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Elementary-School Students' Use of Digital Devices at Home to Support Learning Pre- and Post-COVID-19

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Abstract: As access to digital devices has grown, children in the United States are increasingly making use of digital devices at home. This paper reports two studies with data from two samples, one collected in 2017 and one in 2022, documenting how families of elementary-aged children make use of digital devices at home to support their children's learning in reading, writing, mathematics, and science. Of particular interest was whether parents have reported an increased use of digital devices since COVID-19. Data were collected both times via an online questionnaire, in which parents described their child's access to devices, amount of use, subject-specific use, and their own confidence and beliefs about device use. Most children made use of digital devices to support learning, but the extent of use varied by subject. Children's reported use of digital devices and parents' confidence assisting their children's learning with such devices reportedly increased from pre- to post-COVID. These findings can inform the efforts of researchers exploring the use of digital devices as a tool in the home learning environment and educators working with families already making use of these devices at home.

Keywords: digital devices; elementary education; informal learning; home learning environment; post-COVID use of digital devices

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1. Parents Descriptions of Elementary-School Students' Use of Digital Devices at Home to Support Learning

The availability of digital devices and access to the internet in the home has steadily increased over the past four decades, increasing from 8% of families with children in 1984 [1] to 95% of families with children between 3 and 18 years of age in 2017 [2]. Prior to the onset of COVID-19, children under the age of eight, on average, spent an estimated two and a half hours per day using digital devices [3], with the number steadily increasing as children grew older [4]. More recently, with COVID-19 and the advent of virtual instruction, the use and availability of digital tools at home has grown even more. For example, Sonnenschein et al. [4] surveyed 162 U.S. parents of children ages two through nine years during May 2020, the early part of COVID-19. Children between two and five years of age reportedly spent between two and three hours a day using digital tools, whereas children between six and nine years spent between three and four hours a day. Parents reported that their children had used digital devices more since the start of COVID-19 than before.

There are still many unanswered questions about how digital devices are used for home-based learning. The most important is how the use of digital devices for learning has changed since COVID-19 when instruction in school-based classrooms shut down and instruction became largely virtual [5]. Although most, if not all, schools have resumed in-class instruction, have there been lasting effects due to children having to use digital tools for virtual instruction? In addition, most research, pre- and post-COVID-19, has not compared the use of digital tools at home for different educational subjects, such as reading, mathematics, writing, and science [6–8]. Furthermore, few studies have examined parents'

views about technology, particularly how confident parents feel to assist their children with home-based learning tasks [3,9]. Understanding parents' views is particularly important given COVID-19 and the increased use of digital tools at home for instruction [10]. In other words, we need to understand how parents assist their children at home in different subjects, in order to maximize their children's learning.

The present paper includes two studies that explores parent's views of children's use of digital tools at home to support their learning before and after the onset of COVID-19. Study 1 surveyed parents of elementary-aged children about how their children use such devices at home to support reading, mathematics, writing, and science learning, and parents' views of the use of digital devices for these subjects. These data were collected in 2017. Study 2 collected data in Spring 2022, two years after COVID-19 began, and addressed the same questions, as well as whether parents' reported views about digital device use had changed. In the following literature review, we explore the use of digital devices to support children's learning in reading, writing, mathematics, and science. We then discuss the use of digital devices at home and the role parents play in supporting children's digital device use. We conclude with research on digital use at home during COVID-19.

1.1. The Use of Digital Devices to Support Children's Learning

The use of digital devices has been found to support children's reading [11,12], mathematics [13,14], and science skills [15,16]. Fewer studies have examined device-supported writing [17] and results from those few studies are inconsistent [18]. Sonnenschein et al. (2022) showed that the impetus for digital device use in learning activities at home stemmed from children, parents, and teachers, with the requests from teachers increasing and those from parents decreasing as children aged.

There are important gaps in the current body of research that serve as the impetus for this study. Firstly, most of this research has been conducted in schools, and the extent to which these results can be generalized to the home environment is unclear. Secondly, writing and science at home are understudied subjects. Thirdly, much of the research to date has focused on young children, those in preschool or early elementary school [10]. Fourthly, we do not know enough about parents' beliefs about assisting their children with digital devices. The present two studies address these limitations by examining the use of digital devices in the home for reading, mathematics, writing, and science, four common school subjects. Unless we state differently, research reported here focuses on data collected before the onset of COVID-19 in the United States.

