Sharing Stories "in the Wild": A Mobile Storytelling Case Study Using StoryKit

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Today's mobile devices are equipped with a variety of tools that enable users to capture and share their daily experiences. However, designing authoring tools that effectively integrate the discrete media-capture components of mobile devices to enable rich expression—especially by children—remains a challenge. Evaluating such tools authentically, as they are being used in-situ, can be even more challenging. We detail a long-term, multimethod study on the use of StoryKit, a mobile storytelling application. By taking advantage of a public distribution channel, we were able to evaluate StoryKit's use on a scale beyond that usually found in lab settings or limited field trials. Our results show that StoryKit's simple but well-integrated interface attracted a high number of dedicated users in education contexts at all levels, including children with special learning needs. We include a discussion of the challenges and opportunities that similar "in the wild" studies hold for HCI research.

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General Terms: Design, Human Factors

Additional Key Words and Phrases: Mobile devices, mobile storytelling, creativity, authoring, children, social apps, participatory design

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1. INTRODUCTION

> "Nearly universal literacy is a defining characteristic of today's modern civilization; nearly universal authorship will shape tomorrow's" [Pelli and Bigelow 2009].

Pelli and Bigelow [2009] came to this provocative conclusion after their statistical analysis of rising authorship trends across all media worldwide, from print books to microblogs, over the past six centuries. While it can be argued that our civilization has not achieved "nearly universal literacy," their summary captures a prevailing notion in both popular and scholarly literature on 21st century technologies: Anyone can be a content creator, not just a content consumer; each individual has the potential to be a writer, not just a reader [Jenkins 2006; Puopolo 2012; van Dijck 2009]. Socially mediated technologies such as e-mail, blogs, Twitter, YouTube, and Facebook have increased

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the ability and ease with which we create and distribute digital, networked content, and the collective intelligence potential of the Read/Write web has been widely publicized [Gillmor 2004; Grossman 2006].

The places from which we share our creations are not limited to stationary desktop or laptop computers at home, in an office, or Internet café. In growing numbers worldwide, we are using mobile devices to access, create, and share personalized content [IDC 2011, 2012; Smith 2010]. The increasingly sophisticated media capabilities of today's mobile devices offer opportunities to use them for meaningful creative tasks. As robust computing platforms that are "not only always on, but always on us" [Ross et al. 2011, p. 28], smartphones are intrinsically personal, ripe with potential as tools for individual expression as well as social connection. Overall, there is an increased awareness and expectation that mobile technology can empower us to tell our stories from anywhere, at any time, to anyone.

Today's children were born into this ecosystem of technologies that promote personalized content creation and global reach. A rapidly growing number of children (8–18 years old) own smartphones or "feature phones" with capabilities such as media players and cameras [GSMA and NTT DOCOMO 2010, 2011; Gutnick et al. 2010; Lenhart et al. 2010]. However, research that extends beyond cataloguing children's consumption of mobile systems as basic communication or entertainment devices, to examine instead how they might be used as tools for creative expression and learning, remains small [Druin et al. 2009; Franckel et al. 2010; Shuler 2009].

The same portable and pervasive technologies that individuals use to create and share their activities and ideas can also provide system designers with the means to capture user interactions in more authentic, in situ contexts than traditional lab settings, often on a much larger scale [McMillan et al. 2010; Srivastava et al. 2000]. Communications interaction and infrastructure tools are now available to collect and analyze a growing collection of user connections and activities, from both mobile and static computing environments [Hansen et al. 2010]. Of the research studies that have investigated the use of specific smartphone applications, however, very few have characterized their use outside short field trials, or taken advantage of public distribution mechanisms such as Google Play or Apple's iTunes® App Store [Falaki et al. 2010; McMillan et al. 2010]. Likewise, more research that tackles the challenges of reconciling automatically collected, quantitative digital trace data with qualitative user interactions and appropriation practices, is needed [Crabtree et al. 2006; Rotman et al. 2012]. Thus, the following contextual factors motivated our study:

— users worldwide expect increasingly low barriers yet robust tools for mobile content creation;
— children's mobile devices can (and should) be tools for storytelling and creative expression;
— we can capture usage data from large user groups in natural, not lab contexts.

In this article, we detail a long-term, multimethod study on the use of StoryKit, a mobile application for creating and sharing multimedia stories on iOS mobile devices. We designed StoryKit at the University of Maryland's Human-Computer Interaction Lab (HCIL) to generate insights on mobile storytelling from the perspective of children and families, building from earlier research on mobile reading [Bederson et al. 2009; Druin et al. 2009]. In addition, our StoryKit design efforts enabled us to explore design issues unique to mobile multimedia authoring interfaces for children [Franckel et al. 2010; Quinn et al. 2009]. Our goal was to systematically describe the ways in which children, families, and schools engage in mobile storytelling, asking specifically, "How is StoryKit being used in the wild, by children and the significant adults in their lives,

and how does their use inform the design of mobile authoring tools?" Three research subquestions were derived from this overarching goal to guide our study.

— What media features are being used, and how are they used in stories? (e.g., audio as transcriptions of text or ambient sounds in-context)
— What types of stories are being created? (e.g., family outings, fairy tales)
— What can general usage statistics tell us about who uses StoryKit, and when, where, and how are they using it? (e.g., weekend or weekday use).

We focus on StoryKit use by children to increase our understanding of the ways in which mobile storytelling applications can be designed to enhance their personal expression and literacy practices. We also detail our multi-method, "extreme ethnography", multisited approach [Marcus 1995; Rotman et al. 2012]. By taking advantage of a public distribution channel and comprehensive system logs that maintained user anonymity, we were able to evaluate StoryKit and describe its use on a scale beyond that usually found in human-computer interaction (HCI) field trials. We augmented our quantitative analysis with 20 user interviews.

Our results indicate that StoryKit's relatively simple but well-integrated interface attracted a high number of dedicated users in education contexts at all levels (preschool/nursery through secondary/year 12), and in multiple subject areas. We observed several unexpected "lab-wild divergences" [Rogers 2011], or differences between the ways users created stories "in the wild" and the ways they created them during our design sessions and field test. For example, we noted a much higher use of StoryKit in classrooms by users "in the wild" than we anticipated during our design sessions and field trial. We also found that a mobile authoring tool designed for users across an intergenerational spectrum was particularly well suited for users with special learning needs, such as autism spectrum disorders and Downs' syndrome.

2. RESEARCH LANDSCAPE

Our study draws upon recurring themes from research in socio-cultural studies, intergenerational communication, literacy pedagogy, and the design of interactive technologies that support personal expression. In this section, we summarize research on the impact that storytelling has had on children's literacy, and the potential of mobile technologies to support these activities. We include a discussion of studies that have used "in the wild" data collection and analysis methods related to our own.

2.1. Literature Review: Storytelling, Literacy Research, and Mobile HCI

Storytelling is a fundamental element of human cognition and communication. Many diverse disciplines, from literary criticism and linguistics, to education, organizational leadership, and cultural studies, have demonstrated that storytelling is an essential aspect of human communication and sense-making [Barthes and Lionel 1975; Kelliher 2004; Seely-Brown et al. 2004]. We not only need stories socially, to develop individual identities within larger communities, but we also need them cognitively, to make sense of the world around us [Newman 2005; Polkinghorne 1988]. By reading and creating stories, children can learn about their own identities and culture, as well as explore others [Cassell and Ryokai 2001; Hartnell-Young and Vetere 2008; Huffaker 2004; Madej 2003].

New Media and literacy studies suggest that children are capable content-creators even before they enter formal education contexts. Moreover, family narratives influence their literacy practices and sense of identity. Family narratives often offer the first exposure children have about the ways in which we use technologies to develop communications skills – that is, our literacy practices [Pahl and Rowsell 2005; Peppler and Kafai 2007; Vetere et al. 2009]. Literacy studies have demonstrated that children

can convey rich life experiences and language awareness, even absent sophisticated reading skills [Labbo 1996; Mackey 2003; Rowe 2008]. Technologies that support social interactions among family members can increase a sense of well-being for all [Hutchinson et al. 2003; Vetere et al. 2009]. Improved communications tools such as shared, video-supported book readers, have helped families separated by long distances to enhance literacy learning opportunities [Raffle et al. 2009].

In formal education contexts, the 2008 report from the United States' National Commission on Writing (NCW) found that children as young as 12 wanted more opportunities in school to practice writing in order to be successful in college and the workplace [Lenhart et al. 2008]. Children want to be part of a conversation on universal authorship, and already recognize that an ability to express oneself in all contexts is an effective, lifelong skill.

Mobile technologies are integral components in children's daily lives and possess unique affordances for learning and self-expression. They offer potential for children to express themselves in-context, seamlessly, without disrupting the flow of their formal learning activities or informal play [Ching et al. 2009]. Many mobile devices are equipped with media-capture tools that can be used to create multimodal stories from anything that children experience, imagine, and want to share. Yet, the body of research that combines integrated design for storytelling, a focus on children, and mobile devices is relatively small [Franckel et al. 2010]. Most research has typically targeted one design goal, such as a desktop tool that supports the creation of personal narratives by adults [Landry and Guzdial 2006]; similar nonmobile interfaces for children [Bailey et al. 2006; Klerfelt 2006; Ryokai et al. 2009]; mobile-based multimedia toolsets for adults that lack integrated storytelling features [Wu et al. 2007]; or similar mobile text-messaging tools designed for children that lack story creation support [Makela et al. 2000]. Fails et al.'s [2010, 2011] work to support collaborative mobile storytelling by children (8-11 years old) represents one strand of research that integrates all three facets (children, mobile devices, shared storytelling). Our StoryKit study extends Fails et al.'s [2010, 2011] focus on collocated mobile reading and authoring to encompass both local and remote mobile authorship practices, across a large user population.

2.2. Related Work: Methods and Mechanisms for Evaluation

Although mobile public distribution channels such as Google Play and Apple's iTunes® App Store have been in wide use since 2008 (and others before that), few studies have explored their potential as design evaluation mechanisms [Froehlich et al. 2007; McMillan et al. 2010], and most have applied only one analytic approach (quantitative or qualitative only). Using quantitative techniques, Henze et al. [2010] applied an experimental design on Android user interaction data to focus on three specific visualization techniques, while Falaki et al. [2010] broadly summarized a diverse array of general smartphone user interactions. Qualitatively, Zhai et al. [2009] focused on user reviews for a specific mobile application. In contrast to these studies analyzing user data collected "in the wild," we used a multi-method case study approach. We analyzed data from multiple sources, comprising not only subjective user feedback like Zhai et al. [2009], but also quantitative interface-interaction data, and content analysis of a large number of artifacts created by users in the wild (600+ stories). Our approach follows McMillan et al.'s [2010] multi-method design most closely; however, their user data (game interactions) differed greatly from ours (repository of personal stories).

Overall, the number of applications that have been publicly deployed to support multimedia-based narrative creation by children is limited. Further, reported research

Fig. 1. (a) StoryKit launch screen; (b) Main bookshelf view; (c) Edit bookshelf view; (d) Rearranging books in your Bookshelf. (The rocket book is being moved up in queue.)

that describes extended, real-time use of mobile storytelling tools by children–not just initial field use–is minimal (e.g., Makela et al. [2000]). Our study aims to expand emergent "in the wild" research, in terms of design considerations and detailed analysis of how StoryKit is being used "in the wild."

3. STORYKIT OVERVIEW

3.1. Interface History and Interaction Features

StoryKit extends the mobile reading application from the International Children's Digital Library (ICDL)[1] [Bederson et al. 2009; Quinn et al. 2008] to integrate story creation and editing features [Druin et al. 2009]. Children can create original stories, or modify sample ICDL stories[2] with their own photos, drawings, and audio. StoryKit authors can also share their stories with friends and family via the Internet. The StoryKit interface and interaction flow is shown in Figures 1–4.

The interface consists primarily of full-screen views and a few dialogs. In keeping with its ICDL history and storybook metaphor, the initial view shows a bookshelf (Figure 1(b)). From the bookshelf view, a user can browse and manage the stories stored on the device, and open storybooks for viewing, editing, or sharing. To create a story, a "New Book" option is available at the top left of the bookshelf view (Figure 1(b)). The reading interaction is the same for user-created books as it is for the four ICDL sample stories [Bederson et al. 2009], which are included in the initial StoryKit installation. By tapping on the "Read" button (Figure 2(b)), users are taken to the first page of the story, and they advance each page by swiping a finger across the touch screen. In edit mode, a simple tab-based interface enables users to add text, record sound(s), paint/draw, take pictures with the device's camera, or insert existing images from a photo gallery in a story (Figures 2(d) and 3). StoryKit includes a paint/draw tool, because it was a requirement demanded by the children who helped design it. However, StoryKit does not include video. There were two technical reasons for this: (1) during StoryKit's development (2009), the iOS API did not support video

[1]http://en.childrenslibrary.org/

[2]The ICDL book samples were selected: (1) because StoryKit renders stories editable, or 'remix-able,' copyright and licensing agreements required that the story content be public domain; and (2) from a technical perspective, the formats of the sample books allowed separation of text and image to facilitate editing. For example, a favorite ICDL book, *Waldo At the Zoo*, could not be a sample story in StoryKit because it contains text that is part of the illustration, and cannot be separated easily for editing.

Fig. 2. (a) Main bookshelf view; (b) Individual story screen, with "Edit" selected; (c) Edit pages overview; (d) Edit page view, tools palette at bottom of screen; (e) Rearranging pages.

and (2) we did not want to burden users with overlong story-sharing upload times that video might require. We also had storytelling and literacy reasons to forgo video, based on our experiences with the design and implementation of the ICDL [Druin 2005; Druin et al. 2007; Hutchinson et al. 2006]. Rather than limiting the expressive power of StoryKit, the absence of video editing was designed to focus child users on developing their writing abilities. We felt that photos, audio, and drawings can support written text, but video tends to replace it. The mechanics of sharing stories are detailed in Section 3.3 (Privacy Features). StoryKit users also have access to three support channels: a support e-mail address[3]; an ICDL-hosted "help" form linked from the application's description in the iTunes® store; and an online forum hosted through the ICDL. Appendix A contains two stories created and shared using StoryKit.

3.2. Design Process

An intergenerational, participatory design group at the HCIL designed StoryKit from 2008 to 2009. Eight children (ages 7–11), representing multiple races and ethnicities, and a balance in gender (4 girls, 4 boys), known collectively as Kidsteam, comprised the younger set of designers. Six adults (46–77 years old) who were parents, grandparents, and close friends of the child designers, and six adult researchers (23–46 years

[3]storykit@childrenslibrary.org

Fig. 3. Edit page view with tool palette. (a) Camera; (b) Photo gallery; (c) Text tool; (d) Audio tool; (e) Paint/draw tool.

