Understanding Location-Based Information Sharing in a Mobile Human Computation Game

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Abstract—Human Computation Games (HCGs), harness the element of fun from games and information is generated as a byproduct of gameplay. A number of location-based mobile HCGs have emerged recently. Understanding actual usage and usability issues is crucial in identifying the challenges users face while using such applications. We introduce SPLASH (Seek, PLAy, SHare), a mobile HCG that blends gameplay with location-based information sharing. This paper also highlights the actual usage and users’ perspective of SPLASH by 40 participants who took part in an evaluation of the application. Participants kept a six day diary and completed a post study questionnaire. Results suggested the participants were encouraged to contribute to information by the games in SPLASH. The implications of this study are discussed.

Keywords—information sharing; mobile game; user study; location-based information; human computation game

I. INTRODUCTION

Spurred by the integration of global positioning systems, wireless Internet access and multimedia capabilities in mobile devices, users are now able to create and share location-based information anytime, anywhere. Recently, a number of location-based mobile applications that allow users to share content and play games have emerged. For instance, players in Foursquare (http://foursquare.com) check into places to earn points and share tips about the place with other players at the same time. Games are included in these applications with the aim of motivating continued usage [8, 10]. These applications, termed Human Computation Games (HCGs) [7], harness the element of fun from the games and information is generated as a byproduct of gameplay.

The concept of HCGs drew upon the need for generating useful information, which cannot be automated, by leveraging on human intelligence [7, 20]. Contributing location-based information is a labor intensive process that involves people annotating descriptions to physical locations. On the other hand, games offer entertainment that could serve as motivation for players to utilize their intellectual and creative abilities while engaging in gameplay. By exploiting the entertainment value in games, players are able have fun while performing computations as a byproduct of gameplay.

HCGs were originally designed for the Web [e.g. 19, 21, 22] and they have recently been introduced on the mobile platform. One example is the CityExplorer [16]. The application using gaming elements to motivate players to contribute location-based information. Players compete to claim the most number of markers using their mobile phones to take images of places and select the most appropriate category to tag with the image. Research on mobile content and gaming application have focused largely on design [2, 14, 18] and motivations of usage [8, 10]. Although these issues are crucial, understanding actual usage and usability issues related to information sharing are also essential in identifying the challenges that users face while using the applications [17]. The outcome of such investigations translates into better designed applications that would benefit users and encourage sustained usage.

We aim to fill this research gap by fulfilling two objectives in this study. First, we extend current research through the design and implementation of SPLASH (Seek, PLAy, SHare), a mobile application which blends information sharing with gaming activities. Second, we evaluated SPLASH to shed light on actual usage and perspectives of the application. The remainder of the paper is organized as follows. The following section will introduce related literature followed by SPLASH. The subsequent sections will highlight the methodology and the findings of the study. This paper will conclude with a section that discusses the findings and future directions.

II. RELATED WORK

A. Human Computation Games

Human computation games entwine gameplay with human computation with the aim of generating useful information. These games harness people’s inclination to have enjoyment and fun, and their capability of solving certain problems much better than computers. These games could be seen as a type of social computing application.

The earliest examples of HCGs were implemented for the Web. One such game is the ESP Game [19]. In this game, two unrelated players are required to propose as many matching labels as they can within a time limit. Players earn points based on the number of matched labels. The resulting labels, being descriptions of images, can then be used as indexed terms for image retrieval. Another similar game is Verbosity [22] that collects commonsense knowledge from players. Like the ESP Game, two players are paired up and the roles of narrator and guesser are randomly assigned to
them. A keyword is given to the narrator, who will describe it to a guesser using hints. To make it fun for the narrator, sentence templates contain blanks to be filled. The guesser will see the sentences and type in what he/she thinks the keyword is. The players take turn to describe and guess the keyword and try to guess as much keywords as possible within a defined time period. The commonsense data obtained from this game could be used in search engines. In Curator [23], a pair of players is required to group related items into collections. They are awarded points based on the number of matches that have obtained. The resulting data could be used in a collection recommender system.

