Beyond Gamification: Sociometric Technologies that Encourage Reflection before Behavior Change

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Olga Lyra
Madeira-ITI, University of Madeira

Pedro Teixeira

Ana Caraban
Universidade da Madeira

Maria Jose Ferreira
São Paulo State University

Beyond Gamification: Sociometric Technologies that Encourage Reflection before Behavior Change

Vítor Belim[1], Olga Lyra[1], Pedro Teixeira[1], Ana Caraban[1], Maria José Ferreira[1] Rúben Gouveia[1], Andrés Lucero[2], Evangelos Karapanos[1]

[1]Madeira Interactive Technologies Institute
University of Madeira
9020-105 Funchal, Portugal
[d3str4v4d0, lyra.olga, e.karapanos]@gmail.com

[2]Mads Clausen Institute
University of Southern Denmark
Kolding, Denmark
lucero@acm.org

ABSTRACT
Gamification, the use of game design elements, such as points, levels, badges and achievements, in non-game contexts is a promising approach for encouraging desired behaviors. In this paper we describe our design process and early evaluation of a prototype that sensed children's social interactions (i.e., physical proximity) in the playground, and attempted to encourage pro-social behaviors through motivational feedback on a public display. We illustrate how we came to realize the potentially detrimental effect of gamification on children's intrinsic motivation and depth of reflection, and how we attempted to circumvent this through encouraging empathic understanding on children regarding the consequences of their behaviors on others.

Author Keywords
Persuasive sociometric technologies, children, gamification.

ACM Classification Keywords
H.5.2. Information interfaces and presentation (e.g., HCI): User Interfaces.

INTRODUCTION

Equal access to education has been declared by the United Nations a basic human right [24], and as of September 2009, most EU countries have signed the Ratification of the UN Convention whereby access to an inclusive educational system has become a legal right.

However, while inclusive school communities increase children's exposure to diversity, this does not necessarily eliminate exclusive social practices among them. Empirical findings on the subject are mixed. Inclusive educational environments impact children's attitudes towards social exclusion, primarily based on moral reasoning [12]; yet, practices of social exclusion are still observed on children's behaviors, such as being ignored, being actively excluded from peer activities, or even being verbally or physically harassed [3]. Peer rejection has strong negative influence on children's wellbeing and participation in the educational activities, and can even lead to suicidal thoughts [13]; approximately 8-12% of children report extreme feelings of loneliness at school [1].

In our line of work we attempt to build *persuasive sociometric technologies*, ones that sense children's social interactions in real-time, and provide persuasive, just-in-time recommendations to children with the goal of stimulating pro-social behaviors. This work is motivated by recent advances in sensor technology [6] and social network analysis techniques [19]. For instance, our prototype, *BlueFriends*, uses mobile phones that children wear around their waists (Figure 1, left), and which track pair-wise physical proximity of children during playtime. Using social network analysis techniques we are able to quantify the strength of ties between any two children, but also the presence (or isolation) of each child in the social network using network centrality metrics.

Figure 1. Student wearing a fanny pack with a mobile phone in it (left). Public display with motivational feedback (right).

In this paper we describe the design and our early insights from the field trial of a prototype that a) sensed children's social interactions in the playground; and b) attempted to stimulate pro-social behaviors through motivational feedback on a public display (Figure 1, right). While our initial goal was to employ gamification techniques to

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encourage pro-social behaviors, we quickly realized the potentially detrimental effects of such on children's intrinsic motivation and depth of reflection. For instance, research on the so-called *over-justification effect* [14], has found that extrinsic motivations, such as rewards, can replace children's intrinsic motivation for an activity, such as drawing or playing the piano, leading to a decrease of children's engagement with the activity once the extrinsic motivations are removed. Moreover, while external rewards may increase users' engagement with pro-social behaviors, this does not necessarily warrantee an increase in reflection over their social behaviors, thus possibly leading to unsustainable and superficial changes in children's behaviors.

In the remainder of the paper we describe the design of the *BlueFriends* prototype that aimed at increasing children's empathic understanding of the consequences of their behaviors towards others, with the goal of achieving sustainable pro-social behaviors in school communities.

RELATED WORK

Our work relates to a number of research topics within Child-Computer Interaction (CCI), ranging from technologies that support the social interaction of children at risk of exclusion (e.g. [7, 16]) and technologies that motivate physical and social play, to technologies that leverage gamification as a strategy for the engagement of children.