Fig. 4. Sharing interactions. (a) Preparing to share a book; (b) Share dialog; (c) Share status bar.

old) completed the design team. The adult researchers on the team, including the authors, focused on capturing the design process, and collaborated with the Kidsteam members on their collective design recommendations. Design sessions were held in the HCIL, using the “Cooperative Inquiry” design approach [Druin 1999]. In keeping with the philosophy of Cooperative Inquiry, the Kidsteam members were actively involved in development from conception to completion, sharing ideas, designs and evaluation equally with the adult members of the team.

Five 90-minute design sessions were held over the course of the year, along with a final all-day field session one month before the application was released in the Apple iTunes® App store. Design sessions included both iPhones and iPod Touch devices. Early iPod Touches (circa 2009) used the same software and touch screen as the phone, but lacked a camera, microphone and speaker. Designing for both devices was important in 2008-2009, due to the increasing incorporation of the less expensive iPod Touch in primary and secondary education classrooms [Banister 2010; Murray and Sloan 2008]. Each iPod Touch was fitted with a snap-on speaker/microphone accessory to ensure nearly equivalent interfaces were available. Details regarding the design process and consequent design decisions can be found in Quinn et al. [2009].

3.3. Privacy Features

Because StoryKit was intended as a personal expression and storytelling tool for children and families, protecting their privacy with minimal overhead was a major

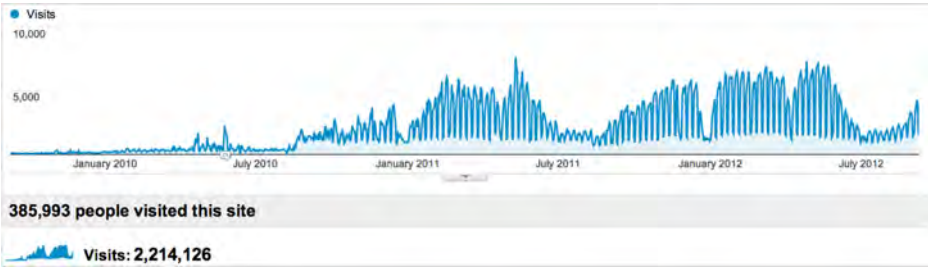

Fig. 5. StoryKit daily use, Sep. 9, 2009–Sep. 8, 2012. Overall daily use corresponds with the school year in the US. The individual spikes reflect high use during the week (Mon-Fri), and lulls over weekends.

design goal. In the United States, we were also obligated to follow U.S. laws such as the Children's Online Privacy Protection Act [COPPA 1998], which limits the collection of personally identifying information of children under 13. StoryKit stories often include pictures, sounds, and related personally identifiable information about their creators, young and old. Consequently, StoryKit does not require personal information from users to share their creations or to use basic features. Often, creating an account may be a significant burden for mobile users, regardless of age. StoryKit does not require users to create accounts or remember passwords.

We designed the interaction to keep any sharing overhead to an absolute minimum (Figure 4). When a user taps the Share button (Figure 4(a)–4(b)), there is a brief privacy notification (that her story will be sent to a server for long-term storage). The story is then synced with the server using a book key comprised of a combination of the device's unique identifier (not traceable to the user) and a book identifier. When uploading is complete, the server returns a private URL that includes the book key, and the application gives the user the opportunity to compose and send an e-mail with the story's private URL to select recipient(s) (Figure 4(c)). The link is designed to be resistant to guessing; it is not stored or linked publicly by the application. Only someone who has received a link from the author can view that author's story.

3.4. StoryKit Use, Brief Overview

StoryKit was launched as an iPhone/iPod Touch application in the Apple iTunes® App Store on September 9th, 2009. Over the course of 3 years (Sep. 9, 2009–Sep. 8, 2012), StoryKit was used over 2 million times by almost 386,000 distinct users in 175 countries and in 40 languages/dialects. Figure 5 shows the growth in daily use of StoryKit from September 2009 to September 2012. Individual peaks correspond to weekdays. Trends coincide with academic calendars in the United States. For example, daily use is high in the fall and spring (northern hemisphere), and low during the summer. While some users try StoryKit only once, others have used it more than 20 times (∼6% of all users), or even 100 times (∼1% of all users).

About 84% of app launches are from the United States, and the top five countries in which StoryKit is used are all English-speaking countries (Table I). Variety still exists, as the next five countries in the top-10 users include Singapore, Hong Kong, Sweden, and Qatar (Table I).

In total, over 810,000 books have been created in 3 years, containing over 2.9 million photos, 2.5 million text-boxes, and 1 million saved sounds. Of the books created, about 100,000 (12.3%) have been shared with friends. The shared stories run a mean length of 6.4 pages (SD = 6.53), with the longest story running 209 pages, and the shortest, one page. Because of the way that shared stories are uploaded and stored on a networked server, we were also able to log additional data about this subset of all

Table I. Top 10 Countries using StoryKit (Sep. 2009–Sep. 2012). Notable Entries Highlighted

Country	Top Number of visits (percentage of use overall)	Return Visits (recurring use)	Average Duration/use (Minutes:Seconds)
1. United States	**82.54%**	83.86%	15:05
2. Australia	4.69%	80.03%	**24:11**
3. United Kingdom	4.03%	80.16%	11:28
4. Canada	3.96%	81.24%	13:55
5. New Zealand	0.59%	78.90%	14:29
6. Singapore	0.33%	80.65%	10:46
7. Sweden	0.32%	79.62%	**16:24**
8. Hong Kong	0.31%	84.71%	12:24
9. Qatar	0.27%	**92.90%**	13:25
10. Ireland	0.26%	79.36%	9:57

StoryKit stories created, including metadata on device types, creation times, and story content data. More details on usage trends are provided in our Findings (Section 5.1).

4. METHODS

We used a multimethod case study design for our study. In contrast to quantitative, experimental methods, we did not seek causality or treatment effects regarding particular design decisions or pedagogical outcomes [Patten 2000]. Case studies typically focus on one instance within broader phenomena of interest [Barone 2004; Dyson and Genishi 2005; Yin 2003, 2009]. For our study, the design and use of StoryKit formed the case; the broader phenomena of interest were the ways in which users create and share stories with mobile devices, and how these practices could inform the design of mobile storytelling applications and our understanding of children's literacy activities.

A multimethod approach allowed for redundancy of data collection and triangulation from multiple perspectives, to help verify data interpretation and clarify emergent themes [Stake 2005]. Sources included interviews with participants, field notes, quantitative usage statistics collected through web-analytics tools, e-mail correspondence from users asking for technical support or giving feedback, and the stories users created. Data were analyzed using a grounded theory approach [Boeije 2002; Corbin and Strauss 2008]. Table II summarizes the various methods used throughout the study, from our initial field trials (pre-release) through September 8, 2012 (36 months in Apple's iTunes® App Store).

The first six months of our study (Aug. 2009–Jan. 2010) are best characterized as a design-research pilot study. During this early stage of our investigation, our design goal was to assess the application's readiness and viability to be broadly distributed by conducting a field trial (Section 4.1.1). Our research goal was to confirm the feasibility and fidelity of characterizing general "in the wild" use through web-based analytics (Section 4.1.2). By December 2009, we found that StoryKit's use in education contexts—not just family stories—was increasing. We noted that our initial genre categories did not cover all the themes that were emerging. Many stories with educational themes (e.g., history, science) were being shared, as more classrooms initiated iPods-in-the-classroom programs [Banister 2010]. StoryKit authors were using the application in ways that we had not initially expected. Parents and teachers of children with special needs (e.g., autism spectrum disorder (ASD)) began to contact us to share the ways in which they were using StoryKit, as well as to make requests for additional features.

Consequently, we decided to take longer samples of data throughout 2010 to refine our coding and to track device trends (iPads went on the market in April 2010, and schools were starting to use them). Our initial efforts are summarized in Bonsignore

Table II. Data Collection and Analysis

Data Source	Timeframe	Description	Analytic Approach
Field observations, notes, short videos of use by 7-adult-child pairs	One-day field trial, Aug. 7, 2009	Field notes were taken throughout the day, supported through 'interactive observation' with other researchers [Millen 2000]	Grounded Theory, with constant comparative analysis across data sources [Boeije 2002; Corbin and Strauss 2008]
Interviews (Field Trial)	Aug. 2009–Dec. 2009	Semi-structured interviews of 8 users (6 adults, 2 children) involved in a one-day field trial, 4 of whom also participated in a longer 6-week field trial	
Interviews (users recruited from "in the wild")	Jan. 2010–Sep. 2012	Semi-structured interviews of 12 adult users of StoryKit (parents and educators)	
Web Analytics (All StoryKit users) N≈386,000 users	Sep. 9, 2009–Sep. 8, 2012	Data collected and summarized via Google Analytics	Descriptive Analytics
Shared Stories (N≈100,000 stories, of which an n = 614 sample were analyzed in-depth)	Sep. 9, 2009–Sep. 8, 2012	614 StoryKit shared stories (uploaded anonymously to ICDL Server)	Genre Analysis [Orlikowski and Yates 1994]
Tech-Support related e-mails from users (N≈500 e-mail requests)	Oct. 2009–Sep. 2012	Initial requests from users for technical support or other feedback (e.g., praise, new feature requests). Note: Follow-up dialogue between StoryKit research team and users not included. These numbers reflect initial user queries only.	Content analysis using Grounded Theory approach to categorize e-mail types [Boeije 2002; Corbin and Strauss 2008]

[2011]. During the 2011–2012 academic school year in the United States, more educators contacted us about their StoryKit use, and the HCIL collaborated with schools to use StoryKit in two informal learning projects on science education [Clegg et al. 2012; Yip et al. 2012]. As a result, we extended our "in the wild" data collection and analysis through summer 2012, and focused on getting more detailed, qualitative feedback from educators to corroborate and clarify what we were seeing in the web-analytics and shared story samples.

4.1. Data Collection

4.1.1. Field Trial Data Collection (Observations, Interviews, Shared Stories). Our field trial took place as a one-day field trip to a local national park, one month before StoryKit launched in the iTunes® App Store (August 2009). All of the StoryKit design partners were invited to participate in the field observations. The field trip format allowed us to frame observations in a realistic example of an outing that family and friends might want to record, as well as a commonly shared experience. The park itself is a historical, working farm and features a wide variety of farm animals and equipment to experience and about which to create stories.

Seven groups, each comprised of an adult paired with one to two children, participated in the field session (Figure 6). Because the session was a familial event, younger siblings were allowed to experiment with StoryKit alongside the core design team children. A total of 18 children and adults participated. Participant ages ranged from 4 to 77 (4–11 years for the children; 37–77 years for the adults). Table III provides a

Fig. 6. Field session participants included children and their grandparents. At left, a boy composes a story about the farm with typing help from his grandfather. At right, a girl asks her grandmother to share some thoughts about the day, using the StoryKit audio tool.[4]

Table III. Field Trial Groups

Group	Device Type	Member, relationship (Age)	Notes
1	iPod Touch	Pat, Audra’s grandmother (65) Audra (8)* Claire, Brian’s sister (8)	Claire: New to StoryKit Pat: provided a post-interview member check
2	iPhone	Tim, adult friend (65) Cathy (8)*	Tim: New to StoryKit
3	iPod Touch	Wanda*, adult friend (46) Scott (10)*	Wanda: new to StoryKit; provided a post-interview member check
4	iPhone	Lisa*, adult friend (37) Natasha (9)*	
5	iPhone	Steve, Chris & Joe’s grandfather (77) Chris (7)* Joe, Chris’s brother (5)	Steve: New to StoryKit; provided a post-interview member check
6	iPhone	Carl, Brian & Clair’s father (53) Brian (10)* Alex (11)*	Carl: New to StoryKit; provided a post-interview member check
7	iPod Touch	Jill, adult friend (47) Rose (9)* Alicia, child of an adult researcher & friend to children on the design team (4)	

summary of the groups, with design team members denoted with asterisks[5](*). Most of the children had been involved in previous StoryKit design sessions. The application was new for half of the adults. Three groups used iPod Touch devices whose capabilities were comparable to those available during early 2009: no camera or built-in microphones. The iPods were equipped with external microphone attachments during the field session (and all prior design sessions).

[4]Permissions were received from all parents for the children in the study to participate and share images of themselves for research or publication purposes.

[5]All names are pseudonyms and all statements are quoted with permission. All aspects of the study have been approved by Institutional Review Board (IRB) procedures required by the University of Maryland, College Park/UMCP (UMCP IRB Protocol numbers 324400-1 and 00-0561).

Data collection included field notes, short video segments, and participant interviews. Interviews represented the most in-depth data collected. The child participants in each group were not excluded from the interviews; however, the focus was on the older adult members, because most of the children's perspectives had been compiled during design sessions leading up to the field day. Each group created a story about their experience. Their creations were stored on the ICDL server for post-session analysis via the StoryKit sharing feature.

4.1.2. Web Analytics on StoryKit Usage. Web usage mining, the process of mining web data to track user behavior patterns, has been studied in several different contexts, such as e-commerce, business intelligence, network management, and system security [Srivastava et al. 2000]. Capturing user profile and interaction data remotely has also been used in mobile interface design and evaluation contexts [Froehlich et al. 2007; Jensen and Larsen 2007; Waterson et al. 2002]. Digital trace data alone does not always provide a complete picture of the ways in which an app is appropriated by users, often capturing only the *where* and *what*, without revealing the *why* and *how* [Froehlich et al. 2007; Rotman et al. 2012]. However, such data can provide reliable information about content layout and interface navigation [Ivory and Hearst 2001; Waterson et al. 2002], which can then be used to guide a more focused, qualitative review.

Based on the potential of automatically collected digital data to evaluate and improve the current StoryKit design, we worked with third party software to enable remote capture of user interactions within Google's web analytics dashboard.[6,7] Data such as geographic locations of users, unique users, types of actions (e.g., "Add audio"), and length of use were reviewed over the course of the study (Sep. 2009–Sep. 2012). These data differ from the other sets collected and analyzed during our study, as they are descriptive and quantitative versus qualitative. However, these statistics enrich our investigation into StoryKit use in terms of global use and technology trending.

4.1.3. Shared Stories Corpus. A primary design feature that evolved during design sessions was the ability to share stories remotely with friends and family. As noted in Section 3.3, StoryKit allows users to privately share their creations with minimal overhead. Users are not required to establish a private account and password; they simply elect to distribute their story via the "Share" button located in the main navigation view for each book.