Prior to COVID-19, most families reported having access to digital devices. Common Sense Media conducted a survey in 2017 with a U.S. nationally representative sample (N = 1454) of parents of children 0–8 years [19]. Most families reported owning several types of digital devices, including laptops, tablets, smartphones, and internet-enabled televisions. An estimated 59% of children, ages 5–8 in their sample, had their own tablet devices (Rideout, 2017). This increased even more in 2020, although low-income children and those of color continued to have less access [3].

Much of the extant research focuses on digital device use in households with children aged 0–8 [19]. As children enter the middle elementary years, they are likely to make more use of digital devices [4]. In addition, as schoolwork becomes more challenging, parents may be more likely to use digital devices to support their children's learning. As we noted before, we are not including, in this section, changes in usage due to the COVID-19 pandemic, although we are aware of these changes.

1.2. The Use of Digital Devices at Home during COVID-19

There is a growing body of research on the use of digital devices at home during COVID-19 [10,20–22]. For example, in a study conducted shortly after the onset of the COVID-19 pandemic, Sonnenschein et al. (2021) found that parents of preschool and early elementary age children reported that their children's use of digital devices had increased since before COVID-19. Sonnenschein et al. (2021) documented parents' reports of their

assistance with school age children early on during COVID-19, when in-school classes were suspended. Although parents offered some technological assistance to their children, much of the parents' time was spent teaching their children.

Jaegera and Blaabaeka (2020) investigated children's use of digital books from Danish libraries during COVID-19. Middle-income children checked out more such books than low-income children. The researchers concluded that the economic gap in children's access to technology increased during COVID. See also [23,24].

Many parents recognize the value of using digital devices and the need for their children to know how to use such devices [25–27]. However, no studies have examined either parents' confidence in using digital devices to support their children's learning at home or parents' views about their role in supporting such learning. Confidence is an important factor for parent involvement in learning [28]. As Hoover-Dempsey et al.'s (2005) model suggests, parents need to believe they have the relevant skills to assist their children with schoolwork.

1.3. The Present Study

The majority of studies examining children's use of digital devices have examined device-based learning in school, but not at home. Parents play a more central role in the home [28], and children's use of devices at home, therefore, is likely different from that in school [29,30]. Moreover, digital usage at home no doubt has changed since COVID-19 with its demands for virtual instruction. The present study explored the use of digital devices at home to support children's learning pre- and post-COVID-19 by addressing the following research questions. There is not sufficient prior research to support forming hypotheses for any of the research questions, except for the third one. Instead, we are interested in obtaining mainly descriptive information about children's digital use at home and parents' views of such.

1. What digital devices do children have access to at home and how often do children use these devices to support their reading, mathematics, writing, and science learning? Are there any differences in device use based on academic subject or grade? (Study 1)
2. What are parents' views regarding children's use of digital devices for reading, mathematics, writing, and science? (Study 1)
3. Do parents report that their child's use of digital devices at home has changed since the onset of COVID-19? (Study 2) We hypothesize that reports of children's digital use will have increased.
4. Do parents report a change in their confidence to assist their children with digital devices since the onset of COVID-19? (Study 2)

2. Study 1

2.1. Method

2.1.1. Participants

This study was approved by the Institutional Review Board of the investigators' university. Parents of elementary-aged children in the U.S. participated in this study (N = 177). On average, parents were mothers (91%), White (82%), college-educated or higher (77%), 39-years-old (SD = 6.02) and indicated a yearly income above $74,999 (75%).

The children of participating parents were evenly distributed between genders (52% female) and across grades: 37% were first/second graders (M_{age} = 6.61, SD_{age} = 0.63), 40% were third/fourth graders (M_{age} = 8.65, SD_{age} = 0.68), and 23% were fifth/sixth graders (M_{age} = 10.48, SD_{age} = 0.63). Parents were recruited via social media, flyers, and direct solicitation in two public, low-income elementary schools in fall 2017. Unfortunately, it was not possible to distinguish who enrolled through the different types of solicitations.

2.1.2. Measures

The online survey had several sections: (1) What digital devices did children use for learning and the frequency of such use, (2) how confident did parents feel supporting their children's use of technology for learning and (3) demographic questions about the focal child and family. Questions were closed- and open-ended (see Table 1 for sample questions). Due to space constraints, however, this paper does not include the responses to the open-ended questions.