With an increasing interest in inclusive educational environments, researchers within CCI have opted to develop technologies that support the school environment integration of children with challenges in their cognitive and social developments. For instance, Escobedo et al. [7] proposed a mobile assistive application that uses augmented reality and visual supports with the goal of assisting students with autism to initiate and maintain social interactions with peers. Similarly, Hendrix et al. [10] developed an interactive tabletop game aimed at helping shy children gain confidence through role-playing, by assuming leading roles in their social interactions with others. Different from this body of work, we understand social exclusion as a group phenomenon [9], and thus focus on the remaining school community (and their stereotyping and discrimination practices) as much as on the child at risk of social exclusion. Next to that, we take a broader look on the root causes of social exclusion, accounting for a wide range of factors of diversity, from children's cognitive and social abilities, to their ethnic, cultural and socio-economic background (see [**Error! Reference source not found.**] for an elaboration).

A second body of related work points to the design of pervasive games that aim at inducing high levels of physical activity and social interactions among children (see [2], [23]). One of the early examples, Camelot [25] aimed at supporting collaboration and competition among children aged 7-10, through high physical activity and interaction with objects. Swinxbee [11] aims at supporting social interactions among children through sharing an RFID-tagged Frisbee. iGameFloor [8] is an interactive floor platform with bottom projection and camera-based tracking of limb contact points for more than 10 users with the goal of supporting social games among collocated children.

While a lot can be learned from this body of work about how technologies can motivate positive social interactions among children, *persuasive sociometric technologies* are different in scope since they aim at increasing social interactions through challenging children's perceptions of diversity, while confronting them with their own practices of excluding others from social activities. As such, *persuasive sociometric technologies* focus on fostering positive attitudes for social interaction among groups of children, something that is taken for granted in the design of the aforementioned pervasive games.

Finally, our work bears a number of similarities to an increasing body of work on *playful interactions* [15] and *gamification* - the use of game design elements, such as points, levels, badges and achievements [20], in non-game contexts [5]. Within CCI, gamification has been employed in a wide range of applications, from engaging children in learning activities [22], to sustaining their interest in empirical studies [4, 26, 17]. For instance, Brewer et al. [4] employed a scoring system and a set of prizes to motivate children to participate effectively in a study of gestural interactions. As a different approach, Lyra et al. [17] studied playful elements of a prototype – ranging from the "magic" RFID-tagged watches, to the expressive physical interactions and the social practice of photo-taking, as intrinsic motivations in sustaining children's engagement with longitudinal behavioral studies.

THE DESIGN OF BLUEFRIENDS

The *BlueFriends* system attempts to minimize social exclusion in the primary school through motivating children to engage in pro-social behaviors. It consists of two parts: a) the *persuasive sociometric technology*, and b) the public display providing feedback on children's behaviors.

Sensing Social Interactions

The *persuasive sociometric technology* consists of 25 smartphones (17 Nokia N95, 8 Android), one per child, worn around children's waist (i.e., a fanny pack) (Figure 1, left). Each device continuously samples for nearby devices, restarting the scan every 10-12 seconds. For each scan, the devices detected have their Received Signal Strength Indication (RSSI) logged into the phone. The RSSI's value varies with the pair-wise distance between the two children, as well as their orientation. In our preliminary tests, we found that RSSI can reliably distinguish pair-wise distances of 1 meter, 2-3 meters, 4 meters and 5-10 meters, regarding the children are facing each other. However, since in real life children might engage in social interactions even when side-facing, we opted for a more pessimistic metric that can reliably capture children's social interactions across a wide range of situations. Figure 2 illustrates our threshold value (horizontal value), that captures when two children are up to four meters apart, even when side-facing (90° or 270°).

Public Display

A 42" Samsung display (Figure 1, right) was placed on a 75cm tall table located by the school's entrance so that children could stop and see their feedback before exiting to the playground. While public displays are generally placed high up on walls for several adults to be able to look at the displayed contents from a distance, we placed a 42" monitor screen on a table so that the public display would sit at a comfortable height for children.

A computer, connected to the display, sensed when a child was in close proximity (via Bluetooth), and the child's personal feedback, implemented in Adobe Flash, would appear in the display. When more than one children were sensed, the display rotated between their feedback (30 seconds per child with continuous loop once all present children's feedback has been presented). While we focused on presenting personal feedback (one child at a time), we opted for a public display to encourage reflection and dialogue among children.

The feedback screen consists of four field landscapes separated by three rivers. While our initial goal was to use this metaphor to represent the four levels of a game, whereas children move to a higher level as they display more pro-social behaviors, we quickly realized that encouraging pro-social behaviors through gamification might result in superficial behavior change without much reflection upon one's behaviors. In a preliminary study of a low-fidelity mockup [Removed-for-Anonymity] we found that motivational feedback techniques, such as positive reinforcement, had a strong effect on children's behaviors – children eagerly adopted new roles and engaged in pro-social behaviors. However, we found children's behaviors to be primarily driven by the game mechanics and, often, children optimized their behavioral process to gain extra points. Contrary, the qualitative characteristics of the game process, in that case, a peer-interviewing technique that exposed children to, often unexpected, knowledge about each other was the most instrumental in increasing children's intrinsic motivation in the process and fostering a sense of empathy among them. Based on these early insights, we decided to minimize our focus on gamification. Instead, our primary goals were: a) to visualize each child's social behaviors, namely his or her *stronger* and *weaker ties*, and b) to induce a sense of empathy with the children that he or she interacts the least with (weak ties), by providing a visualization on the negative consequences of his or her behaviors towards them, as well as demonstrating the positive impact of desired behaviors on everyone's wellbeing.

