Jumping on the Bandwagon: Overcoming Social Barriers to Public Display Use

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ABSTRACT

The fear of social embarrassment has been identified as a significant barrier to people's interactions with public large interactive displays (PLIDs). Prior research has also shown that the presence of others at a display can help to mitigate this issue by drawing on people's innate need to belong and social curiosity. This research investigates the potential to replicate this social effect, within the display itself, by drawing on prior interface design approaches that attempt to emulate the "bandwagon-effect". This effect refers to the tendency for people to mimic the thoughts and behaviors of others. In a four-day field experiment, we deployed three different PLID interfaces featuring bandwagon and call-to-action design concepts. The study found that both the bandwagon and call-to-action designs were effective for engaging passersby, but each influenced different stages of the overall interaction process. We discuss the design implications of our findings, especially the need for socially-safe PLID interactions.

Keywords: Display blindness; interaction blindness; public interaction; large displays; bandwagon-effect; call-to-action.

Index Terms: Human-centered computing—User interface design; Human-centered computing—Empirical studies in interaction design

1 INTRODUCTION

Public large interactive displays (PLIDs) have become increasingly available in public deployments because of better affordability, and their ability to offer interactive content to a broad audience. However, studies conducted across a wide variety of public settings have shown that it can be exceedingly difficult to attract and engage passersby in public settings; indeed, PLIDs commonly only engaged 1-5% of passersby in these studies (e.g., [5, 32, 34]). These studies revealed that many passersby either do not notice the display (referred to as *display blindness* [16]) or do not understand that the display is interactive (referred to as *interaction blindness* [28]). A recent study by Dalton et al. [8] that employed eye-tracking, however, challenged the common belief that display blindness is highly prevalent; they found that most people actually looked at public displays, but then subsequently avoided them when closer. This is consistent with Kukka et al.'s [19] earlier distinction between display blindness and display avoidance (i.e., when people know about the display and choose not to visit it). Memarovic et al. [24] correctly point out that the distinction between display blindness and avoidance is often not clarified in PLID research.

So, why do so many people avoid visiting or interacting with PLIDs? Certainly, possible reasons include, lack of interest or perceived relevance, or lack of availability, but the fear of social embarrassment has also been identified as a significant barrier for attracting and engaging PLID users [2, 4, 7]. Little is known, however, about how it can and should be handled and mitigated in public display design. What we do know is that interaction with PLIDs is largely dependent on the presence of others [2, 27, 38]. This motivated us to explore design approaches that could evoke curiosity and feelings of group belonging in order to mitigate display and interaction avoidance. Inspired by design approaches from the field of marketing, which is adept at psychological persuasion, we developed a PLID design that builds on the psychological phenomenon called the "bandwagon-effect" [21]. In this social effect, people feel the urge to join majority groups to be on the "winning" side [21]. This research explores the potential of this "bandwagon" design approach to persuade people to approach and interact with PLIDs. To the best of our knowledge, this is the first time that bandwagon-effect has been leveraged in PLID usage. We compare this bandwagon approach to the more traditional call-to-action PLID design that provides more explicit action-oriented PLID elements such as "touch me" signs to communicate the interactivity of the display. A strength of the call-to-action approach is its ability to minimize uncertainty about what to do with the display by explicitly communicating that, for instance, a display is "touchable", and thereby avoiding potentially embarrassing "mistakes" [19].

We present the results from a four-day field experiment that evaluated three different PLID interfaces, including our bandwagon design, a call-to-action design, and a control interface that contained neither design approach. To understand how each design impacts display blindness, avoidance, and interaction, we conducted a conversion analysis that examined passerby behavior throughout the interaction process from passing by to touching the display. The results found that the bandwagon approach helped mitigate display avoidance, had no significant impact on display blindness, and actually hindered display interaction in comparison to the call-to-action approach. The call-to-action approach was found to facilitate display interaction in comparison to the bandwagon approach, but has no significant impact on display blindness or avoidance. Impacting different types of passerby behavior (i.e., glancing, stopping, and touching), both the bandwagon and call-to-action design approaches give insight into user behavior around PLIDs. We discuss these insights and their implications for mitigating social concerns with PLIDs.

2 RELATED WORK

2.1 The First-Click Problem

Every first interaction with a public system has to start with a "first click" (i.e., touch or other forms of interaction) [17]. Eliciting this first click from a user begins with the user first noticing the public display, then learning that it is interactive, and last but not least, being motivated to interact with it [27]. Throughout these transition many barriers such as display blindness [28], interaction blindness [31], or display avoidance [19] cause people to withdraw from the display.

Addressing the first-click problem requires users to actually see and notice the display. However, in their observational field study, Huang et al. [16] found that people barely looked at public displays,

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and if they did, they only looked in the direction of the display for one or two seconds. This phenomenon was coined display blindness which is described as the tendency to ignore PLIDs by passersby [28]. Equipped with only selective attention (i.e., the ability to only focus on certain aspects in a public setting), humans sometimes do not pay attention to displays because other things are more relevant to them, or they expect uninteresting content such as advertisements [28].

