Engaging Children in Longitudinal Behavioral Studies through Playful Technologies

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ABSTRACT
Measuring children's behaviors and experiences has been one of the core interests of the field of Child-Computer Interaction. However, maintaining children's engagement in the evaluation process is one of the challenges that researchers need to meet. In this paper we introduce Playful Booth, a system that aimed at engaging children in playful photo taking practices with the goal of capturing their social interactions over prolonged periods of time. We then present a 4-week-long deployment of Playful Booth with a total of seventy children that aimed at addressing three research questions. First, does playful booth create initial engagement on children and does it sustain this engagement over prolonged periods of time? Second, can the deployment be sustained for prolonged periods of time with minimal resources? Last, do behavioral data as captured from playful booth reflect children's actual social participation in the school community?

Categories and Subject Descriptors
H5.2. User Interfaces: Evaluation/methodology.

Keywords
Engagement; playful; field studies; social interactions

1. INTRODUCTION
Measuring children's behaviors and experiences has been one of the core interests of the field of Child-Computer Interaction. However, maintaining children's engagement in the evaluation process is one of the challenges that researchers need to meet.

Interviews, for instance, require well-developed linguistic skills [10] and ability to reflect over one's affective state [11, 13]. Adding the fact that an interview is a time consuming process, children are often becoming tired and disengaged from it [10]. Researchers have thus devised a number of solutions to support children's verbalization and engagement in the interview process, ranging from drawing activities [22, 4, 19] to tangible objects as stimuli for emotional expression [11].

Questionnaires set similar challenges, such as the use of age appropriate language or symbols [13, 14, 5]. Moreover, children often perceive questionnaires as repetitive and time-consuming. These factors combined, often result to *satisficing* (i.e. completing the questionnaire without comprehension and reflection over the answers), thus raising concerns over the validity and reliability of the elicited data [10, 5].

Behavioral measures face similar challenges when long-term capturing is required. While most behavioral studies have relied on researcher-driven logging using pre-defined observation schemes [e.g. 2], it is cumbersome, if not infeasible, to carry out such behavioral logging over prolonged periods of time.

While sensing technologies can provide a solution to this challenge, we have found that they often are too intrusive, require substantial resources and raise privacy and health concerns on children and parents. For instance, in our studies of children's social interactions during playtime [24], we have deployed mobile phones that infer pair-wise proximity through sampling the signal strength of nearby devices using Bluetooth. We found that the size and weight of the phones often constrained children's physical activity while parents raised concerns over the impact of the phones on children's health and privacy. Moreover, the logistics of the study, requiring wearing, removing and charging 25 mobile phones on a daily basis, rendered the study resource-heavy over a prolonged period of time.

In this paper we argue for playful, non-intrusive behavioral logging technologies. We propose that making these technologies playful is critical for sustaining children's engagement over prolonged periods of time. In the remainder of the paper, we present such a system, Playful Booth, and describe a four-week deployment that aimed at exploring the viability of Playful Booth to sustain children's engagement over prolonged periods of time and provide valid longitudinal data of children's behaviors in school while minimizing the required resources.

2. CASE STUDY: MEASURING SOCIAL INCLUSION WITH PLAYFUL BOOTH
Our work on Playful Booth is grounded upon the notion of Inclusive Education, an educational approach that seeks 'Education for All' through developing schools that respond successfully to the diversity of all learners and their different needs [3]. While inclusive education has received increased attention during the last decades [17, 18], researchers have repeatedly criticized a lack of empirical evidence on the impact of inclusive educational environments on children's overt behaviors [e.g. 15, 20].

Instruments for measuring social interactions in schools have largely relied on subjective reports from parents [e.g. 21] or teachers [e.g. 8], or from children themselves [e.g. 9, 1, 12]. While such instruments are broadly used, concerns have been raised with respect to their validity and reliability [16]. Teachers

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and parents have been found to overestimate the social status of disadvantaged children [8]; children's assessments have been found to perform weakly on test-retest reliability. Next to concerns over the validity and reliability of self-report data, these instruments can only provide a momentary evaluation of the perceived social status of a child. The IDC community has repeatedly highlighted the need for instruments that can capture actual behaviors in real time [5, 11].