Table 1. Sample items from parent questionnaire in 2017 and 2022.

Sample Question	Response Type
Please indicate which of the following you have at home: Computer/Laptop, eReader (i.e., Nook, Kindle), Smartphone (phone with internet access), Video Game System (i.e., Xbox, Wii), Television with Internet	Select all that apply
Please indicate which of the following your children have access to at home, supervised or unsupervised: Computer/Laptop, eReader (i.e., Nook, Kindle), Smartphone (phone with internet access), Video Game System (i.e., Xbox, Wii), Television with Internet Connectivity, Other Device (please specify).	Select all that apply
Do you have internet access at home?	Yes/No
Can your children use the internet at home (either supervised or unsupervised)?	Yes/No
What devices does your child use for Math and for Reading?	List all that apply
How confident are you in your ability to assist with activities for which your child uses a digital device? - Reading, Writing, Math and Science	Likert (1–5)
How many days per week does your child use a digital device to engage in the following activities (with or without supervision)?—Reading, Writing, Math and Science	1–7
How do you feel about the amount of time your child uses a digital device to engage in the following activities (with or without supervision)?—Reading, Writing, Math and Science	Likert (1–5)

Digital device access. Parents responded to the question '*Which of the following devices do your children have access to at home?*' Response options included the following: computer/laptop, e-reader, tablet (e.g., iPad), smartphone, video game system, television with internet, other, and none of the above. Parents checked all the options that applied to their household. They also reported whether they had internet access at home (yes/no).

Digital device use. Parents estimated how many minutes per day and days per week their child used a device, with or without supervision, to engage in reading, mathematics, writing, and science. The average amount of device use per week was calculated by multiplying minutes-per-day by days-per-week.

Parent confidence in assisting with digital devices. Parents reported their level of confidence (1 = not confident to 5 = very confident) in their ability to assist with digital reading, mathematics, writing, and science activities.

Parent beliefs about digital device use. Parents were asked 'How do you feel about the amount of time your child uses a digital device to engage in (reading, mathematics, writing, science) activities?' Response options included the following: should be used a lot more, should be used a little more, used just the right amount, should be used a little less, and should be used a lot less. They also were asked, "How confident are you in your ability to assist with activities for which your child uses a digital device?" They were asked separately for each subject. Response options ranged from "not confident, slightly confident, moderately confident, confident, very confident".

2.1.3. Procedure

Individuals accessed the survey using a link. Parents' consent to participate in this research was obtained through an online consent form. If upon reading the consent document parents no longer wished to participate in the study, they could decline to participate (which directed them out of the survey) or exit their browser. The survey took about 15 to 20 min to complete. Parents were offered a chance to receive $25 through a raffle for participating.

3. Results and Discussion

3.1. Children's Access to and Use of Devices for Learning

Ninety-nine percent (n = 175) of families had access to the internet at home and most children (n = 163; 94%) were allowed to use it. Children had access to tablets (n = 155; 88%), computers/laptops (n = 136; 77%), internet-enabled televisions (n = 126; 71%), video game systems (n = 108; 61%), and smartphones (n = 91; 51%) at home. Only 1 parent reported that their child did not have access to any of the devices listed above. Most children (n = 119; 67%) had access to between 3 and 5 of the listed devices.

Children reportedly spent several hours a week using digital devices (reading 5 h, mathematics 2 h, writing 1.6 h, science 1.3 h). Most parents felt that the amount of time their children spent using devices was "just the right amount" or "should be used a little more" for reading (n = 109; 65%), mathematics (n = 98; 59%), writing (n = 99; 59%), and science (n = 88; 53%). Notably, 40% (n = 65) of parents thought that devices could be used "a little more" or "a lot more" for science.

A repeated measures mixed ANOVA was conducted to examine if the amount of time (in minutes) children spent using devices per week varied by academic subject (reading, mathematics, writing, and science) and grade group (1st/2nd, 3rd/4th, 5th/6th). There was a main effect of subject, F (3, 172) = 76.94, $p < 0.001$, $\eta_p^2 = 0.31$, such that all pairwise comparisons of amount of time significantly differed between each subject ($p < 0.05$–0.001). Children spent significantly more minutes using devices for reading (M = 285.17) than mathematics (M = 125.510), writing (M = 98.54), and science (M = 77.18). There was no main effect for child grade group nor significant interaction for child grade group by subject.