Also, people avoid public displays. Huang et al.'s [16] research revealed that some people tend to look more in the direction of a display if something in the vicinity of the display catches their attention first. However, after noticing the display, people tend to actively ignore the display (i.e., they stop looking toward the display). This behavior is referred to as display avoidance [19].

After users notice the display, they can then discover the display's interactivity. The failure to do so is called interaction blindness [31]. Ojala et al. [31] state that some people do not interact with public displays because they do not know that the display is interactive. Making people aware of the display's interactive features, therefore, is a key challenge to overcoming the first-click problem [15].

2.1.1 Doubts Around the Prevalence of Display Blindness

Revisiting display blindness, an eye-tracking study conducted by Dalton et al. [8] found that more people looked at public displays than expected based on earlier findings made by Huang et al. [16]. Dalton et al.'s study also found that people tend to discover displays from a greater distance than might be expected (i.e., around 8 meters, rather than when they are closer and actually passing by the display). This finding offers a possible explanation of Huang et al.'s [16] earlier study that found high rates of display blindness: the observational area may not have been large enough to register far-away views of the display in their observational field study [8]. Dalton's newer findings, based on more accurate eye-gaze measurement techniques across a wider tracking area, suggests that display blindness may actually have a weaker impact on public display usage as originally assumed. Furthermore, in a meta analysis of existing PLID design studies, Memarovic et al. [24] found that the difference between display blindness and display avoidance is not clear in the literature. They question whether display blindness even exists, or whether it is actually a significant barrier to user engagement with PLIDs. Why people avoid public displays remains an open question [24].

2.2 The Need to Belong and Social Embarrassment

To answer this question it might be necessary to look into the social system (i.e., the public place, the PLID, and its users) in which PLID is deployed. Brignull et al. [2] argue in their far-reaching article that the social system around a public display and place, and users' knowledge about it, impacts users' evaluation of a PLID and can ultimately cause them to avoid the public display [2]. Wouters et al. [38] agree by saying that social norms shape public interaction, and can ultimately lead to avoidance. A nice illustration of those social norms is given by Müller et al. [26] when they compare the social context of PLID usage to a scene in a play in which every actor plays a certain role in a public space that they try to maintain. By avoiding interaction with a PLID, passersby are able to keep their role, and not potentially look silly in front of the PLID. Cox et al. [7] add that any public display immediately opens up the possibility of failure by, for example, misunderstanding the technique for interaction, or just being physically and mentally not able to do so. Indeed, a recent study by Ghare et al. [14] found that people preferred randomly triggered animations over user proximity-based triggers because it allowed them to stand at a distance and learn about possible user interactions before committing to approaching the display and engaging in any interactions. Interestingly, when asked about social concerns that people have, they often answer that they are afraid to break the display [19], compromise the operation of it [31], or that they do not have the basic knowledge to operate it [2].

According to Cox et al. [7], the reason why people are so strongly impacted by the social context in which interaction takes place lies in people's wish for social acceptability. They assert that this wish stems from the wish to fit in [7] which is consistent with findings in the field of Psychology. In their seminal paper, Baumeister et al. [1] define the need to belong as a fundamental human motivation to have frequent, affectively pleasant interactions, and avoid social exclusion. To achieve social belonging, people conform to social rules and behave in socially desired ways [20]. When they fail to do so (e.g., by looking silly in front of a PLID), people feel negative affections such as social embarrassment [2,20]. Such social embarrassment has been identified as a social barrier in PLID usage [4]. In this sense, the feeling of embarrassment simply describes the discrepancy between the social role people try to maintain and their actual behavior in a social context [10].

Taking the social system of a PLID into account, it is possible to interpret social phenomena arising in PLID usage. For example, the honey-pot phenomenon describes the effect of a group of people at a PLID being able to attract more and more people [2]. This phenomenon can mitigate and overcome social concerns by helping passersby to overcome the fear of something new, reducing their self-consciousness, and reducing the potential for social embarrassment [2, 38]. Besides removing negative concerns around PLID usage, more importantly, the honey-pot also creates a "social buzz" around the PLID actively attracting passersby by creating an urge to approach the existing group of people [2].

2.3 The Bandwagon-Effect

Motivated by the power of a gathering of people at a PLID to evoke feelings of urge and curiosity and attract someone to the display, we investigated other (social) effects that might create those feelings in order to leverage them in PLID design. One such social effect, called the "bandwagon-effect", was discovered in the field of marketing and advertising. Within this domain, the bandwagon-effect is used to leverage the "attraction of a crowd" in a shopping context. More specifically, the bandwagon-effect is used to exploit the tendency of an individual to buy more of a certain good if other people also buy more [21]. Literally, the bandwagon was a wagon to carry a band. Climbing or jumping on top of it means to put oneself at the head of the crowd. More broadly speaking, jumping on the bandwagon means to join the winning side, or the side that seems more likely to be successful [6]. As a reason for the bandwagon-effect, past research asserts that people have a need for conformity [23,29,33] which stems from the fact that people want to belong to a group [20].