Playful Booth aims at capturing children's social interactions over prolonged periods of time, through engaging them in playful social activities. It does so through a photo-taking practice. Each child wears a wristwatch with an RFID tag embedded into it (see figure 1 left); by inserting their wrist on a box (see figure 1 right), they identify themselves and a photo appears on the screen with their name. More children can do so, and the list of all children appears. Once identification is completed, children can either capture a new photo, or review their common photos (i.e., photos in which all identified children appear).

Figure 1. (left) Watch with RFID tag, (right) Playful Booth installation with navigation buttons and the RFID reader box

In this way, Playful Booth supports children's need for engaging in social interactions; they may initiate new relationships, for instance, through denoting a preference for taking a photo with a child that they didn't have particular social interaction before, they may strengthen an existing relationship through repeated capturing of photos together, or they may recall their common past with their friends through revisiting their common photos. They may create new, broad social networks through inviting many classmates simultaneously to shoot a big group photo; they may seek social participation through appearing uninvited to peers' photos, or they may even reject a peer through refusing to intentionally include them in the photo.

3. FIELD DEPLOYMENT OF PLAYFUL BOOTH

A four-week-long deployment of Playful Booth took place in an inclusive primary school with the goal of inquiring on its viability as a tool for the long-term measurement of children's social interactions. Our goal was to address three research questions: a) does playful booth create initial engagement on children and does it sustain this engagement over prolonged periods of time? b) can the deployment be sustained for prolonged periods of time with minimal resources, and c) do behavioral data as captured from playful booth reflect children's actual social participation in the school community?

A total of seventy children from three different classes, *fourth-graders* (*i.e.,* 10y old, 12 male, 9 female), *second-graders* (*i.e.,* 8y old, 14 male, 12 female) and *kindergarten pupils* (*i.e.,* 5y old, 14 male, 9 female) participated in the study. We chose these different age groups due to the increased importance of social development throughout these age periods, as they start engaging in new social roles and are later challenged to win social status and acceptance by others [6]. Moreover, we wanted to explore whether children from all three age groups would be able to autonomously use the system and remain engaged throughout the study.

At the end of the study self-report measures of social participation and loneliness were elicited from children. Social participation was measured using Luftig's and Nichols' Peer Nomination Inventory (PNI) [9]. PNI consists of six questions in which students nominate classmates "with whom they wish to interact in a variety of social situations or which they like 'best' and like 'least' in the class" [9]. Loneliness was measured using the Social Dissatisfaction Questionnaire [23], which consists of 16 questions measuring a uni-dimensional latent construct of loneliness and social dissatisfaction as well as eight filler questions focusing on children's hobbies and other activities, "designed to help children relax during the interview" [23]. All questions were translated to Portuguese and back-translated to English by two researchers, both native in Portuguese and fluent in English, and deviations observed in the back-translated questions were spotted and resolved by an extended research team.

4. FINDINGS

A central goal in the design of Playful Booth was to create and sustain children's engagement over prolonged periods of time. The findings, overall, exceeded our initial expectations, as we expected the novelty of the system to wear off after some weeks of use, however, no such temporal effect could be observed in our observed timeframe (see figure 2). Overall, a total of 1335 pictures were shot, 236 from kindergarten children (2 weeks), 283 from 2nd-graders (2 weeks) and 816 from 4-th graders (4 weeks). 4-th graders were significantly more engaged with the system than the other two classes with an average of 36 photos per day as compared to 24 in 2nd-graders and 20 in kindergarten, $F(2,47)=8.2$, $p<.01$, $h_p^2=.27$.