3.2. Parents' Views on Use of Devices for Learning

Most parents agreed or strongly agreed that they had good basic computer skills (93%), were comfortable working with new websites and devices (89%), and had a good overall knowledge of technology (85%).

A repeated measures mixed ANOVA was conducted to examine whether parents' confidence to support device-based learning varied by subject and grade group. There was a main effect of subject, F (3, 158) = 12.76, $p < 0.001$, $\eta_p^2 = 0.08$. Parents were similarly confident (p = 0.069) in supporting device use for reading (M = 4.36) and writing (M = 4.29), but significantly less confident supporting science (M = 4.15) and math (M = 4.07) ($p < 0.05$–0.001). Confidence to support science and math did not differ significantly from one another (p = 0.096). There was no main effect for child grade group nor significant interaction for subject by grade group.

In sum, these data show that most elementary-age children, growing up in affluent families in the United States in 2017, had access to many digital devices and internet for learning at home. Most parents reported being confident using digital devices to assist their children's learning; however, they were less confident doing so for science and mathematics.

4. Study 2

This study collected data approximately two years after the start of COVID-19 about children's use of digital devices for learning at home, parents' confidence to assist their children and their views of using digital tools.

5. Method

5.1. Participants

After obtaining IRB approval, participants were recruited through social media sites geared towards parents (e.g., Facebook parent groups, etc.). The sample consisted of 392 participants identifying as parents (59% mothers; 38% fathers and the remainder grandparents/guardians; M_{age} 34.20, SD 6.16) of children in first/second grade (48%), second /third grade (36%), and fifth/sixth grades (17%). Participants' educational levels ranged from high school through a doctoral degree; in total, 61% had at least a college

degree. The majority of respondents were White (53%) or American Indian/Alaska Native (22%), and indicated a yearly income between $50,000 and $74,999 (32%).

Participants were asked to report the type of schooling their children received in 2020–2021 and in spring 2022. In 20–21, 21% received fully virtual instruction, 57% hybrid, and 25% received in person instruction. In the spring of 2022, 74% received in person instruction.

5.2. Measure

The online survey was distributed via Qualtrics and included 38 multiple-choice questions identical to those in Study 1, with several exceptions that probed about post-COVID-19 use of digital tools. For example, "*Has the amount of time your child uses digital devices for reading, writing, mathematics, and/or science changed since the COVID-19 pandemic*?". Response options ranged from decreased a lot (1) to increased a lot (5). Parents were queried about this for reading, mathematics, writing, and science. They also were asked, "*Has your confidence to assist your child with digital devices changed since the COVID-19 pandemic?*" The question was asked for reading, mathematics, writing, and science. There were 5 response options, from decreased a lot to increased a lot. Parents also were asked about the type of instruction (e.g., virtual, in-school classes, hybrid) their children received during COVID-19 and now.

5.3. Procedure

These data were collected in Spring 2022. The procedure was identical to that in Study 1.

6. Results and Discussion

We focus here on responses to two questions: (1) Has children's use of digital devices reportedly changed, and, if so, how?; and (2) Has parents' confidence in using digital devices changed, and, if so, how?

6.1. Children's Access to and Use of Devices for Learning

As was the case in Study 1, 99% (n = 348) of families had access to the internet at home and most children (n = 317; 81%) were allowed to use it. Children had access at home to computers/laptops (n = 320; 82%), smartphones (n = 312; 80%), tablets (n = 300; 77%), internet-enabled televisions (n = 244; 62%), and e-readers (n = 193; 49%).

Consistent with our hypothesis, children's reported use of digital devices for educational activities at home had increased since COVID-19. Fifty-five percent (n = 177) of parents reported that their child's use of digital devices for reading had increased since COVID-19, while 44% (n = 173) indicated that device usage had increased for mathematics. Results were similar for writing (n = 162; 41%) and science (n = 158; 40%). Four one-way ANOVAs, with grade group as the between group variable and time as the dependent variable, did not reveal differences in usage for grade group ($p > 0.10$).

