 items) to "fix" the problem, for a total possible score of 12. Here, the Cronbach's alpha was 0.78 at baseline and 0.58 at post-intervention.

The health knowledge score involved researchers asking children about and having them demonstrate behaviors (hand washing and teeth brushing). Researchers also had children perform a food-sorting task, where children had to put images of foods into "healthy" and "less healthy" piles. Among the behavior questions there were 7 one-point items and 4 three-point items, for the food-sorting task there were 8 items, resulting in a total possible health score of 27. The Cronbach's alpha for the health knowledge scores was 0.73 at baseline and 0.75 at post-intervention.

Independent variables

As data collection occurred in schools, the only demographic information that we collected were the child's sex and age. Baseline performance on each of the constructs also served as independent variables.

We used several approaches to measure media exposure and receptivity. Researchers noted which assignment group children were randomly placed in and recorded the children's attendance at every viewing session. Additionally, researchers assessed the children's knowledge of the program and general media receptivity. At baseline and follow-up assessments, children were shown a card containing images of twelve media characters. Six of these characters were from *Akili and Me*, four were characters from other popular children's programs, and two were foils. Researchers asked children to name each character shown in the picture card. Only a fully correct response received a score of 1; partial or wrong names were scored 0. Researchers use receptivity to examine children's recall and memory of the presented media (Borzekowski, Singpurwalla, et al., 2019). It is critical to assess both program and general media receptivity so one can distinguish between exposure to particular content versus a child's ability to remember media character names. At baseline, the Cronbach's alpha was 0.81 for *Akili and Me* receptivity and 0.85 for general media receptivity; at post-intervention, the Cronbach's alpha was 0.68 for *Akili and Me* receptivity and 0.58 for general media receptivity.

Data analytic approach

For our analyses, the plan was to first consider the collected data and explore bivariate variables, noting whether demographic and learning variables varied significantly across the assigned groups at baseline and follow-up. We anticipated creating HLM models (nesting data by the eight schools), predicting the seven constructs, controlling for the child's sex, age, baseline construct score, and assignment group. As a quality check, we examined change in *Akili and Me* receptivity scores for the five assignment groups. It was in this step that we discovered that children placed in the control group showed similar increases in *Akili and Me* receptivity scores compared to those in the other content groups. Querying our in-country partners, we learned of the government's use, broadcast, and promotion of *Akili and Me* during the school shutdown. The most obvious explanation to similar increases in receptivity was children in our study were watching and accessing *Akili and Me* during the shutdown. In the estimated models presented in this paper, we continue to include the assignment groups but now include *Akili and Me* and general media receptivity to predict the various learning outcomes. By including assignment group, we can see if there were differences for children being in the groups even after the break from school. Models that contain program and general media receptivity allow us to explore if it is a child's cognitive ability to remember characters (general media receptivity) or his or her exposure to specific content (program receptivity) that predicts differences in the outcomes.

Results

Information about the sample appears in Table 1, reflecting the 399 and 363 children who completed data collection at baseline and follow-up, respectively. There was a dropout rate of

Table 1. Information about the sample at baseline and follow-up.

| Categories		Baseline (N = 399)	Follow-up (N = 363)
Sex		n (%)	n (%)
Female		217 (54.4%)	195 (53.72%)
Male		182 (45.6%)	168 (46.28%)
Age			
3–4 years		115 (28.8%)	104 (28.65%)
5 years		147 (36.8%)	135 (37.19%)
6–7 years		137 (34.3%)	124 (34.16%)
Scores	Range	Mean (SD)	Mean (SD)
General media receptivity	0–4	0.32 (0.89)	.85 (1.07)
Akili and Me receptivity	0–6	0.76 (1.40)	4.31 (1.60)
Literacy	0–16	3.71 (3.26)	8.57 (4.39)
Numeracy	0–22	7.57 (4.94)	14.36 (5.32)
Shape knowledge	0–8	1.85 (1.64)	3.50 (2.39)
Color knowledge	0–10	3.36 (1.94)	5.72 (2.56)
English language knowledge	0–8	0.66 (0.95)	1.36 (1.70)
Socio emotional skills	0–12	7.11 (3.24)	7.60 (2.56)
Health knowledge	0–27	12.98 (4.36)	14.96 (4.67)

9% (36 children), but we observed no significant demographic (sex and age) differences between those who were lost to and remained in the final sample.