While the bandwagon-effect has been observed in opinion polls [23,29], its need to conform to majorities has also been exploited in e-commerce [33]. A common way to do that is by implementing a recommendation system (i.e., collaborative filtering technology) which recommends more popular shopping items over others [35]. Sundar et al. [35] found that buying intentions of users were heavily impacted by the ratings and opinions of others representing the underlying bandwagon-effect. According to Knobloch-Westerwick et al. [18], there are two versions on how these recommendation systems work and what they are based on: implicit and explicit recommendation systems. The implicit recommendation approach offered the inspiration for our *Bandwagon* PLID interface. In its basic form, an implicit recommendation systems is based on selections others users have made [18]. It is implicit because user selection behavior is implicitly tracked (e.g., who has visited what Internet page, or has seen what product). In contrast to the Proxemic Peddler [36], the bandwagon-effect is not a visual effect tailored towards an individual interacting with the PLID, but an attracting visualization of previous interaction between the PLID and (multiple) other users. Most-viewed, most-popular, or most-commented rankings are

Figure 1: The information kiosk is implemented within the bookshelf metaphor. Holding several information in books, it is supposed to provide information about the local campus community. This interface formed our *Control* condition and the scaffold to our other interfaces.

Figure 2: The *Bandwagon* interface holds the percentage-counter as an implicit recommendation to implement the bandwagon-effect. At the top-right corner one can see the abstract group-symbol.

examples of an implicit recommendation system [18]. Apart from a shopping context, similar results of the bandwagon-effect have been found towards the favoritism of newspaper articles [39], online videos [13], and content postings in online communities [11].

Inspired by such recommendation systems that implement the bandwagon-effect, we explored ways to guide our PLID design process. A key design guideline, therefore, was that people using recommendation systems do not only realize how popular a certain product is, but also if and how often it has been used and tested before. So, we decided that our PLID should evoke the same impression of popularity (and therefore cause an urge to interact with it) and safety (to use the display) such as a recommendation would do to a popular product. We describe how we incorporated this concept into an existing experimental PLID application below.

3 Designing to Overcome Social Barriers

For the purposes of studying the bandwagon-effect concept, we incorporated several new interface concepts into an existing PLID experimental software platform, developed by Ghare et al. [14] and shared with us by the authors for the purposes of this project. The "Community Bookshelf" information kiosk software application was designed as an experimental interface to support studies on the "first-click" problem in PLIDs. Ghare et al. [14] have previously used it to study other design approaches, such as proxemics, to attract and entice user interaction. Thus, the interface provides the "guise" of a complete PLID application with an attractive interface showing a bookshelf that provides information about the local university campus, as described later. However, the application is a facade only. Once a user touches the display, it simply thanks the user for participating in the experiment (this is described in more detail below). For our purposes, this information kiosk application forms the visual scaffold for integrating our new design concepts into the larger interface. We equipped this scaffold with design variations that implement the bandwagon-effect, call-to-action, or neither approach. This resulted in the design of three interface conditions that we will present after we introduce the basic idea of the information kiosk experimental platform.

3.1 Designing an Information Kiosk

The kiosk interface promises to deliver valuable information about a local university campus such as bus schedules, local cafs, or medical services to the campus community by providing a bookshelf metaphor. The bookshelf metaphor describes a bookshelf where all the information is held in interactive books that are grouped by topic (i.e., each represents information on a certain topic). The idea behind the design is an information system that enables users to get certain information on certain topics (e.g., information about nearby coffee shops) by opening (i.e., touching on) books.

As Ghare et al.'s [14] original work found that random animations within the interface helped to attract and entice user engagement, we enabled these animations in our interfaces to provide a baseline of "attraction" features, across all interfaces, including our control interface. These animations included simple tilting and random opening movements of books. When somebody opens one of those books (i.e., touches them) they open up in an animation. After they opened up, a speech bubble pops up that thanks passersby for touching the display, and directs them to the researchers desk in order to gain further information and to pick up a prize (e.g., candy) if there is interest. A screen-shot of the bookshelf can be found in Figure 1.

3.1.1 Control Interface

The control interface consists of the bookshelf information kiosk interface simply as described above, including the random animations (Figure 1). This means that we did not add any additional design elements (implementing the bandwagon-effect or call-to-action) to its appearance. Consequently, Figure 1 also represents the visual scaffold for our two other experimental interfaces, which we describe below.

3.1.2 Bandwagon Interface

The result of our design process can be found in Figure 2. The top part of the interface contained a percentage counter that represents the percentage of people that touched the display from the amount of the people that passed by the screen. By doing so, this counter measures the likability of our PLID by implicitly tracking user behavior (i.e., users that touch the display). For experimental purposes, the counter was set to a "reasonably high but also believable" number (i.e., 74.6% of viewers touched the display) in order to invoke the bandwagon-effect. We chose this counter for several reasons. First, it is a short, easy to understand title. Second, the percentage number is the first part of the sentence, and therefore, the first thing to read by a user. By placing the percentage number at the beginning of the sentence, we intended for people to see it very quickly and be attracted to it. Third, we chose the word viewers over passersby or users because we believe that most people will identify with viewers when they read (i.e., view) the title. Moreover, we argue that the rating concept would be well understood by our population (primarily millennial-aged undergraduate students in technology programs) due to their typical familiarity with online shopping and social media consumption.