We found that multiple aspects of the system contributed to children's engagement with it. At first, children were captivated by the *magic* of the RFID functionality as they could place their wrist with the watch inside the box and their photo and name would appear on the display: *"Look, it's me! Is this a magic watch? [U66]", "How does it know who I am? [U13]".*

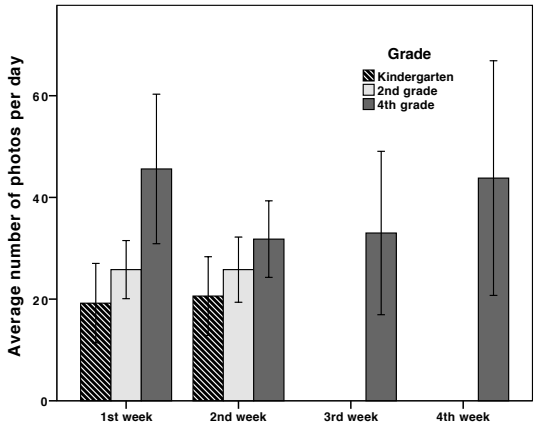

Figure 2. Average number of photos per day for the four weeks of the study; 2nd-graders and kindergarten children participated in the study only for two weeks.

Figure 3. Children interacting with Playful Booth

Secondly, a number of design aspects induced a sense of *playfulness*. First, the big buttons afforded expressive interactions such as hitting them and pressing them together with others. Moreover, their distinctiveness from traditional keyboards often induced a sense of wonder about how they worked. Second, the slap-on material of the watches contributed to their playfulness; children explored different poses in photo taking while attaching their watch to different body parts such as their legs, arms, forehead, neck. Over time, children became attached to their watch: *"Let me take it home, I won't loose it, I promise!" [U9]*, *"Can we take the watches outside? We won't get them dirty" [U62]"*. As they were not allowed to carry their watches outside of school breaks, they would often make paper prototypes and attach them to their hands. Moreover, we found that providing them the ability to choose their favorite color contributed to a sense of ownership.

Thirdly, the mere act of photo taking in a public space not only induced a sense of *belongingness* and *friendship*, but also induced a sense of public performance and being the focus of attention, as other children would wait in the cue for their turn on photo taking. Children further developed playful social practices when being the audience. For instance, they would try to put themselves in the perspective of the camera and hide as soon as the counter (i.e., 3-2-1) for a photo capture would start. While some children commented on the future value of these photos (e.g., *"because with the photos I will have memories of my friends when we are older" [U7]*), we were surprised to observe that children very rarely reviewed their own photos, and the use of the system was centered around photo-taking as a playful social practice rather than an instrumental activity.

Last, the limited deployment of the system to only a few classes of the school induced a sense of *exclusiveness* on the participating children (e.g., *"Are we the only class that will keep using the system at this break? [U16]"*). This was often observed as they were demonstrating the system to their friends from other classes (e.g., *"[explains the procedure], but you can't use it because you don't have a watch [U32]"*). In other times, they explicitly excluded children from other classes: *"You can't be here, only if you have a wristband [U19]"*.

Our second research question was: can the deployment be sustained for prolonged periods of time with minimal resources? Our early experience suggested that while such installations substantially reduce the resources required over traditional behavioral logging infrastructures such as mobile devices, considerable resources are still required in moderating children's behaviors. In our study we found that conflicts were often created among children relating to territoriality (e.g., *"I want to be the king of the buttons! [U33]"*), photobombing practices (i.e., stepping into others' photos), and prolonged occupation of the installation, which required setting limits in the number of photos for each group. Further, while the simple identification using the RFID-tagged watches reduced the resources, watches had to be handed to children before each break and collected at the end of each break. This was done to avoid children's distractions during class time and to avoid loosing the watches.

Our last research question was: do behavioral data as captured from playful booth reflect children's actual social participation in the school community? A number of questions could be ranged challenging the validity of the data, from practical concerns relating to identification, to ones relating to the nature of social behaviors during public photo taking.