Stories shared between September 2009 and September 2012 represent a major data source for our study. During the pilot study phase (Sep. 2009–Jan. 2010), StoryKit users shared a total of 274 stories, which represented approximately 11% of all content created by the user base at that time. The entire corpus of 274 stories was analyzed during the pilot study. From February 2010 to September 2012, 340 additional stories, randomly sampled from an overall corpus of approximately 100,000 shared stories, were qualitatively analyzed. The sample size of shared stories from 2010-2012 was determined by applying a standard survey sample calculation [Bartlett et al. 2001]. Our goal to analyze a large enough sample to reflect the corpus of shared stories with a confidence interval (margin of error) of +/-5, at a 95% confidence level [Bartlett et al. 2001; Creative Research Systems 2012]. Altogether, a random sample of 614 stories was qualitatively analyzed. Story themes and genres were the characteristics

[6]http://www.google.com/analytics/

[7]Google's API for directly supporting mobile application usage statistics was not released for public use until after StoryKit was developed and deployed (Google Analytics Labs, 2009; Introducing Google Analytics for Mobile Apps, 2009).

Table IV. StoryKit Users Interviewed (recruited "from the wild")

Interviewee	Role/Background	Primary iOS Device	Country/ Nationality	StoryKit user since...
1. Judy [m]	Education technology specialists at a local university, developing and conducting training sessions for educators to incorporate technology in the classroom (certification-based).	iPad	United States (New Jersey)	Spring 2011
2. Kristine				
3. Terry [m]	In-service teachers, primary grades (year 1 – year 3)	iPad	United States (Maryland)	Fall 2011
4. Pam				
5. Phyllis				
6. Debbie				
7. Brianna [m]	Mother of 5-year old boy with autistic spectrum disorder (ASD) due to chromosomal conditions (non-verbal)	iPad	New Zealand	Summer 2011
8. Denise [m]	IT coordinator, working with teachers to bring educational technology into classrooms	iPod Touch	Australia	Spring 2010
9. Alice	Mother of 10-year old girl with ASD and intellectual impairment	iPad		Summer 2011
10. Christi	Mother of boy (undisclosed age) with ASD	iPod Touch and iPhone		Fall 2010
11. Laura	Mother of two girls, 4 and 11 years old, who have Downs Syndrome (younger is non-verbal; older is verbal)	iPad		Summer 2011
12. Warren [m]	Education Technology Director at a school in Amsterdam, working with teachers (primary – secondary years).	iPad	The Netherlands (Holland)	Fall 2010

that were qualitatively examined, to gain insight into the types of narratives possible within StoryKit. Quantitative, descriptive statistics for the entire collection of shared stories were also collected and analyzed. These descriptive data included characteristics such as length of stories, types of media used, and device types (e.g., iPod versus iPad).

Based on the anonymous sharing process (detailed in Section 3.3), no personally identifiable or private data about users is required or intentionally collected. However, some StoryKit authors include their names in the author field of their story metadata. None of this personally identifiable data is included without explicit permission from the users.

4.1.4. Interviews with Select Users "From the Wild". In early 2010, increasing numbers of StoryKit users began to contact us to let us know how they were using the app and to ask us for technical help. These users were typically educators who were using StoryKit in the classroom, but we also heard from parents of children with special needs, such as autism spectrum disorder (ASD) and Downs Syndrome. We interviewed several of these users "from the wild" for more details on how they were using StoryKit in classrooms and at home (Table IV). In addition to in-depth interviews with these users, we had multiple interactions with other users who corresponded with us via e-mail. Information on the volume and type of support requests we received from users is included in our findings (Section 5.1).

4.2. Data Analysis

To allow for detailed design considerations and use practices for mobile storytelling applications to emerge, we applied grounded theory [Charmaz 2005; Corbin and Strauss 2008] across our data.

4.2.1. Analysis Process for Interviews and Field Trial Observations. Open coding was used concurrently as the interviews were transcribed, to identify and label user perspectives. Overall, the interviews and observations were deconstructed using the following constant comparison steps:

— thematic coding and comparison of statements within a single interview;
— coding/comparisons between interviews from the field trial and subsequent interviews of "from the wild" participants; and
— coding/comparisons of adult-child comments and interactions in the field trial [Boeije 2002].

To help mitigate the potential for researcher bias in the inferences drawn from the interviews and observations, "member checks" [Lincoln and Guba 1985; Stake 2005] were coordinated with a subset of the participants midway through the coding process. These member checks involved discussing excerpts from interview transcripts, along with the summary codes emerging from them, with interviewees. Participants who provided member checks are specified in the "Notes" column in Table III, or denoted with an "[m]" in Table IV.

4.2.2. Analysis Process for General Usage (via Web Analytics). As we automatically captured user interactions via web analytics tools, we also took advantage of the publicly available analysis features in the Google Analytics™dashboard to measure usage statistics such as user volume, geographic distribution, and duration of use. The interaction data also includes details on the types of actions users take while they are engaged with StoryKit, such as adding photos, text, or sound, and sharing books. We used these digital traces to frame our analysis of the shared stories and inform our interview process. To analyze this data beyond general descriptive output, we also looked at trends in patterns of use over time and across devices. For example, we noticed dips in use during summer months, particularly with iPod and iPad users, presumably because most schools in the United States are on holiday during the summer.

4.2.3. Analysis Process for Shared Stories Repository. The "Shared Stories" corpus represents "traces of human communication in· · · naturally occurring materials" [Bauer 2000, p. 148], with content created by a broad StoryKit user base. Qualitative analysis of these multimedia artifacts complemented analysis of data from the field session, web-analytics, and interviews. Genre analysis was used to characterize the stories and the features of StoryKit's interface that support personal expression [Orlikowski and Yates 1994]. In this case, genres represent "the purpose, content, participants, location, timing and form of communicative action" [Yoshioka et al. 2001]. Genre analysis can suggest ideas for improving the technologies that support genres of communication, as well as the practices that create them [Orlikowski and Yates 1994]. Similar content and genre analysis techniques have been applied to the study of weblogs and social media in HCI [Herring et al. 2004; Schiano et al. 2004; Wei et al. 2007]. Genre analysis enabled us to identify the types/subjects of stories created, where they were created, and often, who was creating them (e.g., child, adult, via audio analysis). Our goal was to establish the types of expressive modes and user audiences that StoryKit supports best—or does not support well.

In keeping with the "children's library" history of the ICDL from which StoryKit originated and the storybook metaphor that grounds its interface, genre analysis also facilitated arranging the shared works according to different facets, much like a library collection. Grounded theory was used to uncover initial categories, supported by

Table V. Inter-Rater Agreement of Genre/Context Categories for Shared Stories

Category	κ	**Interpretation** [Fleiss et al. 2004]
General Context (e.g., Formal, Informal, Blank/Test)	**0.83**	Near perfect agreement (>0.81)
Specific Context (e.g., formal school/in-class; informal family/friends, after-school)	**0.72**	Substantial (0.61-0.8)
Major Genre (Fiction, Non-fiction, Test book, ICDL sample, etc.)	**0.91**	Near perfect agreement (>0.81)
Sub-Genre (Fantasy/Science Fiction, Autobiographical, Informational, Fable/Folktale, Composition/book report, etc.)	**0.89**	Near perfect agreement (>0.81)
Detectable Language (e.g., Spanish, Chinese. Includes Picture-only books with no text)	**0.93**	Near perfect agreement (>0.81)
Author behavior (original or "remix", as in an edited version of one of the sample ICDL books, or a remix of a traditional fairy tale, like an updated Cinderella).	**0.93**	Near perfect agreement (>0.81)

guidelines from the National Council of Teachers of English (NCTE),[8] for characterizing genres of artistic works [Fink 2009]. Stories were initially classified according to layout (e.g., picture book) and theme (e.g., fable, family narrative) [Fink 2009; Krapp 2004].

Toward the end of our pilot study (Dec 2009), we noted that the genres of stories being shared were shifting. As a result, the coding scheme established at the beginning of the study could no longer sufficiently summarize the collection. We conducted several additional coding sessions to develop a scheme that better reflected the stories being shared throughout 2010. This axial coding process involved relating existing codes to each other and to the emerging types of shared stories to develop a richer and more accurate snapshot of the corpus. The new coding scheme expanded our genre analysis to include contexts of use, sub-genres, and detectable languages. Our final coding rubric is listed in Appendix B. To ensure the revised scheme was stable and accurate, two raters independently coded 15% of the random sample of 340 stories that were analyzed (50 stories), with inter-rater agreement ratings (Fleiss' Kappa) ranging from 0.73–0.93 [Fleiss et al. 2004]. Table V lists the categories and associated inter-rater agreement ratings. With the accuracy of the coding scheme established, one rater coded the remaining 290 in the sample.

In addition to storing and serving the shared stories' content data, the StoryKit server maintains metadata logs. The metadata logs contain data such as the types of media used in each story, the number of pages per book, and edit actions that occurred during the creation and revision process for stories. To augment the content analysis of the shared stories, the metadata logs were also analyzed according to attributes such as device, content, and media used. Categorical analysis of the media types used within shared stories was done to highlight the media affordances preferred by StoryKit users.

5. DISCUSSION/FINDINGS

5.1. Overall Usage

When averaged across our 3-year study, individual user sessions last about 15 minutes each, triple the duration for authoring when the app was first launched

[8]http://www.ncte.org, A professional association of educators in literacy, English studies, and language arts.

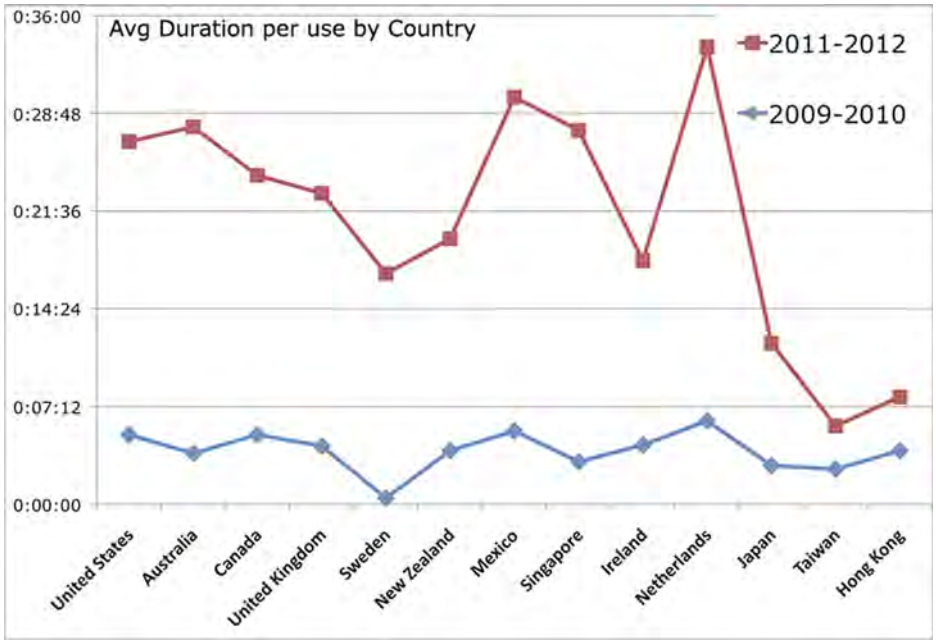

Fig. 7. Average amount of time that users (from top-10 countries) spent with StoryKit each time they used it, over two timeframes (2009–2010 and 2011–2012). The y-axis reflects the amount of time spent in one sitting by [hours:minutes:seconds], so that [0:07:12] is 7 minutes, 12 seconds. Some countries were top-10 users from 2009–2010, but not 2011–2012 and vice-versa, so the total number of countries shown is greater than 10. For example, Sweden was a top-10 country in 2011, but not in 2009.

(about 5 minutes in one sitting in September, 2009). For September 2011 to May 2012 (academic year for most users), this rises to 21.5 minutes (Figure 7). Focusing on just October 2012 in the US, StoryKit was used an average of 33 minutes for a total of almost 100,000 hours in 169,501 sessions. Our teacher interviewees also indicated that StoryKit authors are taking more time to craft and revise their stories.

Throughout the study, we received e-mail from users regarding technical support questions, feature requests, and minor usability issues (Figure 8). For example, some wanted the text visible from the audio recording screen so they could read it aloud. The volume and variety of user inquiries highlighted an issue of concern to any researchers who plan to publish systems in publicly available distribution channels: even small numbers of users can require more attention than expected. The volume of queries we received is represented along the y-axis in Figure 8. These numbers reflect initial e-mail-based queries from users, excluding follow-up dialogue between StoryKit staff and users and any messages unrelated to StoryKit (e.g, spam, blank).

To characterize the types of requests, we received from users, we compiled a topic list based on our experience answering user e-mails, which included problem reports (e.g., "received error 204 when sharing"), feature requests (e.g., "could you build in a shared bookshelf so kids around the world can do collaborative projects?"), and how-to questions (e.g., "How do I delete a page?"). We then coded all e-mail requests received from October 2009 to September 2012 using that scheme. (No e-mail requests were received in September 2009.) The detailed topic-based categories were grouped into broader categories, shown in Table VI(a).

We also classified the type of user who sent an e-mail to us (Table VI(b)). A key distinction was whether requesters were writing on behalf of a school or not, us-

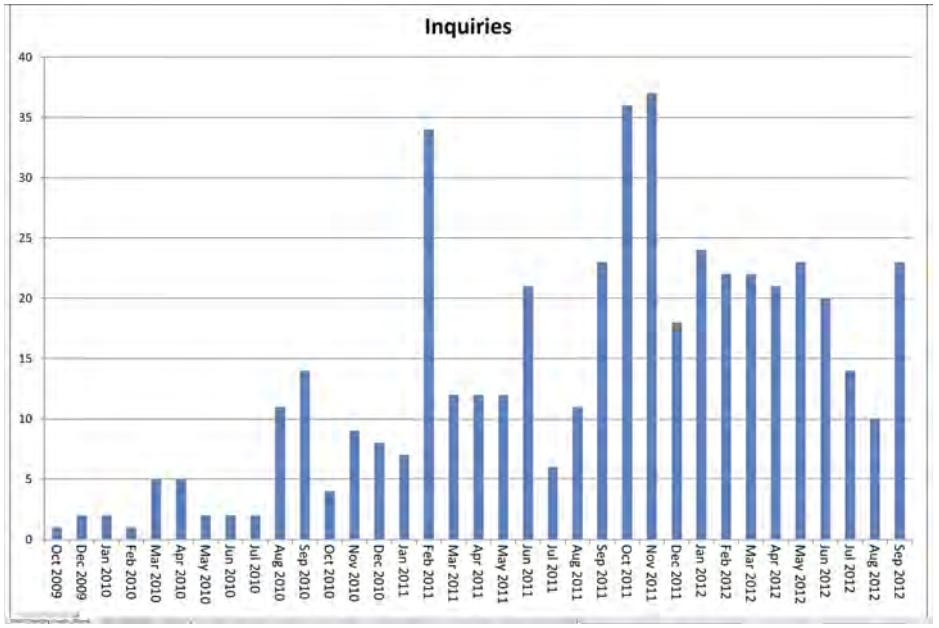

Fig. 8. Number of inquiries sent from users over the timeframe for the study. The spike in November 2011 was due to a lack of shared story space on the StoryKit server. This problem was solved in less than 2 days; however, it highlighted a requirement for tech support and storage resources beyond what was originally projected. The number of queries decreases in the summer months (school holiday in the US).

ing information given in the context of the questions (e.g., "My students would like to. . . .") or the domain name of the e-mail address the message was sent from (e.g., xxxx@xxxxschool.org). We also classified family relationships, where it was evident from message text (e.g., "My daughter is trying to. . . "). Some categories overlap, such as parents of children with special needs, or speech pathologists working in schools.