At the beginning of the installation every child selects a dog to act as his or her avatar. During feedback (see Figure 5), the screen visualizes six dogs – the dog of the primary child (whose social ties are being visualized) and the dogs corresponding to the child's strongest ties (the children that he or she spends the most time with in the playground). As the dogs run along the field (Figure 3), a second group of dogs appears on the other side of a river – the dogs

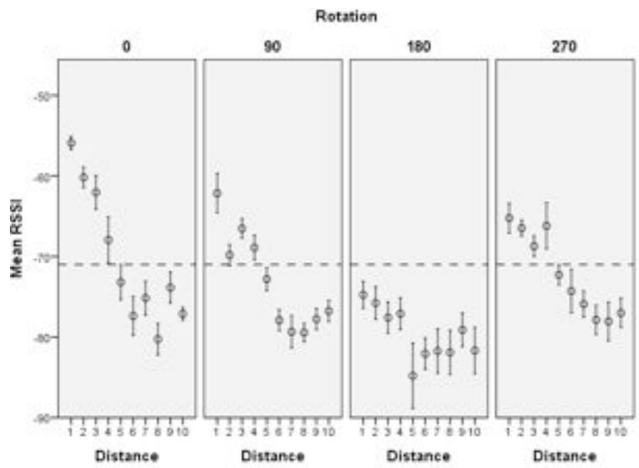

Figure 2. Mean Bluetooth Signal Strength Values (along with 95% confidence intervals) between two devices as a function of distance and orientation. A threshold value (horizontal line) was used to indicate when two children are in close physical proximity (<4m), directly or side-facing each other.

Figure 3. Public display visualization of the avatar of the primary child's avatar and those of the excluded group, separated by a river. Spending time with these children helps building a bridge so that all dogs can play together.

Figure 4. Dogs' feelings are visualized through their physical activity as well as facial expressions.

Figure 5. Public display visualization of the primary child's avatar along with his peers. The avatar of the child engages in free play with its best-buddies (i.e., the avatars of the children that he spends the most time with). An airplane on the background displays messages with contextualized feedback (see also fig 3.), helping children in interpreting the avatar's behaviors.

associated with the children that he or she has interacted the least. The child is informed that a bridge will be built and all dogs will be able to run together once he or she starts spending time together with the children represented in this second group of dogs. The level of interaction that a child has with these (weak-tie) children influences the mood of this second group of dogs. Dogs express their feelings in two ways: a) physical activity, where high physical activity reflects positive mood, and b) facial expressions that reflect happiness, apathy and sadness (Figure 4). Through these two visualizations, we wanted to induce reflection on children regarding the negative consequences of their exclusionary behaviors on other children's feelings, as well as highlight the positive impact of pro-social behaviors on the wellbeing of everyone in the community.

FIELD TRIAL

A longitudinal study of *BlueFriends* was carried out in an inclusive primary school in the area of [Removed for Anonymity]. The goal of this exploratory evaluation was to understand the ability of *BlueFriends* to instigate empathic feelings and motivate pro-social behaviors on children, but to also assess the ecological validity of *BlueFriends* (i.e. the impact the introduction of the sensing technology had on children's typical play patterns).

A total of 50 children from two different classes, second-graders (≈7 years old, 11 male, 13 female) and third-graders (≈8 years old, 14 male, 12 female) participated in the study. We chose this specific age group, as at the age of 7 children start to understand and empathize with other's points of view, according to the Piagetian stages of socio-cognitive development [21]. Consequently, this is a sensitive phase in children's socio-cognitive development, where any educational and technological interventions can have considerable impact on their current and future behaviors. The study lasted for 10 days and was separated into two phases: the *pre-feedback* phase, consisting of six days of sampling, and the *feedback* phase consisting of four days of feedback and three days of sampling (see Table 1). In the pre-feedback phase, children were asked to wear the Sociometric sensors during their free play over the two main school breaks (sampling duration of ≈30 minutes for each break), while no form of feedback was presented at the time. This lasted for six days and constituted two rounds of

	Pre-Feedback						Feedback			
	Sample 1			Sample 2				Sample 3		
Day	1	2	3	4	5	6	7	8	9	10
Sampling	X	X	X	X	X	X		X	X	X
Feedback							X	X	X	X

Table 1. Study procedure with two rounds of sampling of children's social interactions before and one round post-feedback.

sampling, which served both to generate the feedback on the public display as well as to establish a baseline of children's already established social interactions. In the feedback phase we introduced the public display – located in the main corridor of the school – and the feedback screen. During the first day of the feedback session, we did not sample children's social interactions as their behaviors were considerably affected by the introduction of the public display. During the remaining three days we performed one round of sampling, while the public display remained present in the school corridor at all hours.

