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# Children with Autism and Technology Use: A Case Study of the Diary Method

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## Abstract

In this paper, we summarize our findings and recount lessons that we learned using the diary method in a pilot study exploring mobile app use among children with autism spectrum disorder (ASD). Participants included two teachers and five parents. We found that the diary study method worked well to collect data about app use; however, the design of our study inadvertently introduced problems, especially for the participating parents. Problems included feelings of pressure among our participants for their children to engage with apps that they had little interest in. Collecting data about how children with ASD use commercially available technologies like mobile apps is challenging and requires experimentation of methods; this case study paper will help other researchers who are working with similar user groups in navigating these challenges.

## Author Keywords

Autism; children; technologies; diary studies.

## CSS Concepts

- **Human-centered computing**~Human computer interaction (HCI)~HCI design and evaluation methods; *Field studies*;
- **Social and professional topics**~User characteristics; *People with disabilities*.

## Introduction

While people with ASD are incredibly diverse, many researchers have noted that they often have an affinity for technologies [10]. In this paper, we summarize our findings and recount lessons that we learned using a diary study method in a pilot study to investigate interactive technology use (specifically mobile app use) among children with autism spectrum disorder (ASD). In this case study report, we aimed to communicate how diaries were both a successful data collection method for a difficult to access group like children with ASD, and at the same time the diary study design contributed to unexpected problems for some of our participants.

Diary studies, as a data collection method, are intended to capture some aspect of participant experience, e.g. behavior, close to the time of an event. Advocates of the method argue that diaries have several advantages when compared to other common human-computer interaction (HCI) data collection methods.

Whereas HCI user interviews and surveys rely on belated recall, diaries capture user experience somewhat contemporaneously. When compared to observation, diaries have the advantage of minimizing Hawthorne effects; i.e., the result of changing a user's behavior by the presence of an observer [4]. Also, the burden of data collection is transferred to participants resulting in potentially capturing more events than possible through typical observation [3]. However, diary studies have also been critiqued as too burdensome; one common problems with diary studies is collecting an insufficient number of entries [9]. In an often-cited taxonomy, Carter and Mankoff [5] differentiated HCI diaries types between elicitation and

feedback (however, the two types do not need to be binary).

Involvement in an elicitation diary study requires that participants capture an artifact that represents a meaningful experience, e.g. a photo. The artifact(s) then become an anchor for participants to later recount important events related to the researchers' questions.

Conversely, feedback diaries require that participants complete questionnaires about their experiences in the context of the research. Feedback diaries in HCI have often aimed to collect data to inform a new technology (e.g. [10]) and/or time spent on particular tasks (e.g. [6]). Research using feedback diaries have relied on paper-based mediums (e.g., [7]), web-based surveys (e.g. [11]) and mobile devices (e.g. [14]). In this study, we used web-based feedback diaries that involved parents and educators completing questionnaires about how the children with ASD in their care used iPad apps. In the next section we describe background for this project.

### *Foundation for this project*

ASD affects many families; the Center for Disease Control and Prevention estimates that 1 in 59 children are currently identified with ASD in the US [2]. This represents about a 49% increase from the 1 in 88 estimates in 2012. The DSM-V [1] defines a diagnosis of ASD by five criteria and categorize ASD into three levels of severity.

The first two diagnostic criteria describe non-typical behavior: (1) deficits in language and social interaction; and (2) display of restricted, rigid and repetitive pattern of behavior and/or interests. The last three

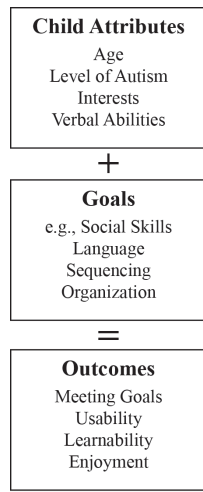


Figure 1. Diagram of a ‘seed case’

diagnostic criteria describe conditions under which the non-typical behavior occurs for an ASD diagnosis: (3) when - in early development; (4) how – the behavior impacts functioning; and (5) why – that the behaviors are not attributed to other causes [1].

Children described at ‘Level 3’ ASD (requiring very substantial support) are the most affected. Children diagnosed with ‘Level 3’ ASD demonstrate limited verbal skills and have minimal abilities to interact with others. Additionally, they often exhibit extreme discomfort with changes and times of transition, sometimes resulting in disruptive behaviors. Children described as ‘Level 1’ (requiring support) demonstrate typical to high intellectual abilities but often have little desire for social interaction. While people with ASD are noted for their diversity, one often cited commonality is an affinity for technology (e.g., [10]).