Our first concern related to whether children might be swapping their watches as a form of trust and friendship. To the extent of our observation, no such behaviors were noticed; we believe this could be due to two reasons. First, children created a sense of ownership to their watch since they personally chose their preferred color. Second and most likely, as the system allowed reviewing their photos at a later point in time, it is likely that children wanted to associate all their photos to their account so they can review them.

Secondly, we were concerned about whether children would go through the trouble of identifying every single child to participate in the photo. We analyzed this for a random subset of 136 photos (10%), by contrasting the number of children posing in each photo to the number of children identified using the RFID tags. Out of 136 photos, only 6 cases (5%) were found in which the two numbers did not correspond. In 4 of these cases, a child was identified using the RFID tag, however, he or she was not present in the photo. Our video analysis showed that most often, this would happen when the child had lost her interest in further photo talking, especially when done in large groups, or when done repetitively by one group. In other 2 cases, a child was present in the photo but not in the RFID data. In one case a child had not identified himself but was invited by his friends to participate in their photo: *"Now, I can't see the pictures if I don't use my watch, but sometimes my friends don't want to do it again (...) because other people are waiting [U44]"*. Contrary to our initial concerns, we did not observe any acts of RFID-bombing, where children might have intruded others' photos using the RFID-tagged watches.

Yet, even though the RFID captured data seem to reflect the actual groupings during photo taking, one could wonder to what extend could the social practice of photo taking affect children's social interactions, for instance, through encouraging prosocial behaviors. Our interviews revealed that Playful Booth data are likely to reflect actual social groupings due to children's tendency to take photos with their friends: *"I like taking photos with [Child's name] and [Child's name] because they are my best friends [U41]", "I don't like [Child's name], he is annoying (...) No, and never will… Well, we only took photos together when we took group photos [U46]"*. Yet, contrary to our expectations, our quantitative analysis revealed non-significant correlations between *degree*, the number of children one has taken a photo with, and *betweenness centrality,* a metric of the importance of a child in the social networks, with *peer acceptance* as measured from the PNI instrument and *loneliness*, hinting at the possibility

that data derived from Playful Booth may reflect a different facet of children's social participation in school. A more elaborate analysis on the quantitative data is required that is beyond the scope of the current paper.

5. DISCUSSION AND CONCLUSION

In this paper we presented Playful Booth as a playful, non-intrusive behavior logging technology. Playful Booth provides the ability to capture *actual behaviors*, thus minimizing reliance on self-reports, and *in real time*, two criticisms that have been repetitively raised in the IDC community [5, 11]. Moreover, Playful Booth can monitor behaviors over prolonged periods of time [7], using limited resources, and thus temporal trends on overt behaviors may be established, for instance, in an attempt to establish the impact of a new technology or a new educational intervention on children's behaviors.

Our empirical study revealed that certain elements of Playful Booth (such as the *sense of magic* that the RFID-tagged watches induced on children, the *expressive interactions* that the buttons afforded, and the *social practices of photo taking* that the system enabled) as well as elements of the implementation (such as the sense of *exclusiveness* that the limited deployment induced and the *sense of attachment* that the personalized watches offered) contributed to creating as well as sustaining children's engagement with the system.

Secondly, our study revealed that while Playful Booth resulted to a substantial decrease in the required resources over traditional sociometric tools relying on mobile devices, and thus rendering Playful Booth as a more viable tool for long-term studies, considerable resources are still required in moderating children's behaviors, where conflicts might arise due to territoriality, photobombing practices and prolonged occupation of the installation.

Last, our study aimed at questioning the validity of the elicited data as indicators of social participation in the school community. While our qualitative inquiry revealed that Playful Booth data are likely to reflect actual social groupings, our quantitative analysis suggested that data derived from Playful Booth and ones derived from self-reports, such as the Peer Nomination Inventory [9] may reflect different facets of social participation in school communities. Our future work will focus on a more elaborate analysis on the quantitative data that was beyond the scope of the current paper.

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