In order to inquire into the impact of *BlueFriends* on children's behaviors and attitudes, we analyzed both quantitative data, consisting of children's social interactions as measured by the Sociometric sensors, as well as qualitative data, consisting of notes kept during our observations of children's behaviors, their verbal interactions with other children, their reactions to the feedback on the public display, as well as transcripts of open-ended interviews conducted with them at the end of each break. Data was analyzed through qualitative content analysis using open and axial coding. In the section below we present some of our early experiences from this deployment.

Early Insights

One of our primary concerns was the intrusiveness of the technology on children's physical activity and social interactions, with detrimental effects both to the acceptance of the technology by children, educators and parents, but also to the ecological validity of the results. Our early experiences with the deployment of *BlueFriends* suggest limited impact on children's physical activity and social interactions. The pouches carrying the mobile devices allowed for the necessary mobility for free play at the analyzed age group, while children quickly forgot about the technology and re-engaged in their typical play behaviors. On the other hand, 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. Thus, while our technology is not expected to have influenced substantially the results of our study, there is a need for lightweight sensing technologies, both in terms of their size and weight (especially when the research interest shifts to younger populations) as well as in

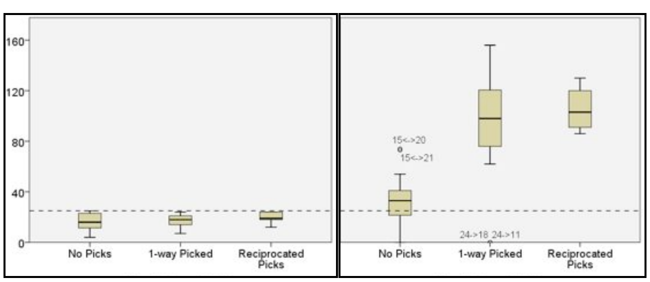

Figure 6. Evolution of weak ties from pre to post-feedback.

terms of the resources required to maintain the study. Playful technologies that provide value to children are more likely to create an eco-system where the responsibility shifts to children for charging and keeping them on during the full duration of the study. Alternatively, Sociometric sensing can also be obtained through stationary, non-wearable technologies (that are not as resource-heavy), as the Playful Booth prototype [17], which infers children's social interactions from the groups they make when taking photos together.

Our second question tapped to the impact *BlueFriends* had on children's social interactions and their attitudes towards pro-social behaviors. Our interest was to understand whether *BlueFriends* triggered them to think about the ways in which they behave or whether children simply engaged with the suggested social activities simply as part of a game. Overall, while children showed initial disbelief to the technology, wondering how their own behaviors translate to those of the avatars (e.g. "Is that really him walking?"), they quickly became captivated once the feedback started reflecting their own groupings (e.g. "How do you know that we are best friends?"). When presented with the empathic feedback (their avatar would approach the river, stop and look at the avatars of his or her excluded children, having low physical activity and crying), children repeatedly showed interest on their feelings and what caused this (e.g. "Why are the dogs on the other side of the river crying?"). When we described the reasons for this, children's reactions varied. Some of the children showed no interest to engage in any social interaction (e.g., "We won't play with him… don't think anybody will because he's repulsive"; "He smells, kicks and pushes all the time"). Most often, though, children showed eager to engage in play with new members (e.g. "Great, we can all play together"), which was also revealed through the analysis of our behavior logs. Figure 6 illustrates the average tie strength between all pairs of children weakly-tied before feedback, and it's evolution. It illustrates that when a child was displayed on another child's feedback screen, this lead to a significant increase in their tie strength post-feedback (1-way picked, $p<0.01$). No change was observed on the tie strength of children that were not present (no-picks), while reciprocated interactions did not lead to significantly higher tie-strength than one-way interactions.

CONCLUSION

In this paper we described the design of *BlueFriends*, a technology that aimed at motivating pro-social behaviors on primary school children through inducing reflection upon their social behaviors. Overall, we found the system to be not intrusive to children's physical activity and open play, and to have a significant effect on their behaviors. On the other hand, children showed interest and empathic feelings when they recognized negative feelings on the avatars, and to a large extent engaged on several pro-social behaviors. Our future work will seek to provide a deeper understanding on children's behaviors and will further explore different ways to instigate pro-social behaviors through encouraging reflection on children's own behaviors.

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