HCGs have also been implemented for mobile devices. CityExplorer, described earlier, is one example. Another instance is the Gopher Game [4], where players contribute to location-based images and textual content in response to tasks found in the Gophers. The player could pick up any Gopher on their mobile phone that they have found and help complete the tasks by interacting with the Gophers. Players earn points through the quality of their contribution that were judged by the community of players. The resulting data could be used in location-based search engines. Similarly, players in EyeSpy [2] share images that they had taken with other players, who have to find and validate where the images were taken. Both image contributor and validator score points when the images have been validated. The images with their location resulting from this game could be used for location-based image retrieval. Indagator [10], on the other hand, takes a different approach from other applications. The application provide users an environment to share and browse through the media rich location-based annotations. The gaming features form another layer over location-based annotations. In other words, gameplay elements are laid over the player’s actual physical environment so that interaction with game objects and other gaming features are done within the real world. Players earn in-game currency through rating annotations, contributing annotations and engaging encounters.

B. Methods of conducting user studies

Understanding actual usage and usability issues in such games are crucial in the continued usage for contributing location-based information through gameplay. Studies on mobile content sharing and gaming application have employed a multitude of perspectives in terms of the methodologies adopted.

Some research has focused on user studies that took place in lab settings. Here, the conditions of the study could be easily controlled. However, it is not able to capture the actual usage of the application in diverse real-world settings [3]. For instance, the user study for Indagator had adopted this approach, using a lab as the setting. This allowed the researchers to attend to queries by the participants and provide more interaction between the researchers and the application. Their study was complemented with post study questionnaires that were filled by the participants. Although quantitative results relating to the aims of the study were obtained, the research did not go further than the lab to explore participants’ experiences while using the application.

In contrast, other work has conducted field studies. The richness and complexity of real usage that are the essence of field studies [17] are captured through different methods of data collection that are used in tandem during the studies. The actual usage of the Gopher Game was analyzed through the server logs and the participants’ diaries. These were in addition to the post study questionnaire and interviews conducted after the participants played the game. Other studies also have relied on data from the server logs that were later triangulated with another set of data garnered from a different method of collection. The actions of participants playing EyeSpy were complemented with interviews. Similarly, PhotoCity [18] complemented data from the server logs with a post study survey. As a result, these studies were able to provide a clearer picture of the users’ perspectives while using the application.

III. SPLASH

At its core, SPLASH allows users to contribute and access location-based content. Layered upon this service, are gaming features that gives users the opportunity to concurrently engage content through play. The application was developed for the Android mobile platform.

Information in SPLASH is in the form media-rich location-based information known as “comments” (Figure 1). Each comment comprises a title, tags, description, one or more media elements and ratings, which are an indicator for information quality. Other information such as author, date and location are also implicitly captured by the system at creation time. In SPLASH’s content model, a real-world location is organized into two conceptual levels. “Places” represent an arbitrary geographic area that holds comments, and examples include buildings, parks, points of interest, and so on. Places may also be further divided into “units”, with each unit containing its own set of comments. For example, a mall in the real-world could be represented by a place in SPLASH. As the mall has multiple stores, each store is considered a SPLASH unit and contains comments related to it. Note however that units are optional, and a place need not be subdivided if there is no necessity to do so.

In SPLASH, information sharing features are entwined with gaming features through virtual rooms where users interact, share information and play games. These rooms are designed to establish a sense of community among users, which has been demonstrated to foster content sharing [10]. Put differently, each place or unit is represented by a virtual room which in turn, provides a platform for accessing SPLASH’s content sharing and gaming features.