Despite the inherent limitations of our e-mail topic measurements (i.e., not all user contexts could be confirmed), the results corroborate our earlier analysis of the shared stories and interviews. A large proportion ($\geq$48.5%) of the users making e-mail inquiries are school users (e.g., teacher or information-technology/IT support), of which a smaller, but significant number ($\geq$8.2%) are using StoryKit with children having special needs or in a speech pathology context, highlighting StoryKit's value as a potential assistive technology tool.

Although they were not part of our original research objective, we became familiar with many of the technical issues that our teachers had to solve, such as school firewalls that added hurdles to the sharing process, a desire to share stories by students with parents and other students, or an inability to establish e-mail accounts. Indeed, a large number of error-related e-mails (60.3%), feature requests (24.8%), and how-to questions (14.3%) came from educators who sought more opportunities for their students to write collaboratively or to share their creations with their larger school and home communities. We created a workaround for the requirement to share stories without e-mail accounts, but school firewall policies in the United States are driven by legal requirements [COPPA 1998; FTC 2012; Mohapatra and Hasty 2012]. A small subset of educators requested confirmation that their students' works remain private (2.3%), underscoring the schools' obligation to protect their students' information

Table VI(a). Technical Support E-mail Categories, by Topic

Topic	Number of E-mails	Percentage
Errors (any)	287	60.3%
- Sharing errors, e.g., uploading, viewing stories online	173	36.3%
- Application errors, except sharing	116	24.4%
- Crash preventing access to story	73	15.3%
Feature Requests (any)	118	24.8%
- Sharing-related feature request	52	10.9%
How-to-do something	68	14.3%
Privacy Concerns	11	2.3%
Praise, testimonials and detailed praise beyond cursory thanks	42	8.8%
- Pure praise, no other request or reason for writing	11	2.3%

Note: Totals are not a simple sum because the categories are not disjoint. Some e-mails contained multiple questions or questions that fit multiple categories. All top-level categories are included, but some subcategories have been omitted. Percentages are relative to the total number of *new* e-mail inquiries that are *related to StoryKit* (i.e., excluding replies/extended correspondence, spam, blank messages, etc.).

Table VI(b). Technical Support E-mail Categories, by User Type

User type	Number of E-mails	Percentage
School-related	$\geq$ 231	$\geq$ 48.5%
Special needs and/or speech pathologist (either school or non-school)	$\geq$ 39	$\geq$ 8.2%
Family	$\geq$ 35	$\geq$ 7.4%
Other explicitly identified user type (e.g., Apple employee, etc.)	3	0.6%
Not identifiable (i.e., no mention of context or school e-mail address)	211	44.3%

Note: Some counts denoted with "$\geq$" are lower bounds because they are based only on information that could be inferred from the message body or e-mail address domain, and do not include users who did not reveal the context of their use. Also, the percentages do not add to 100% because the categories are not disjoint (e.g., speech pathologist in a school, family of child with special needs, etc.).

and adhere to the relevant laws. Since StoryKit was designed from the beginning to support only sharing by e-mail (i.e., no button to share broadly on social networking sites, etc.), the relatively small number of inquiries related to privacy may validate our approach.

The e-mail inquiries included interesting one-off requests, such as a language arts teacher who asked for special formatting to enable her StoryKit "poets" to share poems with specific verse style line-breaks. We have also worked with a child user so dedicated that the number of books in her device's bookshelf (600+) caused the app to crash. Note that this particular girl was a special needs child who delighted in creating stories with her father.

About a year after StoryKit was launched to the public, we began to receive reports of a bug that caused the app to crash when users tried to open specific books for reading or editing. The distribution of topics in the e-mails we received during that period indicates that the bug affected only a small proportion of users. For more than a year, we were unable to replicate the bug on our lab devices, which made diagnosing the problem difficult. During that time, reports of the bug continued to grow (13.7% of total user messages over 2 years). However, most users remained dedicated to the app itself. Many were happy to become bug testers for us, volunteering to give us remote access to their computers so that we could collect more data to diagnose and troubleshoot the bug. Some of these users ran a script we made that extracted internal StoryKit data files from the backups of their devices made by the iTunes software, and sent the files to us. That data ultimately revealed the cause of the bug

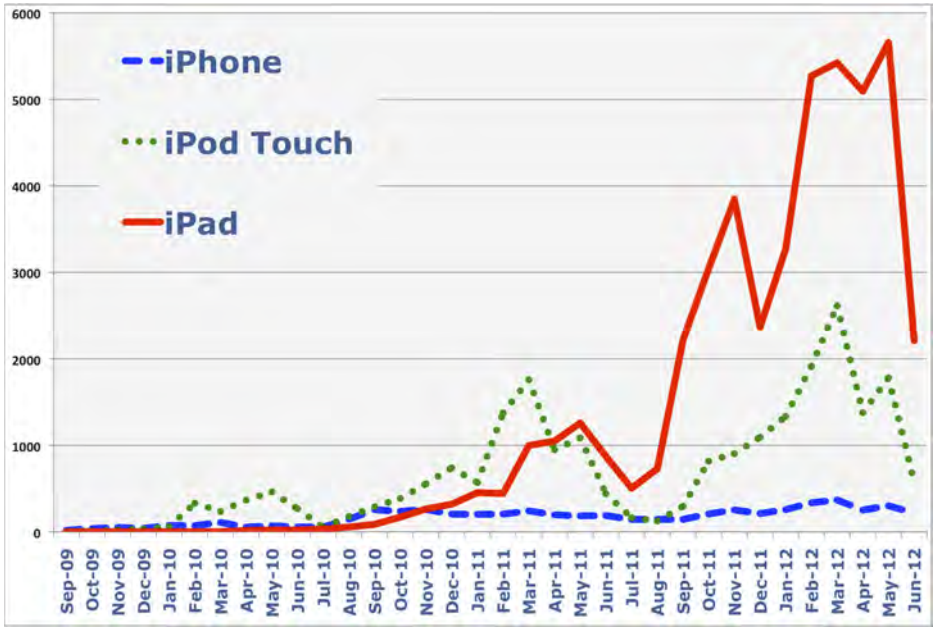

Fig. 9. Platform trends for the StoryKit shared stories repository (2009–2012). The dips in use for iPod Touches and iPads parallel the timeframes during which US schools are on holiday. This graph displays the platform trends for shared stories, not all stories created.

and enabled us to code an update to fix it. Once the update was posted, several users sent us “virtual cheers” as they were finally able to open the previously inaccessible stories. Although the numbers of users who were affected by this bug remained relatively small compared to the total StoryKit user base, their frustration in “losing” stories, coupled with our desire to find the fix to restore them, resulted in many more man-hours of discussion and diagnosis than expected within the bounds of our original design research and prototyping project.

5.2. Storytelling/Story-Sharing Platform Trends

Figure 9 reflects trends in the platforms used by StoryKit authors, from September 2009 to September 2012, as compiled from the shared stories repository. Comparisons among iOS devices for the entire StoryKit user population were not usable, due to a bug noted in the Google Analytics™ reporting of iPads. During the first few months after StoryKit’s public launch, web-analytics data reflected that about 30% of StoryKit users composed their stories on iPod Touches, 70% on iPhones. This trend followed our expectation, based on our design sessions and field test in 2009, when the iPhone had been the platform of choice for field test users, because of its built-in camera and microphone. By January 2010, the iPod/iPhone ratio by users in the wild had flipped. In 2010, the iPod/iPhone ratio remained consistently 80/20. By April 2011, one year after the release of the iPad, stories shared by iPad authors outnumbered those from the other iOS devices: 48% iPad, 43% iPod Touch, 9% iPhone. Today, almost three-quarter of StoryKit users compose on iPads.

The trend lines for both iPads and iPod Touch follow the United States’ (US) school year schedule for most StoryKit users (i.e., spikes from September to December and January to May; dips during holiday timeframes in December and June to August).

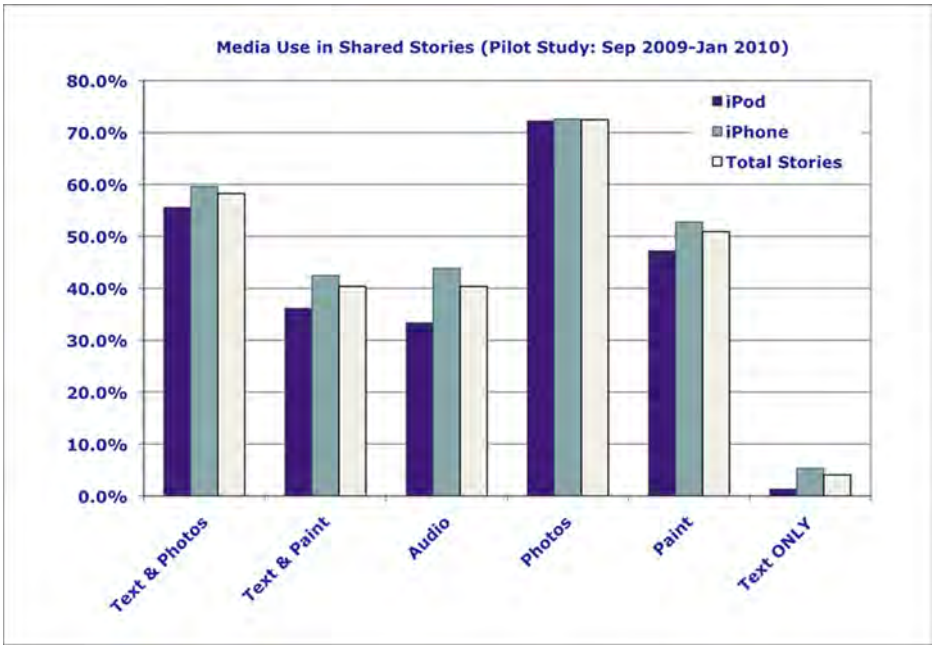

Fig. 10. Media used in shared stories from Sep 2009–Jan 2010. Although early iPods did not have cameras, users creating stories on iPods took advantage of the photo gallery or screenshot captures. The media in the sample ICDL stories that are part of the initial StoryKit bookshelf are not included in the graph, unless users revised ICDL stories with their own content.

This corresponds with our genre analysis that a majority of shared stories created with iPod Touches and iPads during this timeframe contained "formal education" themes (e.g., observing chemical reactions, history of Rome). Increasingly, schools were integrating iPods and iPads into their curricula [Banister 2010; Murray and Sloan 2008], with students and teachers becoming StoryKit's primary user base.

5.3. Media Use

During our pilot study (Sep. 2009–Dec. 2010), media analysis of the shared stories revealed that there was a higher variety than expected in iPod-created stories. For example, 33% of stories created and shared by iPod users included some audio, despite the lack of built-in microphones on early version iPod Touches (before Sep 2010). Similarly, despite the fact that early iPods lacked a built-in camera, the same percentage of iPod and iPhone authors included photos in their stories (72%). In contrast, during our design sessions and final field evaluation (Section 4.1.1), none of the iPod-crafted stories contained photos.

Through e-mail correspondence from users, we learned that many iPod authors chose to use a screen-shot capture work-around to create their picture-book stories. Teachers in classrooms also created photo galleries on the school computers to which their students' iPods were synchronized, so that all students would have a wide selection of shared, stock images to use in their stories. While drawing is the only media (beyond text) that is native to early version iPods, photos were used more than drawing in iPod-based stories. Very few stories (<5%) were comprised of text only, regardless of platform. In short, users in the wild were taking advantage of all of StoryKit's media tools, beyond what we had anticipated in our design sessions and

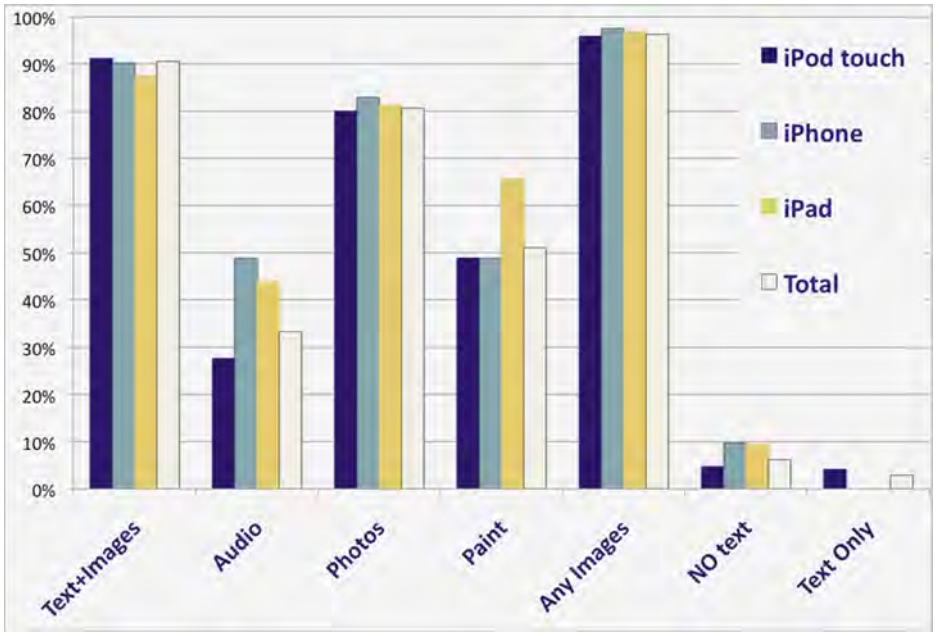

Fig. 11. Distribution of media used in shared stories from Jan 2010–Sep 2012. Stories that contained paint, photos, or both counted in the any images category (~96% of shared stories).

short field evaluation. Figure 10 shows the distribution of media in the stories shared from September 2009 to January 2010.

We also noted differences between the way in which children and adults used audio. Most of the adult-recorded stories were "tests" of the recording feature ("This is a test" was heard often during analysis). Children, heard working with adults or other children, created almost half of the stories containing audio. In contrast to sound testing by adults, children typically recorded themselves singing or narrating.

Throughout our 3-year investigation, we continued to see consistently high amounts of multimedia used in shared stories, and the ratios for most media was similar for all devices, with one exception (Figure 11). The number of stories containing drawings/paintings is much higher in iPads than other device-types. We suspect that the larger screen size of the iPads supports "finger" painting more readily than iPods and iPhones can.