The specific number, 74.6%, as the percentage in our counter was derived from various discussions with user interface and technol-

Figure 3: The *Call-To-Action* interface calls passersby to act. The top of the display holds the text "Touch this display!".

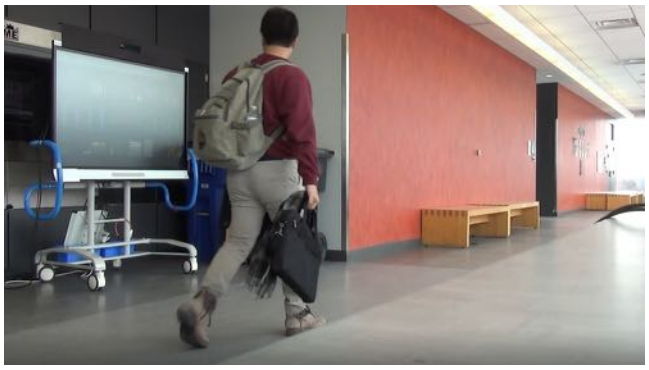

Figure 4: A passersby walks by while looking at the PLID. The PLID was deployed in a hallway at the University of Waterloo.

ogy experts in our broader research group. Evaluating how many passersby actually touch the display, how many passersby laymen would expect to touch the display, and to what number the counter should be set according to our members, we decided that a reasonable number was between 60%-80% in order to attract as many people as possible to touch the PLID without being too high and unrealistic. Furthermore, the counter was fixed for the duration of the study. That means that the amount of actual interaction in the experiment did not impact this fake number. This deception was necessary in order to profit most from the bandwagon-effect, and to create a stable environment in which we can research effects without confounding variables.

Last but not least, we equipped this interface with an abstract group icon at the top right corner of the PLID. Following the idea to signal the PLIDs popularity and acceptance among fellow passersby, we wanted to emphasize the group aspect of the bandwagon-effect. In other words, we hoped to elicit a mental representation of a community of other passersby who had engaged with the PLID's, and who were being (theoretically) implicitly tracked by the the PLID. We hoped that this would increase the system's credibility.

3.1.3 Call-To-Action Interface

In order to compare our *Bandwagon* design with an established way to enhance PLID interaction, we designed an interface that only relies on a call-to-action. In general, research has shown that call-to-actions successfully increased overall interaction with a PLID [5, 17], and communicated interactivity [27]. Furthermore, Kukka et al. [19] found that text-based call-to-actions such as "touch here" are more successful in causing people to interact with a PLID than icons. Thus, our call-to-action display was a version of the control interface with blue text stating "Touch this Display" added to the grey band along the top of the control interface.

4 Field Experiment

In order to test the above PLID interfaces in a real-world setting we conducted a field study on our local university campus. The goal of the study was to determine whether the bandwagon-effect could effectively entice passersby to visit our PLID and thus overcome display avoidance, and how its impact compared to the impact of a call-to-action display and the control display.

4.1 Study Design

The field experiment utilized a 1×4 between-subjects design. This design included the testing of the three interfaces described above, *Control*, *Bandwagon*, *Call-To-Action*, and a fourth interface that combined aspects of the bandwagon and call-to-action design approach. Due to inadvertent confounds in the fourth display, uncovered during the study analysis, we omit the results of this condition.

4.2 Experimental Setting

Our experimental software was installed on a SMART Board 6000 series touch interactive 1920 $\times$ 1080 65" display, mounted on a mobile stand of adjustable height. A Microsoft Kinect V2 was mounted to the top of the display (but hidden behind a black cover) to enable tracking users. As it can be seen in Figure 4, the PLID was deployed to a hallway in an engineering building on a local university campus. The location is adjacent to an above-ground pedestrian pathway that is frequently used by students in-between classes. It is also near to staff offices and classrooms, and thus staff members also commute through the area between meetings or classes.

4.3 Procedure

The PLID was deployed for four days in mid-July, from 10am - 2pm each day. The order of presentation of our experimental conditions was counter-balanced across the four days, using a Latin-square design, with each interface displayed for 1 hour on each day (resulting in four hours of deployment for each interface). This counter-balancing was done because of expected fluctuations in foot traffic throughout the day and week due to class schedules and on-campus events in nearby locations. During the PLID deployment, we observed unobtrusively from a nearby table in the setting (within a cluster of tables used by students for studying and hanging out between classes) and recorded field notes regarding any interesting passersby behavior.

Once a passerby had successfully interacted with the PLID, and determined that they should seek out the "red ribbon" that was attached to the researchers' observation table, they were given a chance to interact with the experimenters, and collect their reward (candy) for touching the PLID and seeking out the researchers' desk. Note, during the study, we observed that many passersby who touched the display were unable to find the "red ribbon" (i.e., the researchers' desk, which was located several metres across the hallway from the display, and behind someone interacting with the display). Most people appeared focused on the immediate display area and not on the tables across from it before giving up quickly and leaving the area without finding our table. Given this observation, we believe it is unlikely that many people came to the area to interact with the display simply to get candy due to potential discussions with friends or colleagues who may have previously interacted with the display.