SPLASH offers map interface to access virtual rooms (Figure 2). Each marker on the map represents a real-world location, which could be either a place or a unit, where virtual rooms are available. Users navigate the map by panning and zooming. Accessing a virtual room is accomplished by selecting a marker of interest or by keyword search. In densely populated areas with many virtual rooms, users are first presented with a list of available rooms for selection.
Virtual rooms also offer entertainment via two types of mini-games: informational and casual mini-games. Mini-games are games that do not require players to be engaged for a significant length of time. These are appropriate to be played on mobile devices to capitalize on the fact that these games could be played in short-bursts of time during interstitial periods [11]. Information mini-games utilize nearby content to help users learn about a particular location. One example is a game that randomly selects a captured image around a user’s current location to create a jigsaw puzzle. By solving the puzzle, users are able to see images shared by others (Figure 4). In contrast, casual mini-games offer pure entertainment. An instance of such games is a balloon bursting game, where users do their best to burst as much colored balloons as possible within a time limit while avoiding bursting the balloons that are filled with bombs (Figure 5). Mini-games are represented by items in the virtual room (see Figure 3) and are played by selecting it.

Virtual rooms are also designed to promote socializing. Each user is represented as an avatar which can be customized with items purchased with gold. The avatars also provide a form of virtual presence for users to encourage them to socialize [6]. These avatars are displayed on users’ profile pages and in virtual rooms that users visit. A “friend” function allows users to add other users as friends. This allows them to quickly view updates of comments posted by their friends, and to also send private messages to them.

To further promote usage of the application, SPLASH offers a number of reward systems. First, users earn in-game currency called gold (Figure 6) when they contribute comments, rate comments or perform well at mini-games. Gold can be used to buy items or customize one’s avatar. Second, the application awards badges for various milestones achieved. These include contributing targeted numbers of comments or ratings, contributing items in virtual rooms, and meeting mini-game objectives. These awards are displayed in a user’s profile page. Third, public scoreboards rank users based on different accomplishments. These include rankings by amount of gold amassed, number of comments contributed, and number of comments rated. At the same time, these scoreboards provide an opportunity for the users to compete with one another [15].

IV. METHODOLOGY

A user study was conducted with the aim of eliciting the actual usage and users’ perspectives of SPLASH. Diaries, data logs as well as questionnaires were utilized in this study to draw out relevant information from the participants. In the study, participants were requested to accomplish tasks using SPLASH for six days. The tasks were meant to exercise SPLASH’s main features and included contributing to location-based content, playing games as well as contributing to items in the virtual rooms.

The diary’s objective was to record usage of SPLASH by the participants. Through the diaries, we were able to uncover the participants’ usage patterns as well as problems encountered. The questions in the diary entries drew out the conditions that the participants were in when doing the task, such as the time, location they were at and what they were doing, in addition to the issues they had encountered.

The questionnaire that was administered at the end of the study focused on seeking participants’ perceptions of SPLASH’s features and functionality. The items were adapted from previous work on mobile gaming and usability [5, 15] and comprised items related to the usability of the features in SPLASH. The items made up eight categories, namely virtual room, general navigation, map navigation, information sharing mechanism, comment creation, avatar, in-game currency and mini-games. The items consisted of affirmative statements that indicated that they understood and knew the functions of each category. The participants were requested to rate the questionnaire items on a scale of 1

Figure 1. A user contributed location-based comment.
Figure 2. Markers on the map indicating availability of virtual rooms.
Figure 3. A virtual room with user contributed item.
(strongly disagree) to 5 (strongly disagree). They were also asked to provide qualitative comments on the features that they liked and disliked, as well as the improvements that could be made in future versions of SPLASH.

Participants were given a tutorial to familiarize themselves with the application, after which, tasks that they had to complete during the evaluation were made known. Mobile devices that had SPLASH installed were loaned to the participants to provide a consistent user experience. Participants were also introduced to the customized Web-based diary application that allowed them to log in and answer questions related to their actions as part of the diary study. They were instructed to complete their diaries at the end of the day after tasks were completed. At the end of the evaluation period, participants completed the questionnaires about the usability and their views of SPLASH.