Across the different viewing groups, we observed no significant differences for the assessed constructs at baseline nor at follow-up. We present score ranges, means, and standard deviations in Table 1. At baseline, most scores had positive skews indicating room for improvement on every construct. Children's scores for the different constructs increased for every construct, with the greatest proportional change for the literacy, followed by English language knowledge, numeracy, and shape knowledge.

During the intervention, attendance was high, with practically all (93%) of the final sample having attended nine or more of the 12 viewing sessions start to finish. We saw no significant differences for attendance by viewing group.

Before the intervention, very few children could name any of the *Akili and Me* characters. The baseline mean for *Akili and Me* receptivity was 0.79 (out of 6). The most well-known character at baseline was the main character Akili; 21% of the children could name her in this assessment. In the follow-up data, we observe that the mean *Akili and Me* receptivity score increased to 4.31. Among the participants, 92% could now name Akili. Of the new characters created for the *Akili and Me* Hausa adaptation, 82.5% and 77.5% of the participating children could now name Hauwa and Musa, respectively.

We also collected data on children's general media receptivity. Of the four general media characters researchers showed to the participating children at baseline, children could identify, on average, fewer than one character (Mean = 0.33). In contrast to the *Akili and Me* receptivity score, the general media receptivity score rose only slightly in the follow-up data, with a new mean of 0.85. Figure 1 illustrates the *Akili and Me* and general media receptivity scores, with means at baseline and post-intervention for the different groups. We can see that across all groups, receptivity for *Akili and Me* increased while general media receptivity remained steady. There were very slight differences across groups.
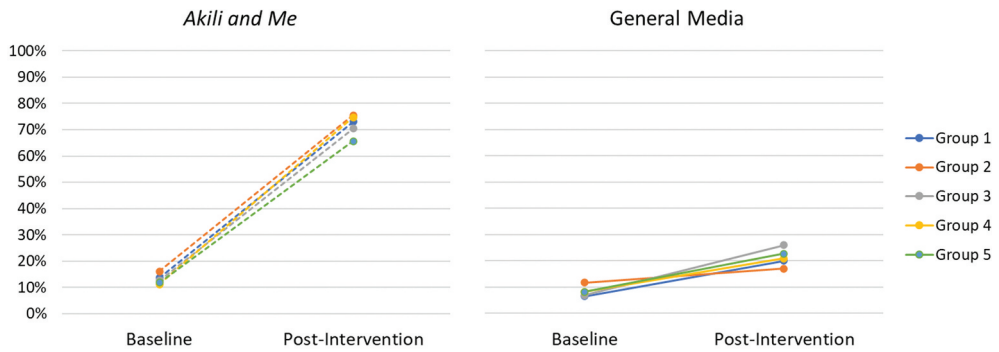
Figure 1. Changes in Akili and Me and general media receptivity, across viewing groups, for the percentage of characters children could name correctly.

HLM models

Table 2 presents the HLM regression models for each of the seven measured constructs. Greater exposure to *Akili and Me*, as represented through the receptivity variable, was significantly associated with improvements in literacy, numeracy, color recognition, socio-emotional skills, and health knowledge. The two outcomes that did not show significant improvement associated with *Akili and Me* receptivity were shape recognition and English language skills. Viewing group, for the most part was not at all associated with the outcomes. The only exception was for predicting the health knowledge scores; being in the socio-emotional (Thursday) viewing group was associated with a lower health score in comparison to those in the control viewing group. Across the models, children's baseline scores were significant predictors for most of the outcomes, although it was negative for the health knowledge score. The child's sex was not a significant predictor, and age was

Table 2. HLM models predicting outcomes.