5.4. Interviews

During our pilot study, initial open coding of user interviews revealed correspondence with Klopfer et al.'s [2002] proposed five properties unique to mobile devices: Portability, Social Interactivity, Context Sensitivity, Connectivity, and Individuality. Through ongoing analysis of the interviews over the 3-year study, we found that StoryKit's simple, but integrated interface supported not only all of the affordances that mobile devices provide as outlined by Klopfer et al. [2002], it also supported many literacy-based activities that children engage in when telling stories [Franckel et al. 2010]. The following sections divide our interview findings according to:

— the ways in which StoryKit integrates all the affordances of the mobile device [Klopfer et al. 2002];

Table VII. Interviewee/User Perspectives, framed by Properties of Mobile Devices

Theme / Category [Klopfer et al. 2002]	Interviewee Perspectives
Social Interactivity – Collaboration and data exchange with others can happen face-to-face	*It's a really nice tool to get kids to... interact with each other, and with their adults... The whole family can sit around and take turns... I like that it can be passed around.* *You can just see right there—two little girls just bonding—from sharing their experiences. [referring to two girls working together on a story during the field session, taking turns to narrate.]*
Portability – Movement across sites and within sites is possible due to small form factor	*For such a small device, where you don't have to have your laptop and you don't have to have a big camera, you can create a nice story that involves the whole family.* *It's sort of magical for me – It's a very unique way of way of writing – you can take it anywhere.*
Connectivity – Shared environments can be created by connecting to other mobile devices or a common network	*When you're done, not only do you have it, but... it's something that you can send out to other members of your family or friends.* *StoryKit is one of the few apps that you can e-mail, so for assignments you can e-mail their teacher a copy.*
Context Sensitivity – Data collection unique to the current location, environment, and time is possible; Response to data (real or simulated)	*Especially the audio part – you could, when you're right there, with the horses, you could record what you see, what you hear... that's a real nice feature.* *That's the sound of the milk hitting the bucket...*
Individuality – Scaffolding for different (or difficult) activities can be customized for individual learners	*Y'know, [one child] may be co-directing, and maybe [another child] is shooting and then both their visions, kind of come together, in the end. With different personalities in the family, it's like they have different strengths, there are different ways to bring them to bear.* *As a special ed teacher, StoryKit is an app that I would use a lot, because it touches all the modalities. When you're working with children with special needs, that's what you need to have... because it has audio and the visual and they can draw things. What ends up happening is—they can finally share what they know, that they couldn't just do through text.*

— the ways in which StoryKit's integrated features support shared storytelling and as well as teacher training;
— the ways in which StoryKit supports children's efforts to engage in literacy practices, such as oral storytelling and learning to revise.

5.4.1. StoryKit Enables Integrated Use of Mobile Device Features/Affordances. Excerpts from our interviews reflect that all of the categories specified by Klopfer et al. [2002] were supported by StoryKit's design (Table VII). In the case of portability and connectivity alone, the indicators are relatively unsurprising, as these features are supported inherently by most mobile devices, and are not unique to applications loaded onto them. For example, StoryKit enabled story creation anywhere users traveled, largely due to the mobility afforded by the handheld devices themselves. Sharing stories remotely, and connecting with online photo galleries to add images, are also supported by the handset and availability of wireless services. Taken together, however, the portability and connectivity inherent in mobiles, coupled with the act of combining media to tell a story, suggested more complex interaction effects for users than Klopfer's categories could describe. Rather than being a separate affordance limited to face-to-face situations only, feelings of social interactivity were more often a *result* of the mobility of the device coupled with the story creation features of StoryKit. In storytelling/

story-sharing, an increase in social interactivity becomes a goal, rather than a single affordance.

StoryKit enhanced the storytelling experience by supporting social interaction in ways that extended the basic data exchange proposed by Klopfer et al. [2002]. Often, it elicited a sense of poignancy. As the grandparent participants observed during their collaborative efforts with their grandchildren.

> It felt, like it was a bonding time. Maybe he doesn't understand the feeling, but he seemed like he was really bonding with me, learning what I had to say... and then [showing] me how to manipulate the [interface] to do certain things... There wasn't anything too difficult for us to do together.

> She [child] was sitting there in the chair with Dave [grandparent] and he was editing... They were just going back and forth and ... it [was] mesmerizing to see them do all those things.

The small form factor, touch interface, and audio-record feature encouraged participants to collaborate more fluidly than desktop tools allow. During the field session, story partners were observed passing the mobile around and taking turns to build their narratives. Our interviews with users "from the wild", particularly teachers, corroborated this finding. During early StoryKit design sessions, a decision was made to let users capture multiple, short (1 minute) audio clips per page, versus allowing for one arbitrarily long recording. This approach proved not only satisfactory to the field use participants, but also added an element of fun, and encouraged playful interaction among family members.

> It's kind of fun to have a time limit—you could pass it around—to see how much information you could give in two minutes... before you have to change hands... like a round-robin game [laughs].

StoryKit's short audio capture effectively mirrored the intermittent, stop-action play that was characteristic of the children's field-day activities, and child's play in general.

In the classroom, teachers found that the portable mobile device and StoryKit interface gave them an opportunity to work through social issues (with 2nd–3rd year primary students).

> One spontaneous thing came out of StoryKit that wasn't just sort of class-oriented. Some of my girls were having a lot of social trouble. We called in a counselor, too. Then I said, well maybe you could take pictures of each other and write why somebody's a good friend—just an idea of what they could do to help solve that little social problem. They took right off with it. They said, "That's a great idea," and they all used [StoryKit] together, which brought them together, and they took turns, so there was compromise there. They wrote what a good friend was, and what they would expect. We took something that was really fun for them [playing with the iPad] and they almost solved the problem completely by coming together to use StoryKit, and now they have this finished product that they made together.

A school's technology director described how the portability of the iPad and StoryKit's intuitive interface (specifically the audio recording), influenced children to collaborate on their stories more readily than they might have with other composition tools.

> I watched a group of 2nd graders as they figured out the audio embed feature. At first, they were narrating their own drawings. One boy had written a story that had a boy and a girl in it. He asked the girl next to him

> to narrate the girl's part. Next thing you know, the whole class is collaborating on each other's stories, providing voices and characters without being prompted. It was a really cool thing to watch. I suppose there are a few other apps that could have had the same effect, but... I think the portability and ease of use and form factor of the iPad, and the easy interface of StoryKit, really make it the ideal multimedia platform for collaboration, especially with really young children.

The mobile StoryKit interface promoted Context Sensitivity, Social Interactivity and Individuality as well. Context sensitive features, such as location-based data, are widely available on most mobile devices [Schmidt et al. 1999]; however, the focus is typically on physical externals. Few mobile applications afford users an opportunity to capture context-sensitive information that supports personal, creative expression. StoryKit's audio-recording feature allows users to capture specific commentary and ambient sounds that can enhance the contextual experience of a story. During the all-day field session, Kidsteam children especially enjoyed recording animals, and even the sound of milk hitting a bucket during a cow-milking activity (Table VII). Aural context sensitivity for capturing and recalling memories affected the ways in which participants crafted their stories in positive ways. As one grandmother participant noted, "These [recordings] add a whole new facet to the storytelling." During one interview, a child participant described a story that he created about his brother's symphony rehearsal. A recording of the rehearsal, featuring sections in which his brother played, formed a core element of his story, and he emphasized how much he enjoyed replaying the experience with friends.

Personalization, or support for tailoring activities to individual users, is cited as one of the more popular affordances of mobile devices, particularly in learning contexts [Murray and Sloan 2008; Naismith et al. 2004; Shuler 2009]. StoryKit's interface also seemed successful in supporting individuality and diverse composition styles, especially special needs' students, as seen in comments excerpted in Table VII.

5.4.2. Emphasis on StoryKit as an Integrated, Flexible Mobile Authoring System. Repeatedly, our participants commented that despite its simple, intuitive interface, StoryKit integrated all of the media features that they wanted to create stories with their children and students, as the following interview excerpts show.

> The integrative function of it, being able to put the whole story—the words and the pictures together *right now* on the page. It was really cool.

> Our students can do everything they want to do once they open the app, from start to finish. They can draw; they can take a picture from inside the app. So it's not like you have to say, okay—first go to the camera; then, go to the photo gallery—they can do it all. I think the integrated design is a wonderful part of it all.

Two of our interview participants are education technology specialists who develop training workshops in which teachers earn professional certifications for technology tools that are used in their schools (such as iPads and associated learning apps). They emphasized that StoryKit not only helped them show teachers that the iPad could be used to foster creativity, it was also an effective tool for them to demonstrate most of the media capabilities of the device itself.

> One of the things we like to share with teachers is the way that iPads can be used in a creative way, and not just drill-and-practice, like some educational apps. We show teachers how to use the camera, how to take a screenshot, how to add photos, add text, record audio. When they create a story with

> StoryKit, it pulls in all of those objects, so it's a great way to show them how you can actually use the features of the iPad itself. The audio, the visual, they absolutely love it—and the kids love it.

Throughout our interviews, we tried to tease apart how much the affordances of mobile devices themselves attracted our growing user base, and how much might be attributed to StoryKit. In the end, most users felt the answer was that StoryKit integrates the multimedia capabilities inherent in mobile devices in ways that enhances the features of both. StoryKit implemented as many media tools that mobile devices offer, but situated them in a mobile authoring framework that was generic and flexible enough to be used in the myriad ways that users chose to appropriate it. Whether it was the subject area, or the configuration and number of iPads used in the classroom, teachers felt StoryKit could be used effectively.

> StoryKit is a really good app for any kind of implementation that is being done in the classroom—you can use it with students in a 1-to-1 classroom, in small groups, or just one iPad being passed around. In workshops with a science focus, we use StoryKit as a field journal to record scientific observations and images from the microscope. I always try to show teachers different ways of using it—for many other content areas than "just a story." StoryKit can be implemented in many situations to take advantage of the portability of the iPad.

5.4.3. StoryKit Supports Literacy Practices. In a survey of research on children's storytelling, Franckel et al. [2010] highlighted four ways in which the affordances of mobile devices complement and mirror activities that children engage in when learning to read and write (Column 1, Table VIII). They include the use of multimedia and especially audio, to support emergent literacy; a means for capturing children's stories in-context, as they play; and the importance of saving stories for children to review and revise. These affordances echo Klopfer et al.'s [2002], but emphasize the literacy activities that mobile storytelling can support, rather than outlining device-specific features. For example, many children engage in storytelling during "fantasy play" [Cassel and Ryokai 2001]. Teachers told us that children were able to capture their stories as they played, and this often encouraged students who did not see themselves as writers (Table VIII).

The value of conversational storytelling as an emergent literacy practice for children too young to create detailed texts was corroborated in both our interviews and our analysis of media content in shared stories. Several teachers pointed out that children who might have difficulty writing have little trouble verbally enacting a story. They used StoryKit to coax reluctant students to first craft stories verbally and then transition to writing, as they grew more confident in their abilities.

However, audio use to support the transition from oral storytelling to written texts also revealed a usability issue. While in record mode in StoryKit, the page being edited is hidden from view. The technical reason for this is that we used the standard iPhone recorder to implement the audio function, and it uses a full-screen interface. This meant that children who are just learning to read and write are not be able to see the page that they are working on while in record mode. For example, a media/technology teacher introduced her second year students to using adjectives by devising a project in which they narrated a descriptive composition about artwork they had incorporated into their stories. She told us that the children were very engaged in trying to accurately describe their characters, but that "it is a bit hard for them to describe the art when they can't see it."

The importance of audio in stories was even more pronounced for children with special needs. Children who are non-verbal, or have limited verbal abilities, still respond to verbal cues from their parents, friends and teachers. Many of these children learn to use assistive augmented communication tools that will convert text, or pictures of objects, into speech to help them communicate. Most of these systems—mobile apps included—use text to speech synthesizers rather than recorded voice. In contrast, StoryKit's audio recording capability was a feature that parents of children with special needs appreciated. These parents consistently told us that StoryKit's audio-recording tool was a major reason they used StoryKit with their children, in addition to (and often instead of) other assistive and augmented communication technologies, as noted in the following interview excerpts.

> My 11-year old is verbal and can do most stories with little help. Being able to record her own voice is great because she has a backup in case she stammers or is nervous during a class presentation. It is useful for her nonverbal 4-year old sister to hear her sister's child voice in a story rather than a synthesized voice. This is why we went with your app rather than the recorded voice in Pictello.

Storytelling research has shown that integrated multimedia in authoring applications supports children's needs to communicate in multiple, combined modes when expressing their ideas [Franckel et al. 2010]. In mobile interaction design, multimodality typically refers to the multiple modes by which a user can interact with a mobile device (e.g., gesture/touch, voice, keyboard input). Similarly, in literacy studies, multimodality refers to the concept that no shared communication exists in a single mode, such as a written text alone [Kress 1996]. That is, "multimodal communication" includes multiple media by default, and focuses on the ways in which a multimedia message is presented or interpreted [Nigay and Coutaz 1993].

An e-mail may contain various media elements that make it multimedia, but users interpret their meaning multimodally, as a holistic message. Another example is in the way that award-winning picture books place equal value on text and image to convey their narrative meaning [Bederson et al. 2009]. As children learn to combine media to craft richer, more expressive stories, they are gaining multimodal literacy. Our teacher participants commented that their students learned to use sounds to augment the text of their stories, not just repeat the words on the page (Table VIII).

Our interviews showed that StoryKit's shared story capability was useful in terms of literacy development. A digital repository of their creations that could be shared and revisited was important to teachers, parents, and children alike (Table VIII). For teachers, the shared stories could become an assessment tool as well as a means for reporting activity and progress to parents.

> I use the shared stories as part of my progress reporting to parents and classroom teachers.

> Having the shared story helps us to see—Do they really understand? It's kind of a checking point for us to see if they were able to explain a lesson in a way that was like telling a story to somebody else.

For parents of children with special needs, having a record of routines and social events was important for communication.

> We are always on the lookout for things that help us communicate with our children. I'm not sure if "normal" parents would be looking for things like StoryKit, but I've always been making photo books to share because it's such an important part of our communication with our kids who can't speak.