A repeated measure mixed ANOVA was conducted to examine if the amount of time (in minutes) children spent using devices per week varied by academic subject and grade group. There was a main effect for subject, F (3, 352) = 6.294, $p < 0.001$, $\eta_p^2 = 0.018$, such that all pairwise comparisons of amount of time significantly differed between reading and the other subjects, but did not differ between each other. Children spent significantly more minutes using devices for reading (M = 304.28) than for mathematics (M = 283.5, writing (M = 277.43) and science (M = 273.58). There was no main effect for child grade group nor significant interaction of child grade group by subject. The average number of minutes children spent engaging in digital device use for learning was clearly higher than in study one.

6.2. Children's Use of Digital Devices since the Start of COVID-19

All families in this study had access to a variety of digital devices and the internet. About half the parents reported that their children's use of digital devices since the start of COVID-19 increased or increased a lot (Reading: 54%, Mathematics 53%, Writing 50%, Science 49%). Children reportedly spent between three and four hours a week using digital devices for their studies (reading 3.91 h, mathematics 3.27 h, writing 3.14 h, science 3.03 h). Four one-way ANOVAs, with grade group as the between group variable and subject as the dependent variable, did not reveal differences in usage due to grade group ($p > 0.10$) for any subject.

6.3. Parents' Confidence in Using Digital Devices since the Start of COVID-19

Most parents agreed or strongly agreed that they had good basic computer skills (93%), were comfortable working with new websites and devices (89%), and had a good overall knowledge of technology (85%). A mixed repeated measure ANOVA, assessing parents' confidence to use digital devices to assist their children's learning, showed a statistically significant effect for subject, F (3, 322) = 7.433 p <.01, η_p^2 = 0.023. Parents reported being significantly less confident using digital devices to support science (M = 3.30) and mathematics (M = 3.42) than reading (M = 3.62) and writing (M = 3.60) ($p < 0.05$–0.001). Confidence to support science and math differed significantly ($p = 0.028$), with parents reporting being more confident supporting mathematics than science.

There was also a significant interaction between subject and grade level, F (6, 322) = 2.181 $p < 0.043$, $\eta_p^2 = 0.013$. Parents of children in grades 1/2 were more likely to report lower levels of confidence assisting in mathematics F (2, 322) = 2.73, $p < 0.067$, $\eta_p^2 = 0.017$ and science, F (2, 322) = 6.099 $p < 0.010$, $\eta_p^2 = 0.028$ than parents of children in older grades.

In total, 63% to 67% of the parents reported that their confidence to use digital devices to assist their children's learning had increased or increased a lot since before COVID-19 (Reading 67%, Mathematics 63%, Writing 67%, Science 62%). This contrasts with 46% to 59% of parents who mentioned this in 2017. Parents in 2022 discussed that using digital devices was easy and convenient.

Four one-way ANOVAs, with grade group as the between group variable and subject as the dependent variable, did not reveal differences in use for grade group ($p > 0.10$). To further explore the variability in ratings of confidence, we use t-tests to compare parents' confidence assisting their children using digital devices in time 1 and 2. As shown in Table 2, parents were significantly more confident overall and for specific subjects in time 2 than time 1. The effect sizes ranged from small to moderate in size.

Table 2. Mean scores, SDs, and group effects for parents' confidence to support device-based learning.

	2022		**2017**		**Group Effects (Independent *t*-Test Stats)**		
	Mean	***SD***	***Mean***	***SD***	***t***	***p-Value***	***ES (Cohen's d)***
Parent confidence overall	3.88	0.91	3.47	0.72	5.14	0.00	0.49
Parent confidence by subject							
Reading	3.98	0.99	3.67	0.86	3.48	<0.01	0.33
Writing	3.95	1.00	3.61	0.96	3.68	<0.01	0.35
Mathematics	3.79	1.08	3.41	0.97	3.87	<0.01	0.37
Science	3.81	1.13	3.20	1.15	5.65	<0.01	0.54

In sum, the data from Study 2 show that children's use of digital devices for learning at home has increased since COVID-19 and parents' confidence assisting their children to do so has increased. There also continues to be some differences in parents' confidence to use digital devices across subjects.

7. General Discussion

These findings provide insight into the digital home learning environments of elementary school-aged children and the increasing role digital devices are playing, particularly following school closures due to COVID-19. Consistent with recent surveys, e.g., [3], and other research [31], digital usage among children is increasing. This is generally true for all children, regardless of demographic background, but particularly for middle income White children.