4.3.1 Survey

We randomly recruited passersby to participate in a survey. Participants were selected who either had interacted with the display, and approached the researchers desk, or who did not interact with the

display. For the latter type of recruited participant, we approached them once they left the observation area and requested their participation. Passersby were first read a verbal recruitment script, and if interested, the investigator asked them to sit down at the researchers table, and complete the survey on an electronic tablet. Additionally, we asked them to fill out the Social Phobia Inventory (SPIN) [9] which will be used to evaluate the level of social anxiety of a selected sub-population of passersby in a future publication and compare those results to their initial behavior in front of the display. Overall, we recruited 31 participants, about half of whom interacted with our public display. Besides understanding why passersby interacted with the PLID, this gives us the opportunity to understand why passersby did not.

The study protocol was approved by our institutional research ethics board. This approval included the stipulation that a sign be posted in the study location the week following the field study with information on the study and the contact information of the researchers and the research ethics office should anyone have any questions or concerns with the study.

5 Data Collection and Analysis

To determine the extent to which passersby attended to and interacted with the display, we conducted an analysis of the collected video data following the closed coding approach of Ghare et al. [14] that included the following behavioral codes:

None Shows no intention to look or pause with display in view, walks by as if it is not there.

Glanced The action of looking at the display but without stopping. A head turn towards the display is equal to a glance.

Stopped The action of stopping and looking at the display.

Touched The action of touching the display.

Following Ghare et al.'s [14] video analysis, we treated individuals and groups of passersby "as a single unit of analysis". Simply referring to them as passersby, this gives us the opportunity to investigate the first appearance of the above mentioned target behaviors which were more likely caused by the display itself rather than by group dynamics (e.g., a group member asking their peers to look at the PLID which generally causes them to stop), without having to exclude groups of passersby from our analysis [14]. Note that passersby were coded multiple times for multiple appearances of a target behavior, while in analysis we just registered whether each of the target behaviors occurred at least once for each passersby. In ongoing research, we are further investigating the impact of groups on PLID interaction behavior.

We conducted a conversion analysis to investigate the effects of our PLID interfaces on changes in the frequencies of our target behaviors using Fisher's Exact test (with $\alpha = .05$) [12]. This test was used because of its robustness to small cell counts (e.g., amount of touches for some conditions) in comparison to a more traditional Chi-squared test [3]. Running successive tests along the funnel (i.e., the narrowing band of engagement from no engagement to touching the PLID similar to Michelis et al. [25]), the data were filtered by the pool of passersby who performed the prior behavior in the funnel (e.g., analyzing whether passersby stopped in front of the PLID only if they glanced at it before).

The key advantage of such conversion analysis is that it enables us to look into the effects on display blindness, display avoidance and interaction blindness by our design approaches. By measuring display blindness as the ratio of people that glanced at the display (and therefore were not blind to it) to those that did not, display avoidance as the ratio of people that stopped to look at the display (and therefore did not avoid it) to those that did not, we are able to register and test changes in ratios caused by our design approaches.

Finally in the qualitative results section, we also analyzed the collected survey data to better understand people's perceptions of the display and their motivations for approaching and, if applicable, interacting with it.

6 Results

In the following, we will start by describing our descriptive results of how many passerby we registered for each condition and in total, how many passersby glanced at, stopped to look at, and how many touched our PLID. We'll then present the results of our conversion analysis which investigates how the described frequencies of target behavior are impacted by our experimental conditions. Last but not least, we will present the results of our survey in the qualitative results section.

6.1 Quantitative Results

In total we registered 1113 passersby (groups and individuals) that passed by the display (Table 1). Of those 1113 passersby (all coded as Passed by), 490 of them glanced at (44.0%), 63 stopped before (5.7%), and 38 touched (3.4%) the display. As it can be seen in Table 1, we registered between 343 and 418 passing by our PLID in our experimental conditions. Most passersby passed by in our *Control* condition. Of those passersby, most of them (i.e., percentage-wise) glanced at our PLID in the *Call-To-Action* condition (47.5%). After glancing, most passerby stopped to look at the PLID in the *Bandwagon* condition (9.9%). Last but not least, the *Call-To-Action* interface drew in the most touches by passersby (5.0%).

Next, we present the results of our conversion analysis. As shown in Table 2, we found a significant difference across the three interfaces for each of our tested target behaviors (i.e., glancing ($p = .041$), stopping ($p < .001$), and touching ($p = .004$)). That means that for all target behaviors there was a significant difference between our experimental interfaces in the appearance of those behaviors, which is unlikely to be caused by chance.

To investigate the differences between particular interfaces for these behaviors, we conducted pairwise comparisons of our three interfaces, correcting for family-wise error with Bonferroni. These comparisons revealed no differences across the individual interfaces for glanced behavior. Of those people who glanced at the display, significantly more of them were found to stop and visit the display in the *Bandwagon* condition than those in the *Control* condition ($OR = 5.31, CI = [2.31, 13.73], p < .001$). No differences were found across the other interface pairings for stopping behavior. Finally, among those people who stopped at the display, significantly more of them touched the display in the *Call-To-Action* condition than in *Bandwagon* condition ($OR = 7.28, CI = [1.67, 45.8], p = .012$). No other differences were found for touching behavior.