This reported affinity for technologies has resulted in numerous academic endeavors and commercial products focused on the creation of interactive technologies for ASD. The larger project, for which this diary study is part, started as a follow-up and extension of earlier work [12] concerned with ASD and technologies. To extend the earlier work, we conducted 19 interviews and 230 surveys from parents, teachers and therapists who had children with ASD. Findings from the interviews and surveys had implications for the design of an information sharing and recommender system to help teachers, therapists and parents choose interactive technologies for their children with ASD [13]. In our review looking for similar information sharing resources for ASD, we found a recommender for iOS apps called “i.AM Search”; the app has not been available since 2012.

i.AM Search’s parent company, Wysumarts was founded by a mother of a child with ASD who was frustrated by having to choose from the overwhelming number of apps designed for ASD available at the iTunes store. The app relied on suggestions provided by their ‘team of experts’. We felt that the existence of i.AM Search underscored the need for tools to help people learn about ASD-related technologies. However, we also believe that reliance on experts is not a scalable model for a free product. Instead, we argue for sharing systems built on user-created reviews. To begin experimenting with potential system designs, we needed instances of technology use. Hence, the need for the use of feedback diaries that detailed use-cases that we could use as ‘seed-cases’.

We defined a ‘seed case’ in this project as a combination of: (a) child attributes (age, level of ASD, interests); (b) the goals for using an interactive technology (e.g. social skills, ease of transitions); (c) the perceived success of the interactive technology at achieving the goals of use for that child; and (d) how usable and learnable the technology was for that child. See Figure 1 for a diagram of a ‘seed case’.

**Diary Methods**

This study was approved by DePaul University’s Internal Review Board.

*Participants*

We recruited seven participants for the diary studies from the 19 interviewees from the earlier project [13]; five were parents and two were special education teachers. All the children that our participants reported on were between the ages of 5-12; all were boys. See Table 1 for a participant description.

Pseudonym	Relationship	Child age(s)
Cole	Special Education Teacher	5-7
Kathy	Special Education Teacher	3-5
Mia	Parent	12
Emma	Parent	10
Kim	Parent	9
Jayden	Parent	9
Kayla	Parent	7

Table 1. Pilot Diary Study Participants

*Data Collection*

We purchased four iPads and protected them with heavy-duty cases; we chose iPads because of the prevalence of IOS apps discussed in the interviews and surveys [13]. We loaded the iPads with 75 different apps that were well-reviewed by our interviewees and survey responders. Parent participants were given the iPads for six-week sessions and paid \$50.00 for participating. Teacher participants were given the iPads for twelve-weeks and were paid \$200.00 for their participation. Participants were told to use whatever apps they/their target-child desired and to report on their experience(s) in the web-based diaries. We collected diary data between April-September of 2018.

## DIARY DESIGN FOR THE PILOT STUDY

We created web-based diaries using Survey Monkey. The surveys were identical except for how it referred to the target child (your child or your student).

In the first diary entry for any child, we asked participants about the target child they were reporting about. Information included the child's age, gender, interests, ASD-related challenges, tablet experience, and whether they had used any apps or other technologies to address their target child's ASD-related challenges. We then asked participants to report on their experiences for up to three apps.

We asked about many attributes of the apps. Open ended questions included: (1) time spent using; (2) intended goals; and (3) their perception of the app. Close-ended (Likert scale 1-5) questions included: (1) efficacy, that is, did it meet the goals they intended; (2) how worth the price was the app; (3) how much

help the child needed to use the app; and (4) how appropriate the app was for the child.

## POST STUDY QUESTIONS (FOCUS ON THE DIARY STUDY METHOD)

After the study, we asked our seven pilot study participants how they felt about completing the web-based online diaries. Specifically, we asked about: (1) their perceived challenges of the study; (2) how much burden they felt to complete the diaries; (3) what they would change about the study and the diary method; and (4) and what worked well with the diary data collection method.

*Data Analysis*

We also summarized the close-ended (Likert scale) questions from the diaries. We also inductively coded the open-ended post study questions for common and salient themes using Atlas.ti<sup>1</sup>.