Most parents in both studies in this study reported that their children had access to the internet and various digital devices at home. Consistent with other research, e.g., [32], tablets were the most popular digital devices accessed by children prior to COVID-19; however, in Study 2, computers/laptops were more prevalent. Prior to and following the COVID-19 closures, most children also had access to computers/laptops, internet-enabled televisions, video game systems, e-readers, and smartphones. Moreover, it appears that children are using these devices to engage in a variety of educational activities. Not only is children's access to the internet and digital tools for learning common, but their parents reported feeling comfortable using technology. This is different from what has been reported in some other studies, but may reflect that they are not comfortable having to teach their children, as opposed to not being comfortable using technology [22,33].

On average, parents reported that their children used digital devices at home most frequently for reading. They dedicated less time to device-supported math, writing, and science activities each week. Parents tended to feel more confident and less anxious about supporting their child's reading compared to math [34,35]. Therefore, it may be that parents encourage children to engage in reading more than other subjects. Importantly, however, these results do not shed light on the quality of the learning taking place during device-based learning.

Overall, parents were confident in their ability to support their child's learning with digital devices at home, particularly following the COVID-19 school closures. Consistent with previous research [35–37], parents were more confident about supporting their child's reading and writing, and less confident about supporting math and science. It has been argued that an advantage of technology is that it can compensate for differences in parents' ability to support their children's learning [38]. Therefore, it is interesting that, even when learning is paired with technology, the language, arts and STEM confidence gap remains. Parents in our sample were confident about their ability to use technology and devices. Perhaps our findings are more representative of parents' overall feelings of confidence about these subjects. Future research should examine whether technology attenuates or exacerbates these differences in parents' confidence, especially as device-based learning increases in popularity.

8. Conclusions and Application

This study surveyed the parents of elementary-aged children to gain insight about how parents view digital devices and how their children use such devices at home to support their reading, writing, math, and science learning. Overall, we found that, although the extent of such use varied by subject, children used these devices at home to support their learning.

COVID-19 has shown us the need to consider the importance of access to technology for all families. As access to digital devices increases, schools are likely to rely increasingly on digital learning. Schools need to ensure that parents are supported in using devices for home learning, particularly in science and mathematics. Informal science experiences at home foster learning in familiar, culturally relevant ways that classrooms cannot [39], and science learning at home is associated with higher child interest, confidence, and achievement in science at school [40,41]. Technology may be a way for educators and researchers to connect with parents to support science learning at home. Hirsh-Pasek and colleagues (2015) called for a set of standards for creators of educational apps; however, we

also need to ensure that parents are able to identify and select appropriate media for their children [41].

Parents are confident in their use of digital devices, but may not be in using them to teach their children. A logical next step may be for researchers to work with schools in developing a digital home-leaning curriculum that is both accessible and understandable for parents. A digital home-learning curriculum would not only provide recommendations for online learning platforms and activities, but also suggestions for ways in which parents can engage with their children during digital device use. For example, sample follow-up questions can be provided so that parents can extend learning and check for misconceptions. In addition to extending thinking through questioning, providing connection to, and ideas for, real-life applications allows parents to extend concepts into their daily routines. It is also important that schools provide ideas and resources to parents for supporting their child when misconceptions occur. Digital learning activities that require parental input should be kept short. Parents are confident but do not have extensive time or knowledge for teaching [22].

If schools are to require digital based learning activities at home, they need to make sure all students have access. This may require lending devices as needed and knowing where to direct parents for no and low-cost internet access. During the initial wave of COVID-19, many children missed out on learning due to the extensive steps parents needed to take to borrow school devices. School systems need to find more efficient ways to lend devices.

Limitations

This study makes important contributions to the literature on digital use at home for educational tasks; however, there are several limitations to the generalizability of the findings. Firstly, the diversity of our sample, particularly in Study 1, was limited. The majority of parents were White, highly educated, and economically advantaged. Although parents in Study 2 were also mainly White and highly educated, they were not as affluent. Of particular interest for future studies is including a low-income, less affluent population. Secondly, these were self-reported data collected through an online survey, suggesting that parents who participated had some technological familiarity and access. Nonetheless, the results from our study add to the literature by examining device use at home for academic subjects.

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