6.2 Qualitative Results

As aforementioned, we collected survey responses from 31 passersby, some of whom interacted with the display, and some who did not (but maybe glanced or stopped). Our survey provided insights on people's motives for either stopping and engaging with the display or for avoiding the display. In the following, we report the insights gained from this survey.

First, all 31 participants reported that they glanced at the display. Thus, they were all able to answer a question related to what drew their attention to the display. In response to this question, 24 participants reported that the "physical display device" was the main feature that attracted them. Fourteen of 31 respondents reported that they were attracted by the colorfulness of the display, while six people reported that display's recent appearance in the deployment setting attracted them. One person reported that they were attracted to the display by the statistic of the *Bandwagon* interface.

Fifteen of 31 respondents stopped to look at the display but did not touch it. A variety of reasons were given for not interacting with the

Table 1: The total and relative amount of people that passed by, glanced at, stopped before, or touched our display for every interface condition. Relative amounts from the amount of passersby for each condition are given in %.

CONDITION	*Passed*	*Glanced*	*Stopped*	*Touched*
Control	418	164 (39.2%)	8 (1.9%)	6 (1.4%)
Bandwagon	352	163 (46.3%)	35 (9.9%)	15 (4.3%)
Call-To-Action	343	163 (47.5%)	20 (5.8%)	17 (5.0%)
Total	1113	490 (44.0%)	63 (5.7%)	38 (3.4%)

Table 2: The results of our conversion analysis. For each of our experimental conditions we present the frequencies of our target behaviors filtered by the previous behavior. For example, in the *Control* condition 164 passersby glanced at the PLID. Of those 164 passersby, 156 did not stop to look at the PLID, while 8 passersby did. Below those frequencies the results of Fisher's exact test are presented which do not offer odds ratios if there are more than two categories in one variable (we have three interfaces). At the bottom of the table we present the results of our pairwise comparisons for each test. We adjusted the p values with Bonferroni (i.e., $p \cdot m$ while $m = 3$ for three pairwise comparisons). Significant p-values ($p < 0.05$) are in bold.

CONDITION	*Not glanced*	*Glanced*	*Not stopped*	*Stopped*	*Not touched*	*Touched*
Control	254	164	156	8	2	6
Bandwagon	189	163	128	35	20	15
Call-To-Action	180	163	143	20	3	17
Fisher's Exact Test	p = **0.041**		p < **0.001**		p = **0.004**	
PAIRWISE COMPARISON	*Odds Ratio [CI]*	*Adjusted p*	*Odds Ratio [CI]*	*Adjusted p*	*Odds Ratio [CI]*	*Adjusted p*
Control and *Bandwagon*	1.34 [0.99, 1.80]	0.146	5.31 [2.31, 13.73]	< **0.001**	0.26 [0.02, 1.71]	0.397
Control and *Call-To-Action*	1.40 [1.04, 1.89]	0.068	2.72 [1.11, 7.37]	0.055	1.84 [0.13, 20.7]	1.000
Bandwagon and *Call-To-Action*	1.05 [0.77, 1.43]	1.000	0.51 [0.27, 0.97]	0.113	7.28 [1.67, 45.8]	**0.012**

display, including being in a hurry (6 respondents), not finding the display content personally interesting (2 respondents), being unsure what would happen if they touched the display (3 respondents), not being able to access the display because other people were in the way (1 respondent), not needed to touch the display because a friend she was with did it for her (1 respondent), and, finally, not wanting "to be part of the statistic" (i.e., percentage-counter in the *Bandwagon* interface) (2 respondents).

Finally, survey participants were asked how much they feared to embarrass themselves in front of public displays. Thirteen (41.94%) respondents reported they were not concerned at all, eight (25.81%) were a little concerned, seven (22.58%) were somewhat concerned, and three (9.68%) were very concerned. Thus, over 30% of respondents reported they were at least somewhat concerned about embarrassing themselves in front of a public display. Almost 10% of respondents reported they were very concerned about the potential for social embarrassment.

7 Discussion

As shown in Table 1, the individual interfaces persuaded 1.4% (*Control*), 4.3% (*Bandwagon*) and 5.0% (*Call-To-Action*) of passersby to touch the display. These rates are consistent with, or on the high side of, meaningful engagement levels reported in other studies, including 3.4-5% [34], 1.46-1.74% [5], and 2.2-2.9% [32]. Due to the relatively short time of deployment, however, it is likely these numbers also include a novelty effect (i.e., something is interesting because it is new). Thus, we may expect these numbers to decrease and stabilize at a certain level of interaction [22]. However, given our inclusion of a control condition, and the visual similarity of our three deployed interfaces at a broad level, we would also expect the novelty effect to be similar across all conditions, maintaining the internal validity of our reported findings.