Table VIII. Interview Perspectives, Framed by Children's Storytelling and Literacy Activities

Theme [Franckel et al. 2010]	Interviewee Perspectives (most are teachers)
Context Sensitivity and Support for imaginary play Children bridge imaginary and physical worlds via their stories; StoryKit's portability and multimedia-equipped interface supports this behavior.	*I loved how it evolved. They were building with Legos and creating people and ships and scenes. And then, they were taking pictures and writing the stories around it. What was amazing was that the boys got really into it, and my boys weren't writers. I felt that, because the Legos were hands-on, that took away the whole idea of having to come up with a plot line, and characters and sequence, because it was physical. They'd start with: Here's the Lego guy, here's the ship, and that's the planet. It was concrete, and they were able to use StoryKit to document it.*
A need for multimedia and multimodal communication Storytelling is multimodal, and so are children; StoryKit supports both. "Multimodal communication" includes multiple media, but emphasizes the ways that authors present and interpret multimedia messages as a whole.	*In the beginning, they used sound almost to repeat the text, but then they started to use sound to enhance the text. So, their text might say, "he walked into the room and looked surprised." But their audio would say, "Oh my god, why is that there?!" [laughs] The sounds would be different, and would add to the story. So it was just really fun to watch.* *Maybe they are starting to understand revision and writing as a craft. We'd talk about their stories—not critique them, but ask, "What did you think; what are you trying to say?" So, they started to get a feel for their audience—which is what you want them to get in writing.*
Importance of Audio Children naturally engage in conversational storytelling; StoryKit supports oral storytelling and encourages reluctant readers/writers to participate more readily.	*The younger kids know what they want to say, but maybe they can't spell the words, or they're not really sure how to write them properly. So, rather than muck up a piece of paper and have a teacher make corrections so that it looks terrible to them, they just write the least possible. But—they loved recording stories. I couldn't get over how articulate the kids were – and excited about their stories.*
Memory/composition archive Children need tools that enable them to save and share stories as they create them. StoryKit can support this need.	*StoryKit has enabled my daughters to share their news at school and pre-school, and also have a story about themselves that they can read over and over again.* *A lot of times– even me, as a photographer – you have ALL these photos, but to actually put them together in something that makes sense or is easy to share, it's a lot. [StoryKit] gives you an end-product in mind. Instead of just taking a bunch of pictures, then having to go back and rearrange them. . . You have them already there, with your mind already thinking on the story.*

5.5. Genre Analysis

During the pilot study (Sep. 2009—Jan. 2010), genre analysis reflected that more educators were using StoryKit than initially expected, in a wide variety of subject areas. Based on this finding, context was included as a distinct code in the content analysis conducted for the shared stories posted from 2010–2012 (Appendix C, Figure C.2). Overall, about 58% of shared stories are being created in formal education settings. Device metadata logged with the shared stories were used to help determine whether devices were classroom assets or not (e.g., system name="*XX Library iPod#6*" or system name="*xxxSchool iPad T7863*" versus system name="*Mary's iPod*"). Notably, 75% of iPod-based stories and 45% of iPad-based stories were identified as being created in a formal education context during 2010–2012.

As content characteristics were analyzed, narrative devices typical of US curriculum language arts genres were noted [Fink 2009]. Several stories contained animals that talked or wore clothes—they possessed human characteristics—classic traits of the fairy/folktale (Figure 12). Fairytales and fantasies included tales about stuffed animals that go on quests, an aircraft carrier defying terrorists, superheroes, vampires, and zebras in search of the perfect ice cream. One science fiction fantasy, about a boy

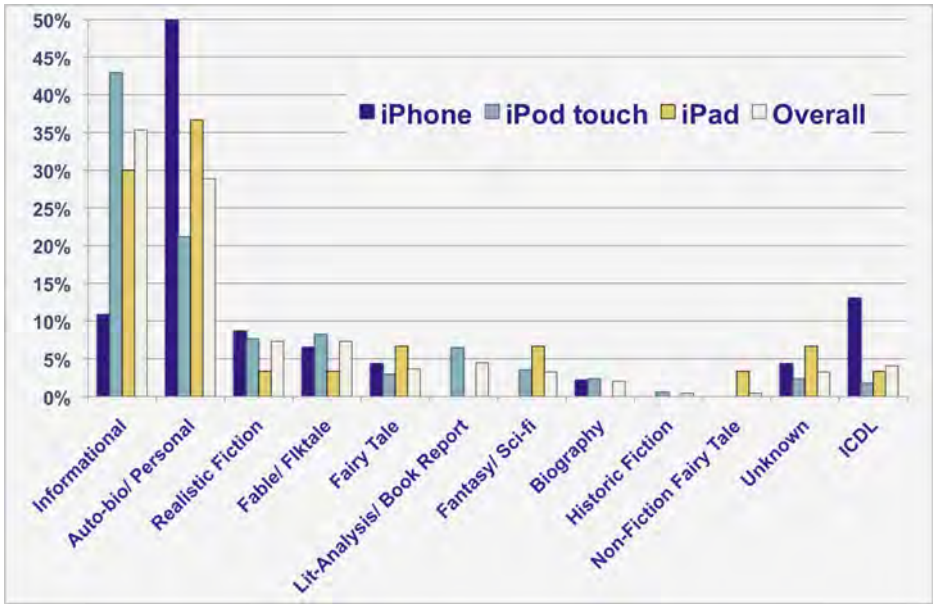

Fig. 12. Major Subgeners detected in the 2010–2012 sample of shared stories.

with super powers, was composed of almost 1900 words on one page. Perhaps unsurprisingly, children created most of these stories (determined by audio).

Informational stories represented almost 45% of the stories analyzed (Figure 12). Most of these stories were created in formal education contexts. These stories were photo-journalistic and documentary-like in nature, covering diverse topics such as science reports, math exercises and visualizations (e.g., parametric equations and associated graphs), youth violence, religion, and language learning (e.g., bi-lingual stories with vocabulary practice). Indeed, over the long duration of our study, the informational stories subset showed us that our collection's diversity could be more accurately represented with another level of coding for that subset, to highlight all the subject areas in which teachers were appropriating StoryKit. Our genre analysis represented education topic areas biographies and book reports well, but topics that fell under the "informational" umbrella remained hidden.

About 5% of the stories were tests of the application itself, containing random typing and squiggle-drawings. Based on feedback from some of our interviewees, users may have also been testing StoryKit's "Share" feature by sharing an ICDL sample storybook (4%) as opposed to an original work. Only a small percentage modified ("remixed") the ICDL sample stories with photos, drawings or audio narration (3% of ICDL stories shared) before sharing.

About half of the stories were personal or family-oriented narratives (Figure 12). Adults created most of these stories, but some were created in classrooms (∼20%). Each story typically contained photos of children, with short captions describing the context. About one-third of the auto-biographical/personal stories contained recordings, with a balance of audio performed by adults or children (or both). Sounds and images from this subset showed that stories could be created in a car, a child's room, or on a neighbor's porch—in short, they capitalized on mobility. The diversity of genres and media use represented within the corpus punctuated the expressive power enabled by StoryKit's integrated design.

6. SUMMARY OF IMPLICATIONS FOR DESIGN AND LITERACY EDUCATION

In this section, we summarize our lessons learned, in terms of implications for literacy education, and for designers/researchers who are considering similar studies.

6.1. Implications for System Designers/Evaluators

The following are design considerations for "in the wild" deployments of mobile tools that support creative expression by a diverse population of users, especially children. We include classic concerns about the scalability and sustainability of "in the wild" studies [Carter and Mankoff 2005; Froehlich et al. 2007; Rogers 2011].

Combine Automatic Tracing Tools (e.g., Web Analytics) with Qualitative Content Analysis. This recommendation is not new; however, researchers may be able to draw upon our StoryKit design rationale, participatory methods, and multimethod data collection and analysis format when building and studying similar mobile toolsets. We took advantage of a public distribution mechanism and automated, unobtrusive collection of user interaction data for studying how our design worked "in the wild." Platform adoption trends (e.g., increased use of iPads in classrooms) and literacy practices (e.g., emphasis on audio) were revealed with a combination of quantitative usage statistics and qualitative content analysis.

We analyzed diverse sources of data not only to help triangulate and corroborate our findings using a classic mixed-methods approach. We were also able to use the quantitative, digital traces from web analytics and system logs to guide our long-term content analysis, interview process, and improve our e-mail correspondence with users. For example, our web analytics and log metadata highlighted an increase in the number of iPad users composing with StoryKit, including the ways in which their use reflected academic schedules. As a result, we used log data from the shared stories repository to expand our random sample selection of stories that we qualitatively categorized and to confirm the number and types of stories that were being created in education contexts. Similarly, our metadata logs reflected much higher use of photos and audio in iPod-based stories than we expected, given our design sessions and field trial. We used this data to query users about the ways in which they were incorporating photos and audio in iPods before such features were native to these devices.

The web analytics informed our understanding of StoryKit user geography (Where is it being used?); platform types (iPad, iPod, iPhone); user engagement trends (e.g., How long are they composing stories? Do they return?); and features used (How often is the live camera used versus the photo gallery or drawing"). Our content analysis informed our understanding of how users were appropriating StoryKit as a tool for creative expression, as well as indicating the application's expressive power. In addition, most of our interviews were initiated through our open help desk correspondence with users. In these ways, we were able to balance scalability concerns while minimizing user impact and maintaining user privacy.

However, the relative ease with which we were able to scale "in the wild" data collection and analysis was offset by the amount of support users asked of us because we deployed StoryKit in a public venue. Moreover, we manually analyzed the shared story content. It would be worthwhile for future projects to consider how to include integrated analysis or self-categorization tools to make content analysis more scalable and semi-automated. We recognize that this is difficult as any coding scheme is unlikely to be complete before deployment. Consequently, coding schemes should be able to be modified dynamically after deployment.

Consider the Pros and Cons of Implementing Predefined User Surveys and Prompts [e.g., Froehlich et al. 2007] Versus Allowing More Open-Ended Communication

Channels with Users. Although we benefited from a lengthy co-design process and successful field trial, we remained uncertain about the types of use cases we might encounter prior to StoryKit's public launch. Therefore, we opted to offer users relatively open, generic support channels (e.g., a StoryKit support e-mail, existing ICDL-hosted help form and online forum), rather than embedding pre-defined, and potentially narrowly scoped survey prompts into StoryKit. This design decision not only relieved us of the difficulty of designing for use cases not yet known, it also serendipitously afforded us opportunities to cultivate highly positive relationships with users. These personal interactions have enriched our understanding of the challenges educators face as they try to incorporate new technology into their classrooms, and given us insights into design requirements for mobile authoring tools in learning environments for children.

We fielded many requests for technical support and new features that were not part of our original research objectives. The level of effort required to maintain these connections, as well as a high level of responsive service is high for a small academic research team. Ultimately, we felt that the time and resources spent were well worth it because we gained an increased understanding of our diverse user base of educators, families, and children. The feature requests we received expanded the ways in which we had envisioned that families would use StoryKit. Our open-ended "in the wild" support channel yielded use case categories that we may now use to develop more comprehensive embedded user surveys. However, the free form, voluntary nature of the existing user feedback may attract users who do not accurately or comprehensively represent the overall StoryKit user base, and neglect users who opt not to initiate queries. Web analytics and shared stories metadata can offset this limitation.

In addition to the technical support requests we received from users via our generic support channels, we enjoyed word-of-mouth advantages of "in the wild" public distribution. McMillan et al. [2010] found that "an unanticipated but welcome benefit to [public] distribution is free advertising . . . beyond our own announcements of the trial, e.g. in interviewing one of Yoshi's users, we learnt that she first heard of the game in a review in an Italian technology blog. In releasing a research prototype through a public marketplace, we harness some of the enthusiasm of amateur and professional writers who regularly scour the store for new applications to try and discuss" [p. 215]. Our experience corroborates McMillan et al.'s "in the wild" finding. We ourselves have used the products of avid StoryKit fans to help respond to queries from other StoryKit users (e.g., their YouTube tutorials and blog posts). Indeed, a generalized benefit of publicly distributing research prototypes and products "in the wild" is large scale, free advertizing and opportunities to recruit users outside traditional research venues for more authentic evaluations. This is especially true as society worldwide is growing more "prosumer" and "do-it-yourself" (DIY) producer-minded, as noted in our introduction.

Acknowledge and Accommodate the Tension Between Supporting User Privacy and User Community, Especially in Mobile Application Designs for Children. Our experience working with children has sensitized us to privacy concerns regarding their mobile application use. To ensure privacy for our users, we chose not to implement more open story- sharing or story community features. There has been an increasing interest in revising and enforcing policies that ensure children's privacy during mobile application use [FTC 2012; Mohapatra and Hasty 2012]. Our e-mail support system has become a design-idea forum and repository for social media-inspired feature requests from users, as well as a record of user opinions on topics such as user privacy.

A few schools (private and public) have shared their perspectives and concerns about the story-sharing process. Some have also requested confirmation that their stories will not be accessible by anyone outside their community, while others are concerned that their students' and teachers' intellectual property may be compromised.

On the other hand, we also heard significant requests for more open-access community bookshelves that can be shared between schools. We have followed a conservative path to date to avoid violating the privacy expectations of some for the sharing benefit of others. However, we believe that future designers of mobile applications for children must balance these competing needs.

Be Aware of Infrastructure Requirements for "in the Wild" Studies, Especially of Mobile Authoring Toolsets that Support Archiving and Sharing of Users' Creative Artifacts. Designers of mobile authoring apps that allow users to archive their creations must consider the infrastructure required to support this. Dedicated StoryKit users not only expect us to maintain the server to which their shared stories are uploaded and stored, but they also expect their shared story collection to be maintained in perpetuity. We have already had to adjust our server storage allocations and shared story-tracking mechanisms to accommodate the rapidly growing collection. As noted above, users have made useful suggestions about establishing shared community "bookshelves" (e.g., schools sharing their collections with other schools), but these require additional resources that limited research funding cannot always accommodate, despite the potential benefits and our desire to do so.

Existing Web Analytics Tools Remain Limited in Terms of Flexibility and International Distribution. While this is not a novel "in the wild" design implication, it is worth mentioning that the web analytics-based tools we employed do not always keep pace with rapidly changing mobile technologies. Over the course of our 3-year study, new hardware platforms were launched (e.g., iPad, 3rd–4th generation iPods) and StoryKit was installed over several generations of mobile operating systems. One negative consequence of this rapidly evolving environment was that Google Analytics™could not accurately report platform trends (e.g., errors in iPad numbers). Instead, we relied upon the shared stories subset of the entire StoryKit user base. This limitation also made it more difficult to discern geographically distributed mobile platform trends. Differences in countries whose academic schedules differ from the U.S. calendar year could not be extracted for more refined comparison, because our shared story metadata logs do not store user location data to protect user privacy.

Attend to "Lab-Wild Divergences" [Rogers 2011] for Opportunities to Improve Existing Designs and/or Initiate Future Research into New Domains. Genre analysis and user comments revealed that StoryKit is used extensively in contexts for which it was not originally intended. We confirmed that families are using StoryKit to capture and share family events, but its appropriation by educators has highlighted its flexibility in covering topics and formats we had not considered during design sessions. These data "*from* the wild" offer an avenue of additional research and continued connections to our users "in the wild," not just those users we invite to our labs.