**Findings**

In the next sections we summarize the top-level findings from the diaries and recount the lessons learned from our diary methods.

*Diary Study: Top Level Findings*

We collected a total of 79 'seed cases', a large majority of those (n = 60) were from the two-special education teachers (n = 19 from parents). The data for the seed cases involved 10 different children (n = 7 from the teachers), all boys aged 5-12; two of the parent participants did not submit a single completed diary.

Participants reported on a total of 36 different apps; the three most common reports were about app

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<sup>1</sup> <https://atlasti.com/>

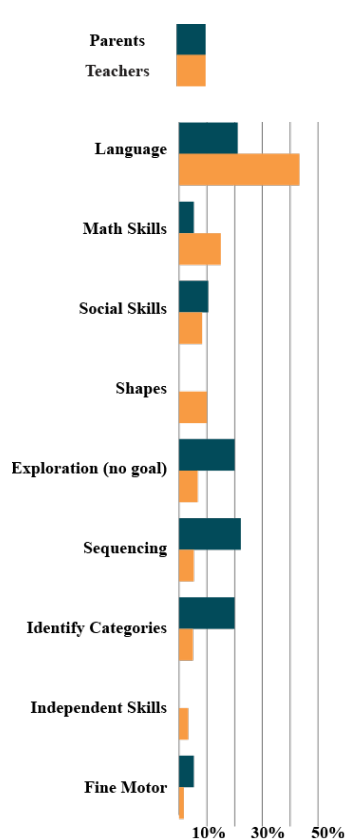


Figure 2. Breakdown of Common Goals for Using the Different Apps. (While language-related goals were most common among teachers, apps aimed at sequencing were most common for parents. The y-axis lists all stated goals; the x-axis presents the percent of apps used aimed for each goal by user group).

bundles: (1) 'Intro to Math by Mobile Montessori'<sup>2</sup> (18 cases); (2) 'Sight Words'<sup>3</sup> (five cases); and 'Injini: Child Development Game Suite'<sup>4</sup> (five cases). The average time spent on any particular app varied between the teachers (11 minutes per app) and the parents (25 minutes per app).

The goals for using the apps were quite varied. The most common goal, Language, accounted for 43% of the goals for the teachers (e.g. "For this student, who is primarily non-verbal, I wanted him to learn plural forms of English words" – Cole). Parents cited Language as their goal for 21% of the cases. The most cited goal for parents (21% of cases) was Sequencing (e.g., "improve my child's ability to do sequences to understand what comes first" – Kimberly). See Figure 2 for a breakdown of goals by parents and teachers.

Our participants rated how well the apps met their intended goals; both groups rated the goal match at a high average of 4.2 of 5. In support of our notion that a recommender needs to present customized selections, both teachers rated the same product as a 1 or 2 goal match for one student while ranking it a 5 for another; this occurred for four different apps.

Teachers were more likely to agree that the apps were worth the price (average level of agreement was 4.5 of 5) when compared to parents (average of 3.9).

Children did not require much help with using the apps. Teachers reported a required level of help at an average of 2.7 of 5 (5 = a lot of help), and parents

reported that their children needed an average of help level of 2.1 of 5.

Teachers ranked the appropriateness of the apps for their students at 4.5 of 5, indicating that most of the apps were viewed as aimed at an appropriate level. Parents were less likely to agree that the apps they tried were appropriate; they ranked them at an average of 3.8 of 5.

#### Post Study Questions

We organized this section by the questions we asked: (1) challenges of the study; (2) perceived burden of completing the diaries; (3) what they would change; and (4) what worked well with the data collection method.

#### (1) CHALLENGES OF THE STUDY

By far, the most cited challenge by parents was in motivating the children to use the iPad. Kim responded to the question, writing:

"Some of the challenges I faced were getting my child to use different apps, since he would select his favorite ones only."

Similarly, Mia submitted:

"The main burden of completing the diaries was getting Kyle (pseudonym) to participate. I let him choose the apps and asked him to spend a few minutes with several of them, but he discovered that they were for much younger kids (Kyle was 12 years old). It became a chore to get him to sit down and interact with the apps, and in the end, we just didn't find the motivation to do so."