Category	Literacy	Numeracy	Shape knowledge	Color knowledge	English language knowledge	Socio-Emotional skills	Health knowledge
Intercept	4.69**	8.08***	2.52**	3.29***	0.66	6.88***	14.92***
Sex							
Male (ref female)	0.10	0.40	−.04	0.21	−0.12	−0.02	0.04
Age (ref 3 to 4)							
5 years	0.12	0.43	.29	0.12	0.13	0.07	0.16
6–7 years	0.86	1.34*	.32	0.39	0.63**	−0.02	1.11**
Baseline score	0.45***	0.32***	.14*	0.23***	0.22*	−0.03	−0.09*
Treatment (ref Group 5 - Fridays – control exposure)							
Group 1 – Mondays	−0.23	−0.17	−.43	−0.49	−0.15	0.03	−0.42
Group 2 - Tuesdays	0.31	0.24	−.29	−0.73	−0.23	−0.07	0.21
Group 3 – Wednesdays	−0.29	−0.42	−.62	−0.47	−0.16	0.10	−0.21
Group 4 – Thursdays	−0.74	−0.54	−.24	−0.48	−0.09	−0.35	−1.15*
General media receptivity	0.20	0.35	.57***	0.39**	0.45***	−0.02	−0.09
Akili & Me receptivity	0.43**	0.69***	.08	0.35***	0.02	0.24*	0.26*
% gain with each *Akili & Me* character	2.7	3.1	NS	3.5	NS	2.0	1.0

Note: *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

only significant for numeracy, English language skills, and health knowledge. General media receptivity contributed to higher outcome scores for shape recognition, color recognition, and English language skills.

Discussion

This study was designed to look at children's exposure to different content in the Hausa version of *Akili and Me*. Because of the timing of data collection and the COVID–19 pandemic, the results and especially those of our control group suggest that Nigerian boys and girls who became familiar with this culturally- and locally-made educational program had improved skills and knowledge after the school shutdown. When researchers conducted data collection a year after the controlled exposure, they found that practically all the participating children now knew characters from the *Akili and Me* program. At baseline, children could name fewer than one *Akili and Me* character; in contrast, in the follow-up data collection, receptivity scores revealed that participating children including those in the control group could now name over four of the *Akili and Me* characters. We can presume that during Nigeria's school shutdown, children in this study were watching and subsequently benefited from this educational program.

This research is particularly novel because outside forces changed the study from a quasi-experiment to more of a natural exposure study. During the school shutdown, children were able to view the *Akili and Me* material from their homes; elements of the quasi-experimental design were lost, such as the control group. Children could access and engage with the program on their own terms, without the obligation and constraints of being a study participant. In a familiar environment children could control how much of the program they watched, showing the effectiveness of the media messages outside of the school and more-controlled setting. As a result of the pandemic and the ability for children to view *Akili and Me* content at home, the effectiveness of the program could be viewed from a different perspective.

Turning to our original design of random group assignment, we observed no significant differences in the learning and developmental outcomes. We believe that the control of only seeing one type of content was lost during the school shutdown; children who watched *Akili and Me* at home could access and engage with all the show's content. Children were no longer constrained to see just one type of content.

Overall, we saw that greater exposure to *Akili and Me*, as measured through media receptivity, was a significant predictor in five of the seven outcomes. Children who were more familiar with *Akili and Me* characters performed better on the educational constructs controlling for where they were at baseline. The greatest percentage increase associated with receptivity was for color knowledge, where we saw an increase of 3.5% in the outcome score associated with knowing each additional character, controlling for sex, age, baseline score, general media receptivity, and group assignment. Along these lines and findings, we can predict that children who went from none to full knowledge of the *Akili and Me* characters would have a 21.0% gain in the color knowledge construct.

Although the study was interrupted by COVID–19, the resulting data offers exciting information. The timing was such that the Hausa version of *Akili and Me* was ready for dissemination, just as the government closed schools and requested educational material from production companies. We know that during this period, broadcasters and

educators promoted the use of the program and we see, especially among those children who were in our control group, that exposure happened. Children came to know the *Akili and Me* characters, even at greater rates than observed in other intervention and school-based studies (Borzekowski, Lando, et al., 2019; Borzekowski, 2018). Children who could name characters (and, ostensibly were paying attention to the content) gained knowledge of the material embedded in the show's stories and vignettes. Program receptivity can serve as a proxy for exposure to the tested show content (Borzekowski, Lando, et al., 2019; Borzekowski, Singpurwalla, et al., 2019; Rimal et al., 2013), especially if researchers control for general media receptivity in regression models. Interestingly, we see that program receptivity and general media receptivity differ in significance for the various constructs. This suggests that we are capturing exposure rather than children's cognitive skill to remember characters. Other media studies examining receptivity of presented characters show similar results; young children's naming of various characters can predict learning of constructs (Borzekowski, Lando, et al., 2019; Borzekowski, Singpurwalla, et al., 2019; Borzekowski, 2018).