Perhaps most encouragingly to us as designers, we found that a design that was meant to accommodate individuals at the ends of an intergenerational spectrum is also supporting children with special needs, who are too often treated as being at the margins of society. Our study offers empirical evidence that Universal Design and Universal Design for Learning (UDL) principles can and should be applied from initial design sessions and beyond ["CAST: About UDL"; "Ronald L. Mace"].

In their design and evaluation of Lillypad, a mobile learning device to support scientific inquiry, Rogers et al. [2007] asserted that the design improvements they achieved would not have been possible using only initial user testing: their in situ setting revealed many usability and user experience issues that early lab tests never exposed. Similarly, had we ended our StoryKit study with only the data from our field trial, we would have had a completely different understanding of the ways in which

individuals might want to experience mobile storytelling. We would have missed its value and potential as a scaffold for literacy or a social support for children with special learning needs.

Rogers et al. [2007] also emphasized how short video vignettes culled from within their in situ study "[sensitized them] to how the Lillypad would (rather than should) be used in practice" [p. 351]. We also discovered user experience richness in the small stories that grew from big data. Because of our long-term, mixed-method study using public distribution channels, users shared experiences that would be improbable to acquire in lab settings. In our one day field trial, we could not have learned about the way in which StoryKit helped a group of 2nd grade girls resolve a social issue, or helped the autistic girl who had written and shared over 600 stories with her father, or highlighted the way in which users devised work-around solutions so that they could create stories with multiple media, even if their particular devices did not come natively equipped to do so. In situ anecdotes like these sensitized us to more effectively respond to the user experience question of how people want to engage in personal, creative expression with mobile technologies. As noted by Rotman et al. [2012], the inclusion of qualitative data sources that "go beyond the obvious traces that users and institutions leave through their online interaction" [p. 208] gives a voice to users that is not possible otherwise.

6.2. Implications for Literacy Practices

Many educators are using StoryKit to promote creative composition and personalized learning in the classroom. Their efforts can provide insight for future curricular designers. Beyond these implications, our study provides a compelling look at the long-term adoption and appropriation of mobile technologies in learning contexts, beyond short-term, small-scale pilot studies [Reid and Ostashewski 2011; Shah 2011].

The Types of Stories Possible within Mobile Storytelling Applications like Storykit are as Diverse as the Individual Authors Themselves. StoryKit users are constructing narratives ranging from the everyday to funny and fanciful. Even the shortest stories by children revealed an unexpected level of individuality. Though some classroom-based shared stories used the same stock images imported from photo galleries that teachers made, the ways in which children used them were diverse. For example, one class created several stories on the life cycles of igneous rocks. This standard natural science topic resulted in very different stories from individual students. Each child covered all the cycles of change that igneous rocks undergo, but they also anthropomorphized their subjects in such a way that each rock's life cycle was a different life adventure.

These findings indicate that *storytelling and literacy practices need not be limited to language arts themes*. Classroom texts showcased the versatility of StoryKit's interface to engage students in multiple subject areas. Repeatedly, the educators we interviewed told us that StoryKit's simplicity and flexibility allowed them to tailor its use to for many different learning contexts and topics.

High Multimedia Media Use Confirms that the Nature of Narrative Has Changed. The shared stories, whether created by child or adult, strengthen the popular notion that 21st century content-creators do not see narrative as text-based only; rather, they view narrative as a multimedia enterprise. Most authors took advantage of all the media tools that StoryKit offers. Very few stories existed in a single mode, and images were present in nearly every story ($\sim$96%). About 90% paired image with text and 13% contained all media types (audio, text, drawings, photos).

Audio is an Effective Tool for Educators and Families to Engage Preliterate Children in Literacy Practices. In classroom contexts, the types of stories with sound indicated

that teachers use the audio tool in StoryKit as a first step in composition and vocabulary. Our interviews confirmed StoryKit's value in supporting the need for audio in stories created by early readers and writers. Educators have a long tradition of using oral storytelling to support children as they begin to read and write. With StoryKit, they now have a means to motivate and reinforce these efforts in personalized ways.

StoryKit's Audio Tool Has Been a Boon for Children with Special Needs, and the Adults who Support Their Development. The power of StoryKit's audio for children with special needs, so often relegated to text-to-speech systems that use synthesized speech, was also confirmed by our interviews. These systems, along with newer mobile applications enable nonverbal children to communicate independently, and are necessary and useful tools. However, parents emphasized that their children were often more responsive and focused when they were able to hear the voices of their parents and siblings as they practiced common words and reviewed social skills.

Digital Artifacts Enable Reflection, Revision, and the Development of Writing as a Craft (StoryKit as Literacy Toolkit). The number of edits logged for even the shortest stories offer compelling contradictory evidence to popular conceptions that school-aged children care little about the way their stories are presented. Our metadata for shared stories reflected that users revised their stories as many as 697 times (one 138-page story), with an average of 20 revisions per 6-page book. Our interviews with teachers indicated that, over time, as they revisited their saved and shared narrative artifacts, many children began to consider their audience as they composed stories. They used audio not only for narration of written text, but as a meaningful enhancement to a story. They began to use the multimedia features of StoryKit in more richly expressive (multimodal) ways, achieving the goals of many common literacy standards and frameworks.

7. CONCLUSION

Through a series of participatory design sessions, field evaluation, interaction logs, artifact analysis, and interviews, our study explored the use of StoryKit, initially with a team of co-designers, and finally over an extended timeframe, "in the wild." Our goal was to provide an in-depth description of how StoryKit's design influenced the types of stories that authors shared, and the literacy practices they engaged in. Our findings suggest that a simple, integrated, mobile storytelling interface enables children to easily and enjoyably capture their personalized impressions about the world around them. Native interaction mechanisms supported by mobile devices in general, coupled with the StoryKit interface in particular, inspired a collaborative creative process and enriched storytelling experiences for users of all ages.

With a growing number of schools using iPods and iPads in the classroom, we saw StoryKit use "in the wild" grow to levels that we never anticipated during our design sessions and field test. Despite the relatively generic description of StoryKit in the iTunes® App Store, educators were quick to use StoryKit in many different subject areas and at all age levels. Despite a lack of commercial advertising, StoryKit's intuitive interface, its integration of all the media features available in most generations of iOS devices (except video), and its free availability encouraged a wide word-of-mouth distribution and level of use that happened organically. As the parent of a child with ASD told us, "StoryKit is certainly one of the apps that I share with my friends." An educator who uses StoryKit in teacher-training workshops concluded: "StoryKit is so useful across so many grade levels and so many disciplines. It's really one of our go-to apps."

The stories children create when engaged in play with toys and friends are ephemeral; yet, capturing their creations is important, from two perspectives. First, in Papert's [1993] constructionist tradition, children can learn language, social skills and creativity through building an artifact, in this case, a shared story. Our study shows that StoryKit is, in effect, a narrative construction kit for children. Second, the shared stories can become an important repository for preserving family memories: "The mere fact that the memories and nostalgia are recovered is reason enough to have it be of interest" (grandfather participant).

In her review of the evolution of children's literature from oral tradition to print to today's digital environments, Madej [2003] noted, "It has taken time for narrative to develop the depth of its form and meaning within each new medium." So it is for the stories whose creation and distribution is supported with emergent mobile authoring tools such as StoryKit. However, by harnessing properties unique to mobiles in an integrated, personal expression interface, StoryKit enabled users to transcend the stationary desktop model of authoring systems, and create a rich repository of experiences, from the mundane to monumental, lived experiences to imaginary tales.

A video summarizing the "Stories behind StoryKit", which includes background on the design process, overall usage statistics, and user feedback is available from the following URL: http://www.youtube.com/watch?v=IEkNHWLV0hU, or at the StoryKit FAQ page on the ICDL website, http://iphone.childrenslibrary.org/.

ELECTRONIC APPENDIX

The electronic appendices for this article can be accessed in the ACM Digital Library.

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REFERENCES

Bailey, B., Tettegah, S., and Bradley, T. 2006. Clover: Connecting technology and character education using personally-constructed animated vignettes. *Interact. Comput. 18*, 4, 793–819.

Banister, S. 2010. Integrating the iPod Touch in K–12 education: Visions and vices. *Comput. Schools 27*, 2, 121–131. DOI:10.1080/07380561003801590.

Barone, D. M. 2004. Case-study research. In *Literacy Research Methodologies*. Guilford Press, New York, 7–27.

Barthes, R. and Lionel, D. 1975. An introduction to the structural analysis of narrative. *New Literary History 6*, 2, 237–272.

Bartlett, J. E., II, Kotrlik, J. W., and Higgins, C. C. 2001. Organizational research: Determining appropriate sample size in survey research. *Inf. Tech. Learn. Perf. J. 19*, 1, 43–50.

Bauer, M. W. 2000. Classical content analysis: A review. In *Qualitative Researching with Text, Image, and Sound.* Sage Publications, London, 131–151.

Bederson, B. B., Quinn, A., and Druin, A. 2009. Designing the reading experience for scanned multi-lingual picture books on mobile phones. In *Proceedings of the 9th ACM/IEEE-CS Joint Conference on Digital Libraries*. ACM, New York, 304–308.

Boeije, H. 2002. A purposeful approach to the constant comparative method in the analysis of qualitative interviews. *Qual. Quant. 36*, 4, 391–409.

Bonsignore, E. 2011. Sharing stories "in the wild": A mobile storytelling case study. In *Proceedings of the Annual Conference Extended Abstracts on Human Factors in Computing Systems*. ACM, New York, 917–922.

Carter, S. and Mankoff, J. 2005. Prototypes in the wild: Lessons from three ubicomp systems. *IEEE Pervas. Comput. 4*, 4, 51–57.

CAST: About UDL. CAST (Center for Applied Special Technology). http://www.cast.org/udl/.

Cassell, J. and Ryokai, K. 2001. Making space for voice: Technologies to support children's fantasy and storytelling. *Pers. Ubiquit. Comput. 5*, 3, 169–190.

Charmaz, K. 2005. Grounded theory in the 21st century: Applications for advancing social justice studies. In *The Sage Handbook of Qualitative Research* 3rd Ed. Sage Publications, Thousand Oaks, CA, 507–535.

Children's Online Privacy Protection Act of 1998 (COPPA). 1998. Pub. L. 112-123, §§6501–6506, 15 U.S.C. Chapter 91.

Ching, D., Shuler, C., Lewis, A., and Levine, M. H. 2009. Harnessing the potential of mobile technologies for children and learning. In *Mobile Technology for Children*, A. Druin Ed., Morgan Kaufmann, 23–42.

Clegg, T., Bonsignore, E., Yip, J. C., Gelderblom, H., Kuhn, A., Valenstein, T., and Druin, A. 2012. Technology for promoting scientific practice and personal meaning in life-relevant learning. In *Proceedings of the 11th International Conference on Interaction Design and Children (IDC'12)*. ACM, 152–161.

Corbin, J. and Strauss, A. 2008. *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory* 3rd Ed., Sage, Thousand Oaks, CA.

Crabtree, A., Benford, S., Greenhalgh, C., Tennent, P., Chalmers, M., and Brown, B. 2006. Supporting ethnographic studies of ubiquitous computing in the wild. In *Proceedings of the 6th Conference on Designing Interactive Systems (DIS'06)*. ACM, 60–69.

Creative Research Systems. 2012. Sample size calculator. Creative Research Systems, Petaluma, CA. http://www.surveysystem.com/sscalc.htm.

Druin, A. 1999. Cooperative inquiry. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI'99)*. ACM, 592–599.

Druin, A. 2005. What children can teach us: Developing digital libraries for children with children. *Lib. Quart. 75*, 1, 20–41.

Druin, A. Ed. 2009. *Mobile Technology for Children: Designing for Interaction and Learning*. Morgan Kaufmann.

Druin, A., Weeks, A., Massey, S., and Bederson, B. B. 2007. Children's interests and concerns when using the international children's digital library: A four-country case study. In *Proceedings of the 7th ACM/IEEE-CS Joint Conference on Digital Libraries*. ACM, 167–176.

Druin, A., Bederson, B. B., and Quinn, A. 2009. Designing intergenerational mobile storytelling. In *Proceedings of the 8th International Conference on Interaction Design and Children*. ACM, 325–328.

Dyson, A. H. and Genishi, C. 2005. *On the Case: Approaches to Language and Literacy Research*. Teachers College Press, New York.

Fails, J. A., Druin, A., and Guha, M. L. 2010. Mobile collaboration: Collaboratively reading and creating children's stories on mobile devices. In *Proceedings of the 9th International Conference on Interaction Design and Children*. ACM, 20–29.

Fails, J. A., Druin, A., and Guha, M. L. 2011. Content splitting and space sharing: Collaboratively reading and sharing children's stories on mobile devices. In *Proceedings of the 13th International Conference on Human Computer Interaction with Mobile Devices and Services*. ACM, 361–370.

Falaki, H., Mahajan, R., Kandula, S., Lymberopoulos, D., Govindan, R., and Estrin, D. 2010. Diversity in smartphone usage. In *Proceedings of the 8th International Conference on Mobile Systems, Applications, and Services*. ACM, 179–194.

Federal Trade Commission (FTC). 2012. FTC Strengthens Kids' Privacy, Gives Parents Greater Control over Their Information by Amending Children's Online Privacy Protection Rule. Federal Trade Commission (FTC). http://ftc.gov/opa/2012/12/coppa.shtm (Last accessed 12/12).

Fink, L. S. 2009. Genre study: A collaborative approach. readwritethink.org Classroom Resources Lesson Plans. http://www.readwritethink.org/classroom-resources/lesson-plans/genre-study-collaborative-approach-270.html?tab=3#tabs (Last accessed 12/09).

Fleiss, J. L., Levin, B., and Paik, M. C. 2004. The measurement of interrater agreement. In *Statistical Methods for Rates and Proportions*. John Wiley & Sons, Inc, 598–626.

Franckel, S., Bonsignore, E., and Druin, A. 2010. Designing for children's mobile storytelling. *Int. J. Mob. Hum.-Comput. Interact. 2*, 2, 19–36.

Froehlich, J., Chen, M. Y., Consolvo, S., Harrison, B., and Landay, J. A. 2007. MyExperience: A system for *in situ* tracing and capturing of user feedback on mobile phones. In *Proceedings of the 5th International Conference on Mobile Systems, Applications and Services*. ACM, 57–70.

Gillmor, D. 2004. *We the Media: Grassroots Journalism by the People, for the People* 1st Ed. O'Reilly, Sebastopol, CA.

Grossman, L. 2006. TIME Person of the Year: You. *Time 168*, 26, 38–41.

GSM ASSOCIATION (GSMA) and NTT DOCOMO. 2010. Children's use of mobile phones and personal relationships – an international comparison 2010 (Survey Study). GSM Association. http://www.gsma.com/myouth-supporting-documents/.