Our findings also show a high frequency of glancing behavior across conditions, with 39.2% (*Control*), 46.3% (*Bandwagon*) and 47.5% (*Call-To-Action*) of passersby glancing at the PLID, respectively per condition, and 44.0% in total. This finding is close to the average percentage of passersby who glanced at the public displays in a shopping mall in Dalton et al.'s [8] eye-tracking study mentioned earlier in the paper. They found that, on average, the displays in their study were glanced at by 37.8% of passersby [8]. This similarity to our results supports Dalton et al.'s assertion that passersby are not inherently blind to displays (i.e., display blindness). Indeed, our results show that many more passersby actually glanced at the PLID in comparison to Huang et al.'s findings (4 - 16.2%) [16], indicating that display blindness was not a significant barrier to user engagement in our study context. The reason for this difference might lie in the way glances were registered as stated by the researchers themselves [16]. While we relied on video coding and Dalton et al. on eye-tracking technology, Huang et al. only relied on observational field notes potentially missing out on many instances of glances by passersby. It is also likely that we are also under reporting actual glance behavior in our study because our measurement technique relied on video analysis. Thus, we were limited to observable glances in the video frame. Glances that occurred from far away would not have been detectable using this method.

7.1 Mitigating Display Avoidance

Looking at display avoidance, the *Bandwagon* interface was shown to positively influence people's willingness to stop and investigate the display. Examining the data from the individual interfaces shows that 3-5 times more passersby stopped at the PLID in the *Bandwagon* condition (9.9%) compared to the *Control* condition (1.9%). This difference is significant according to our conversion analysis which indicates that the *Bandwagon* design had the intended effect to prompt people to stop and see what "other people" (suggested by the display) had done or found interesting. This notion is supported by at least one survey respondent explicitly reporting that they were intrigued by the statistic that the *Bandwagon* interface offered. Note, we did not mention any specific interfaces in our questions and, instead, asked about general attitudes of PLID usage, thus, we received little direct feedback on the *Bandwagon* interface. This survey respondent's comment brings to mind the honey-pot phenomenon, discussed earlier in the paper, which is often seen in PLID studies whereby people stop because others have stopped. Wouters

et al. [38] have previously reported that the honey-pot phenomenon lowers the potential for social embarrassment by helping to reduce uncertainty around potential system interactions, and can trigger "anticipation to learn more about the features and interactivity" [p. 10] of the system. Something similar may have been induced by the *Bandwagon* condition.

7.2 Mitigating Interaction Blindness and Avoidance

In general, once a PLID persuades passersby to stop and investigate, it next needs to communicate its interactivity and then motivate them to interact with the display. Thus, we argue that any passerby who touches the PLID has transitioned through these two mental states, thus overcoming interaction blindness and avoidance, though perhaps not in that order (e.g., they may touch the display and then learn of or confirm its interactivity through its reaction).

Interestingly, our conversion analysis found that there was a significant difference in touch behavior across the three interfaces. The pairwise comparison revealed that there was a significant difference between the *Bandwagon* interface and the *Call-To-Action* interface. The *Call-To-Action* interface more effectively mitigated both interaction blindness and avoidance barriers in comparison to the *Bandwagon* interface.

The positive impact of the *Call-To-Action* interface on display interaction in comparison to the *Bandwagon* interface is likely explained by the ability of direct, action-oriented messaging to reduce any ambiguity about the display's potential interactivity. That is, it was able to communicate that the PLID was interactive, and that it enables *touch-based* interaction, something that the *Bandwagon* interface was lacking. By lowering the display's ambiguity we argue that *Call-To-Action* interface helped to mitigate social concerns such as the fear of social embarrassment stemming from potentially performing the wrong actions at the display and subsequently looking silly or incompetent.

For the *Bandwagon* interface, however, the results were surprising. While the *Bandwagon* interface was the most successful in causing passersby to stop, it was the only condition of the three in which the majority of visitors (i.e., passersby that have stopped) ended up withdrawing from the display without touching it. While this touch data alone do not clarify whether this was due to interaction blindness or interaction avoidance, the survey responses shed some light into this result. Two respondents from the *Bandwagon* condition spontaneously commented that they did "not want to be part of the statistic". This suggests that they understood they "could" interact with the display but did not want to become one of "viewers who touched the display".

This reaction is consistent with another social phenomenon, called the snob-effect. Also defined by Leibenstein [21], the snob-effect describes the opposite effect to the bandwagon-effect that causes people to stop following a majority to keep their individualism. Thus, it appears that for some passersby, the bandwagon-effect may have drawn them to the display, but that the suggestion of a "majority group" within the display (e.g., the 74.6% of prior visitors who touched the display) may have invoked the snob-effect and prevented them to interact with the display in order to potentially keep their individualism. Additionally, the more inherent possibility of being tracked by the PLID in the *Bandwagon* condition may have deterred passersby.

Nevertheless, this shows the complex nature of mitigating social barriers; humans are complex social creatures, with both individual and social desires and needs. To our knowledge, this is the first study to uncover the potential of the snob-effect to negatively impact PLID interactions; this phenomenon warrants further investigation, especially balancing multiple social effects to successfully engage passersby.