A limitation of this study is that we lack information on how children became familiar with the *Akili and Me* characters; some children may have watched the show through just the school-based intervention, while others could have accessed the broadcast, web-based, or mobile application versions of the program. We know that during the school shutdown, government and educators actively promoted different types of educational media through several platforms, hoping that multiple approaches would increase the likelihood that children accessed available material. A missed opportunity though was a full exploration of how children were using media during their time at home. Our research team failed to change the follow-up survey; as a result, we do not know the ways and how often children were exposed to *Akili and Me*. Future studies could consider how the type of platform that media is delivered through affects reception and learning, especially among children from LMICs. Parental (or guardian) mediation also affects learning from children, and because we did not ask in the follow-up survey, we do not know if and how co-viewing of this program played a role in learning. Furthermore, since there was a long time between baseline and follow-up data collection, it is unclear if and how children's natural development and maturation played a role in learning the presented content.

Beyond the variable of receptivity, it is interesting to see which variables were and were not significant in this study's final models. As in other and similar evaluations of educational media on young children (D. L. G. Borzekowski, 2018; Kostyrka-Allchorne et al., 2017; Mares & Pan, 2013), the child's sex was not predictive differences in the outcomes. Typically, preschool boys and girls perform similarly on educational outcomes; it is not until children are older and more impacted by socio-cultural influences do we see sex differences for different constructs (Kersey et al., 2018). Child's age was significant for only the English and health scores, suggesting that over the intervention period, slightly older children made more gains than younger children on these outcomes. Children's baseline scores predicted improved outcomes for literacy, numeracy, shape recognition, color recognition, and English language skills, suggesting that if a child had more knowledge of a construct at the beginning of this study, they were more knowledgeable about that construct months later. Curiously, for health knowledge

the child's baseline score was associated with a decreased score. We can only assume that during the school shutdown for COVID–19, many things affected children's understanding of health. Interestingly general media (but not *Akili and Me*) receptivity predicted improved English language knowledge. Possibly during the school shutdown, children were watching many different types of programs. Different exposure, especially to shows beyond this locally-produced and predominantly Hausa program, could alter children's learning of new vocabulary words.

This work adds to the literature showing that educational media can serve children living in challenging environments and times. As observed in other low- and middle-income countries, when broadcasters offer educational programming that reflects children's culture, learning can occur. The human characters of Akili, Hauwa, and Musa resemble the target audiences racially and culturally; social cognitive theory can help explain why the *Akili and Me* characters might motivate learning (Bandura, 2001; Cohen, 2001; Bussey & Bandura, 1999. Young audiences in northern Nigeria might identify and aspire to be like these Hausa-speaking role models, and as a result, attend more to the conveyed lessons of the program.

Returning to the ecological model, the availability and success of *Akili and Me* is an example of how media can affect child development on several levels. The study results show that children who knew the characters more had greater gains on educational outcomes, demonstrating how media can impact children on a personal level. We note that when governments shut schools (mesosystem), officials were able to turn to media broadcasters and producers (exosystem) and offer educational content to reach children within their homes (microsystem). From qualitative research done with children from subSaharan countries during the COVID–19 pandemic, media affected children across these different systems (Borzekowski et al., 2021).

This study occurred in northern Nigeria, and it is unclear whether we can generalize these findings to other locations in Nigeria, sub-Saharan Africa, and beyond. Producers of *Akili and Me* will use information from this research to continue development of content and refinement of adaptations, but the team will need to test new material with different samples. Data from this study demonstrate that those children who watched learned more than children who did not watch educational content during the school shut down. This contributes to our understanding that young children, especially those whose formal learning was affected during the COVID–19 pandemic, could make gains if they had the opportunity to watch and learn from an animated educational program. If governments need to shut down schools because of man-made or natural disasters, we recommend that communities distribute and utilize educational media to prevent young children from losing valuable instruction and content.

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Disclosure statement

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Authors' contributions

DLGB was contracted to create and conduct the study. DLGB, HB, and MJ developed the protocol and instruments. DLGB and HB gained IRB approval for the work. LK conducted the statistical analyses. LJ assisted with table and figure creation. All authors discussed the results and contributed to the final manuscript.

Data availability statement

The research team will make available the data and instruments from this study upon formal request.

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