GSM ASSOCIATION (GSMA) and NTT DOCOMO. 2011. Children's use of mobile – an international comparison 2011 (Survey Study). GSM Association. http://www.gsma.com/myouth-supporting-documents/.

Gutnick, A. L., Robb, M., Takeuchi, L., and Kotler, J. 2010. *Always Connected: The New Digital Media Habits of Young Children*. The Joan Ganz Cooney Center at Sesame Workshop, New York.

Hansen, D. L., Schneiderman, B., and Smith, M. A. 2010. *Analyzing Social Media Networks with NodeXL: Insights from a Connected World*. Morgan Kaufmann, San Francisco, CA.

Hartnell-Young, E. and Vetere, F. 2008. A means of personalising learning: Incorporating old and new literacies in the curriculum with mobile phones. *Curricul. J. 19*, 4, 283–292.

Henze, N., Poppinga, B., and Boll, S. 2010. Experiments in the wild: Public evaluation of off-screen visualizations in the Android market. In *Proceedings of the 6th Nordic Conference on Human-Computer Interaction: Extending Boundaries (NordCHI'10)*. ACM, 675–678.

Herring, S. C., Scheidt, L. A., Bonus, S., and Wright, E. 2004. Bridging the gap: A genre analysis of weblogs. In *Proceedings of the 37th Annual Hawaii International Conference on System Sciences*. 101–111.

Huffaker, D. 2004. Spinning yarns around the digital fire: Storytelling and dialogue among youth on the internet. In *Information Technology in Childhood Education Annual (ITCE)*. EditLib, 63–75. http://www.editlib.org/p/5679.

Hutchinson, H., Mackay, W., Westerlund, B., Bederson, B. B., Druin, A., Plaisant, C., Beaudouin-Lafon, M., et al. 2003. Technology probes: Inspiring design for and with families. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. ACM, 17–24.

Hutchinson, H. B., Bederson, B. B., and Druin, A. 2006. The evolution of the International Children's Digital Library searching and browsing interface. In *Proceedings of the Conference on Interaction Design and Children*. ACM, 105–112.

International Data Corporation (IDC). 2011. IDC: More mobile internet users than wireline users in the U.S. by 2015. *Analyze the Future. IDC.* Press Release. http://www.idc.com/getdoc.jsp?containerId=prUS23028711.

International Data Corporation (IDC). 2012. Worldwide mobile phone market maintains its growth trajectory in the fourth quarter despite soft demand for feature phones, according to IDC. *Analyze the Future. IDC*. Press Release. http://www.idc.com/getdoc.jsp?containerId=prUS23297412.

Ivory, M. Y., and Hearst, M. A. 2001. The state of the art in automating usability evaluation of user interfaces. *ACM Comput. Surv. 33*, 4, 470–516.

Jenkins, H. 2006. *Convergence Culture: Where Old and New Media Collide*. New York University Press, New York.

Jensen, K. L. and Larsen, L. B. 2007. Evaluating the usefulness of mobile services based on captured usage data from longitudinal field trials. In *Proceedings of the 4th International Conference on Mobile Technology, Applications, and Systems and the 1st International Symposium on Computer Human Interaction in Mobile Technology*. ACM, 675–682.

Kelliher, A. 2004. Everyday cinema. In *Proceedings of the 1st ACM workshop on Story Representation, Mechanism and Context*. ACM, 59–62.

Klerfelt A. 2006. Cyberage narratives: Creative computing in after-school centres. *Childhood 13*, 2, 175–203.

Klopfer, E., Squire, K., and Jenkins, H. 2002. Environmental Detectives: PDAs as a window into a virtual simulated world. In *Proceedings of the IEEE International Workshop on Wireless and Mobile Technologies in Education*. 95–98.

Krapp, J. V. 2004. So many books: Genres of children's fiction. *School Library Media Activ. Month. 21*, 2, 44–45.

Kress, G. R. 1996. *Before Writing?: Rethinking the Paths to Literacy*. Routledge, New York.

Labbo, L. D. 1996. A semiotic analysis of young children's symbol making in a classroom computer center. *Read. Resear. Quart. 31*, 4, 356.

Landry, B. M. and Guzdial, M. 2006. iTell: Supporting retrospective storytelling with digital photos. In *Proceedings of the 6th Conference on Designing Interactive Systems*. ACM, 160–168.

Lenhart, A., Arafeh, S., Smith, A., and Macgill, A. R. 2008. Writing, technology, and teens. Pew Internet & American Life Project, National Commission on Writing. http://www.writingcommission.org/report.html.

Lenhart, A., Ling, R., Campbell, S., and Purcell, K. 2010. Teens and mobile phones. Pew Internet and American Life Project. Pew Research Center, Washington, DC, 114. http://pewinternet.org/Reports/2010/Teens-and-Mobile-Phones.aspx.

Lincoln, Y. and Guba, E. G. 1985. *Naturalistic Inquiry*. Sage Publications, Thousand Oaks, CA.

Mace, R. L.: Universal Design. College of design: Design.ncsu.edu. http://design.ncsu.edu/alumni-friends/alumni-profiles/ronald-mace.

Mackey, M. 2003. Researching new forms of literacy. *Read. Res. Quart. 38*, 3, 403–407.

Madej, K. 2003. Towards digital narrative for children: From education to entertainment, a historical perspective. *ACM Comput. Entertain. 1*, 1.

Makela, A., Giller, V., Tscheligi, M., and Sefelin, R. 2000. Joking, storytelling, artsharing, expressing affection: A field trial of how children and their social network communicate with digital images in leisure time. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. ACM, 548–555.

Marcus, G. E. 1995. Ethnography in/of the world system: The emergence of multi-sited ethnography. *Ann. Rev. Anthropol. 24*, 95–117.

McMillan, D., Morrison, A., Brown, O., Hall, M., and Chalmers, M. 2010. Further into the wild: Running worldwide trials of mobile systems. In *Pervasive Computing*, Lecture Notes in Computer Science, vol. 6030, 210–227.

Millen, D. R. 2000. Rapid ethnography: Time deepening strategies for HCI field research. In *Proceedings of the 3rd Conference on Designing Interactive Systems: Processes, Practices, Methods, and Techniques*. ACM, New York, 280–286.

Mohapatra, M. and Hasty, A. 2012. Mobile apps for kids: Disclosures still not making the grade. Federal Trade Commission, Washington, DC, USA, (FTC). http://ftc.gov/os/2012/12/121210mobilekidsappreport.pdf.

Murray, C. and Sloan, J. 2008. iPod Touch research project. Department of Education, Early Childhood Development (DEECD), Delphian eLearning Pty Ltd, Apple Computer Australia.

Naismith, L., Lonsdale, P., Vavoula, G., and Sharples, M. 2004. Literature review in mobile technologies and learning. NESTA FutureLab Series (FutureLab No. 11). University of Birmingham, Birmingham, UK, 1–46.

Newman, K. 2005. The case for the narrative brain. In *Proceedings of the 2nd Australasian Conference on Interactive Entertainment*. Creativity & Cognition Studios Press, Sydney, Australia, 145–149.

Nigay, L. and Coutaz, J. 1993. A design space for multimodal systems: Concurrent processing and data fusion. In *Proceedings of the INTERACT'93 and CHI'93 Conference on Human Factors in Computing Systems*. ACM, 172–178.

Orlikowski, W. J. and Yates, J. 1994. Genre repertoire: The structuring of communicative practices in organizations. *Administrat. Sci. Quart. 39*, 4, 541–574.

Pahl, K. and Rowsell, J. 2005. *Literacy and Education: Understanding the New Literacy Studies in the Classroom*. Sage Publications Ltd., London.

Papert, S. 1993. *Mindstorms?: Children, Computers, and Powerful Ideas* 2nd Ed. Basic Books, New York.

Patten, M. L. 2000. Topic 12: Qualitative research. In *Proposing Empirical Research*. Pyrczak, Los Angeles CA, 29–30.

Peppler, K. A. and Kafai, Y. B. 2007. From supergoo to scratch: Exploring creative digital media production in informal learning. *Learn. Media Technol. 32*, 2, 149–166.

Pelli, D. G. and Bigelow, C. 2009. A writing revolution: Analysis. *Seed Mag*. http://seedmagazine.com/content/article/a_writing_revolution/.

Polkinghorne, D. 1988. *Narrative Knowing and the Human Sciences*. State University of New York Press, Albany, NY.

Puopolo, J. 2012. The emergence of the content creation class. TechCrunch | Social. http://techcrunch.com/2012/01/29/the-emergence-of-the-content-creation-class/.

Quinn, A., J., Hu, C., Arisaka, T., Rose, A., and Bederson, B. B. 2008. Readability of scanned books in digital libraries. In *Proceedings of ACM Conference on Human Factors in Computing Systems (CHI'08)*. ACM, New York, 705–714.

Quinn, A., Bederson, B., Bonsignore, E., and Druin, A. 2009. StoryKit: Designing a mobile application for story creation by children and older adults. Tech. rep. HCIL-2009-22, Human Computer Interaction Lab, University of Maryland, College Park, MD.

Raffle, H., Ballagas, R., Revelle, G., Horii, H., Follmer, S., Go, J., Reardon, E., et al. 2009. Storyplay: Reading with young children (and Elmo) over a distance. Res. rep., Nokia Research Center, Joan Ganz Cooney Center at Sesame Workshop, 1–10. http://research.nokia.com/projects/storyplay.

Reid, D. and Ostashewski, N. 2011. iPads in the classroom – new technologies, old issues: Are they worth the effort? In *World Conference on Educational Multimedia, Hypermedia and Telecommunications*, T. Bastiaens and M. Ebner Eds., AACE, 1689–1694. http://www.editlib.org/p/38089.

Rogers, Y. 2011. Interaction design gone wild: Striving for wild theory. *Interact. 18*, 4, 58–62.

Rogers, Y., Connelly, K., Tedesco, L., Hazlewood, W., Kurtz, A., Hall, R. E., Hursey, J., et al. 2007. Why it's worth the hassle: the value of in-situ studies when designing Ubicomp. In *Proceedings of the 9th International Conference on Ubiquitous Computing (Ubicomp'07)*. Springer-Verlag, Berlin, Germany, 336–353.

Ross, P. E., Romero, J. J., Jones, W. D., Bleicher, A., Calamia, J., Middleton, J., Stevenson, R., et al. 2011. Top 11 technologies of the decade. *IEEE Spectrum 48*, 1, 27–63.

Rotman, D., Preece, J., He, Y., and Druin, A. 2012. Extreme ethnography: Challenges for research in large scale online environments. In *Proceedings of the iConference*. ACM, 207–214.

Rowe, D. W. 2008. Social contracts for writing: Negotiating shared understandings about text in the preschool years. *Read. Res. Quart. 43*, 1, 66–95.

Ryokai, K., Lee, M. J., and Breitbart, J. M. 2009. Children's storytelling and programming with robotic characters. In *Proceeding of the 7th ACM Conference on Creativity and Cognition*. ACM, 19–28.

Schiano, D. J., Nardi, B. A., Gumbrecht, M., and Swartz, L. 2004. Blogging by the rest of us. In *CHI'04 Extended Abstracts on Human Factors in Computing Systems*. ACM, 1143–1146.

Schmidt, A., Beigl, M., and Gellersen, H. 1999. There is more to context than location. *Comput. Graph. 23*, 6, 893–901.

Seely-Brown, J., Denning, S., Prusak, L., and Groh, K. 2004. *Storytelling in Organizations: Why Storytelling is Transforming 21st Century Organizations and Management*. Elsevier Science & Technology, Boston, MA.

Shah, N. 2011. Special Ed. Pupils find learning tool In iPad applications. (cover story). *Educ. Week, 30*, 22, 1–17.

Shuler, C. 2009. Pockets of potential: Using mobile technologies to promote children's learning. Joan Ganz Cooney Center at Sesame Workshop. http://joanganzcooneycenter.org/publications/index.html.

Smith, A. 2010. Mobile access 2010. Pew Internet & American Life Project. Washington, DC?: Pew Research Center. http://www.pewinternet.org/~/media/Files/Reports/2010/PIP_Mobile_Access_2010.pdf.

Srivastava, J., Cooley, R., Deshpande, M., and Tan, P.-N. 2000. Web usage mining: Discovery and applications of usage patterns from Web data. *SIGKDD Explor. Newsl. 1*, 2, 12–23.

Stake, R. E. 2005. Qualitative case studies. In *The Sage Handbook of Qualitative Research* 3rd Ed., Sage Publications Ltd., Thousand Oaks, CA, 443–466.

van Dijck, J. 2009. Users like you? Theorizing agency in user-generated content. *Media, Culture Society*, *31*, 1, 41–58. DOI:10.1177/0163443708098245.

Vetere, F., Davis, H., Gibbs, M., and Howard, S. 2009. The magic box and collage: Responding to the challenge of distributed intergenerational play. *Int. J. Hum. Comput. Stud. 67*, 2, 165–178.

Waterson, S., Landay, J. A., and Matthews, T. 2002. In the lab and out in the wild: Remote web usability testing for mobile devices. In *CHI'02 Extended Abstracts on Human Factors in Computing Systems*. ACM, 796–797.

Wei, L. P., Do, E. Y.-L., and Eastman, C. M. 2007. On context of content: A comparative methodology review of how HCI and mass communication analyze blogs and social media. In *CHI'07 Extended Abstracts on Human Factors in Computing Systems*. ACM, 2753–2758.

Wu, C., Teng, C. J., Chen, Y., Lin, T., Chu, H., and Hsu, J. Y. 2007. Point-of-capture archiving and editing of personal experiences from a mobile device. *Pers. Ubiq. Comput. 11*, 4, 235–249.

Yin, R. K. 2003. Designing case studies. In *Case Study Research: Design and Methods* 3rd Ed., Thousand Oaks, CA: Sage Publications, 19–56.

Yin, R. 2009. *Case Study Research: Design and Methods* 4th Ed. Sage, Thousand Oaks, CA.

Yip, J. C., Clegg Tamara, Bonsignore, E., Gelderblom, H., Lewittes, B., Guha, M. L., and Druin, A. 2012. Kitchen chemistry: Supporting learners' decisions in science. In *Proceedings of the 10th International Conference of the Learning Sciences (ICLS'12)*. International Society of the Learning Sciences.

Yoshioka, T., Herman, G., Yates, J., and Orlikowski, W. 2001. Genre taxonomy: A knowledge repository of communicative actions. *ACM Trans. Inf. Syst.*, *19*, 4, 431–456.

Zhai, S., Kristensson, P. O., Gong, P., Greiner, M., Peng, S. A., Liu, L. M., and Dunnigan, A. 2009. Shapewriter on the iphone: From the laboratory to the real world. In *Proceedings of the 27th International Conference Extended Abstracts on Human Factors in Computing Systems*. ACM, 2667–2670.

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