7.3 Designing for Intriguing Socially-Safe Interaction

The findings from our study indicate that it is important for a PLID design to go beyond communicating interactivity to engage users, but also that it must offer "socially-safe" interactions. By this we mean that any interaction modalities and on-screen interface layout and logic should minimize the potential for failure to thereby minimize the potential for social embarrassment. The survey results from our study, which indicated that many passersby were at least somewhat concerned with embarrassing themselves in front of a PLID, highlight the need for this requirement for designing effective PLID interaction. We argue that the simplest way to realize this requirement is to speak to the long-held wisdom in usability design: provide simple, straightforward interaction to improve the learnability of the system [30].

In Wigdor and Wixon's book, "Brave NUI World" [37], they recommend a design technique called "self-revealing gestures" that provides visual guidance to help users learn and use multitouch gestures (e.g., arrows on screen during resizing action to indicate that users should drag their fingers in a certain direction to complete the action). They also recommend using hover information, when available, to preview potential user actions available in the current system state to minimize user uncertainty during system use. We argue that the same design advice is relevant to PLIDs (whether they are multitouch or not). Providing "previews" of available user actions may help reduce uncertainty about system usage and increase someone's confidence in how the system can be used. This increased confidence may in turn mitigate their fear of social embarrassment due to "messing up" while interacting with the display, and potentially result in a greater willingness to interact with the display.

The "socially-safe" concept also applies to the type of interaction modality provided by the system. In recent work, Coenen et al. [5] explored the use of alternative, more subtle interaction modalities, specifically in the form of pressure-based floor mats, in response to people's negative reactions to one PLID deployment that utilized mid-air gestures. They found that people felt their interactions were too "on display" when using the gesture-based system, which consequently led to frequent interaction avoidance behavior. In contrast, however, other work has found some gestural systems, especially playful ones [27] helped to encourage interactions. These inconsistent results again show the complexity of overcoming social issues. Different contexts (e.g., formal versus informal), different PLID design goals (e.g., providing information versus providing an experience), and different user populations (e.g., young versus old; technology savvy or not) are among many factors that should be considered when determining how "socially-safe" a specific PLID design is. Further studies are warranted to better understand how to balance various social concerns that may arise under different usage and design conditions to help develop common design patterns that can work across differing contexts, and also unique design solutions that apply in specific contexts.

8 LIMITATIONS

A limitation of our study relates to a common methodological challenge for all in-the-wild PLID studies: the potential for passersby to return to the display later in the deployment period. If they do, these passersby may show completely different behavior. We attempted to code these occurrences in our video analysis, but recognizing returning passersby was difficult and in most cases relied on the researchers' recognition of someone's clothes. Since we felt this coding was unreliable, it was omitted from our analysis. However, we acknowledge that some passersby passed by our display multiple times potentially diluting our between-subjects design.

Another limitation is the deception of passersby: The information kiosk is not a fully functional system and only provides the facade of an information kiosk. Passersby that observed other passersby while interacting with the PLID may have reacted differently if the system

was fully functional. This potential confound is why we chose to analyze groups of people at the display as a "group" and a single unit of analysis, but we acknowledge that someone at a distance may have witnessed this behaviour and may not have been counted in the "group". Furthermore, the percentage-counter in the *Bandwagon* interface was based on a temporary, stable, fake number that we used to keep situations comparable to each other. We tried to debrief passersby on this deception as much as our role as investigators allowed it to overcome this issue.

Another limitation is the study sample demographics. Since the study was run on an university campus in an Engineering building, most passersby were Engineering students. Surprising, however, is the fact that despite our sample population's expected familiarity and comfort level with interactive technologies, we still found similarly low numbers of touch events across the different conditions, consistent with many studies done elsewhere with different populations and contexts. To overcome the problem that very few passersby actually interact with the PLID (which all studies investigating the first-click problem have), we used Fisher's exact test which is effective in dealing with small cell numbers. Nevertheless, it is an issue that limits our results, and requires further investigation with larger sample sizes and longer deployments.

9 Conclusions

Similar to the well known commonly discussed challenges of display and interaction blindness in PLID research, display avoidance and interaction avoidance behaviors often thwart designers' efforts to engage potential users in public settings. Social barriers, such as the fear of social embarrassment, have previously been identified by PLID researchers [2, 4], and likely play a significant role in these avoidance behaviors. To address this issue we explored the potential of the bandwagon-effect to increase passersby engagement with PLIDs. The intent was to impart a sense of "group" or "community" within the PLID interface in order to invoke feelings of curiosity about the display. This in turn, was meant to make people "jump on" (i.e., also visit and interact with the display like the others in the group who did so).

We compared this bandwagon design approach to the more traditional call-to-action PLID design approach in a four-day field experiment. Our results revealed that the bandwagon approach caused passersby to stop in front of the PLID effectively overcoming display blindness and avoidance. Furthermore, we found that the call-to-action approach was able to cause more passersby to touch the PLID after they had stopped in front of it in comparison to the bandwagon approach. Our data analysis indicated that this may have been caused by another social phenomenon being triggered, the snob effect. However, this warrants further investigation. These results highlight the need for providing "socially-safe" PLID designs to help reduce the social concerns of potential users due to the inherently visible, "on-display" nature of interacting with a public display.

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