<sup>2</sup> <https://www.mobilemontessori.org/appbundles>

<sup>3</sup> <https://sightwords.com/>

<sup>4</sup> <https://apps.apple.com/us/app/injini/>

The two teachers' challenges were more related to managing aspects of the study. For example, Cole wrote:

"The only challenges that I really experienced was time. Having only one iPad for four students, if I wasn't diligent in recording which student used which app, I would repeat."

Kathy's challenge was related to a concern of the lag time between the event and completing a diary entry:

"If I were at home or with a child, it may be harder to remember to log the data."

#### (2) BURDEN OF COMPLETING THE DIARIES

Completing the web-based diaries was not perceived as burdensome by any of the parents or teachers. Kathy (teacher) wrote in response to the questionnaire:

"I didn't think there were any challenges to the online diaries. Being in a school, I am on my computer fairly often and it is easily accessible."

Mia (parent) turned this question back again to problems she had with the study design:

"The methodology was only burdensome in that I needed to task him with interaction on the iPad, which I didn't do. The questions/form were no big deal to fill in."

#### (3) WHAT THEY WOULD CHANGE

Again, the focus of what participants would change was not on the diaries as a data collection method, but the study design. Kathy (teacher) wrote:

"I don't think there were any questions that were not asked that should have been. I had a difficult time getting my students with ASD to play other

games once they found a particular game they were interested in, so I didn't explore too many of the other games, but the data collection was easy!"

Cole (teacher) suggested that having his students select the apps was not as productive for the children as the sessions could have been, submitting:

"I would also choose more apps that have more rigor, most of the apps were for very low children and all of my students were much higher, although they enjoyed them, they were just playing because it was so easy for them."

Kim (parent) also wanted better guidance for app selection:

"Maybe give specifics as to which apps would be best for your particular child's needs. Maybe offer discounts if you decide to purchase an app. after doing study."

#### (4) WHAT WORKED WELL WITH THE DATA COLLECTION

All participants felt that the web-based diary data collection method worked well. For example, Cole (teacher) wrote:

"Your method of data collection was right on. It allowed me to be reflective, honest, and provide insight that was necessary to research. The diary was not intensive or cumbersome which facilitated in my completing it promptly."

### Discussion and Future Work

Participants did not have any problems with completing the web-based diaries; the challenges of participating were a result of our study design. Implicit in our participants' responses was a feeling of pressure to experiment with different apps. The children, however,

only wanted to work with a small number of apps. In hindsight, this is completely unsurprising for children; i.e., why would any child want to work with new apps if the ones they had experience with were perceived as at least adequate? While we did not explicitly tell participants to try multiple apps, the large number that we installed may have inadvertently implied that we wanted a lot of experimentation. And while participants did not tell us the method was burdensome, the small number of entries from some parents indicated otherwise, supporting a critique of the method [9].

We also feel, in retrospect, that introducing an iPad into people's homes was not a good idea for two reasons. First, the interaction between parent and child is complex and fraught with power dynamics; i.e. the iPad introduced another task for parents to ask their child to complete, leading to conflicts. Second, it was not really fair to the children to introduce the iPads and the apps without letting them keep the devices and apps. We did not feel that these reasons generalized to a school situation, which perhaps contributed to the greater success of the school studies. That is, children are less likely to challenge instruction from their teacher and are very used to engaging with materials they cannot keep. In future work, we plan to only put iPads in classrooms; however, we hope with greater funding we can put enough iPads in a classroom so that the children do not need to share to address Cole's concern.

However, we still want to collect data from parents. As we work towards our goal of an information sharing and recommender system for ASD technologies, we hope to provide a means for people to share their experiences without our placing hardware in homes.

As such, we plan to experiment with modifications to our methods so that participating parents use their own hardware; in previous work [13] we found that most people already own a mobile device and/or computer. These modifications could take two different formats. In the first format, participants could be given a budget and asked to select from a range of apps that they felt were appropriate for their child. We would then solicit them for reviews, emphasizing that several reviews on the same product is not undesirable to mitigate the unintended pressure of trying many products. In the second format, we could create a reward system (e.g. credit towards purchases) for meaningful contributions to our system where they would use their own software. In both modifications we plan to increase rewards for contributions to help offset any perceptions of the method as overly burdensome.

In summation, the diary study method worked well to collect data about technology use. But the design of the study was flawed, especially for our parent participants. Collecting data about children with ASD is challenging and requires experimentation of methods. We believe what we learned in this pilot study will help other researchers navigate similar challenges.

### Acknowledgments

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