V. RESULTS

The study had 40 participants, who were between 20 and 45 years old ($M = 26.3$ years old, $SD = 5$) with 25 males. The majority of the participants were a mix of undergraduate and postgraduate students, with seven being working adults. Here, 50% of the participants came from a Computer Science/IT background, while the rest were from various disciplines such as Arts, Humanities and Social Sciences, Engineering, Media and Advertising, Bio Science and Mathematics. The participants were regular mobile users who used their phones regularly for sending text messages and making phone calls. They also used their mobile phones to play games and to navigate using map applications. However, the participants rarely surfed the Internet on the mobile or use mobile social networking applications.

A. Usage behavior

We examined the participants’ usage behavior from their diary entries. The participants contributed an average of 182.63 entries during the course of the evaluation ($SD = 111.61$, Min = 14, Max = 465). Figure 7 shows the accumulation of information sharing and gameplay activities over a 24-hour period. We present both information sharing and gameplay activities that took place.

The participants tended to be engaged in information sharing at 8:00, 13:00, 15:00, 19:00 and 22:00. These timings coincided with the participants commuting hours and free time. For gameplay activities, the significant peaks were at 8:00, 14:00 and 20:00, which also represented the commuting hours and free time for the participants. Most activities took place in the evening between 19:00 to 22:00 that constituted leisure time for the participants. Perhaps SPLASH provided entertainment to them as they were winding down for the day. For example, participants remarked that they were playing with SPLASH “before sleeping” (Participant 24) or while they were “resting” (Participant 33). A substantial number of activities also took place during lunch time between 12:00 and 15:00. The participants took the opportunity to engage themselves with SPLASH. Participant 27 recalled playing SPLASH during his “lunch break”, while Participant 37 was playing “after lunch while chatting with friends”. It is also worth noting that the activities also took place during their commuting hours (i.e. 08:00 and 18:00). They made use of the application to possibly combat boredom during their commute.
instance, Participant 8 played while “in the train” and Participant 2 highlighted playing it while “on the bus”.

The participants reported the locations where they had used SPLASH over the course of the six days. We identified eight different categories of locations from the participants’ diaries: home, work, school, transport area (e.g. bus stop, train station), in transit (e.g. in the bus, train or car, or walking), food outlet (e.g. a restaurant), recreation area (e.g. a museum), shopping mall and school. Figure 8 shows the number actions that took place in the different categories of locations. The participants used the application at home 47% of the time. For the rest of the time, the application was used in locations that were away from home. Next, the application was used in the participants’ school (15.2%) or work place (13.5%). They also used the application during their transit (14.8%). This corroborated with the earlier finding on the peak times that SPLASH was used. Finally, the remaining the locations where SPLASH was used constituted 9.5% of the time. Results suggest that the application was used for either leisure (e.g. at home) or during interstitial periods (e.g. in transit, at a transport area).

The participants also reported the situations that they were in while using SPLASH from their diaries. We identified four categories of situations, namely, free time, commuting, waiting or multitasking. Figure 9 shows the different situations that the participants were in. It is not surprising that the participants used SPLASH during their free time. This indicates that they see SPLASH providing them with something to do in order to kill time. SPLASH was also used in situations while they had to wait. For instance, their diaries highlighted that they had used it while in a queue waiting for their turn to be served (“queuing for dinner” - Participant 19), or while waiting for their meals (“waiting for food” – Participant 9). Other situations included waiting for a public transport (“waiting for bus” – Participant 16, “waiting for the MRT (a local train system)” – Participant 26), or in one case, “waiting for the traffic jam to ease” (Participant 38). Another situation was to occupy them while waiting for their friends or family members (“waiting for friends” – Participant 26, “waiting for my mum to finish her grocery shopping” – Participant 40) or for an appointment (“waiting for meeting (to start)” – Participant 16). The participants also used SPLASH during their commute (“travelling on bus” – Participant 27, “on train” – Participant 29). Finally, there were some instances when the participants were using SPLASH while doing another task. For example, they were using the application “while eating” (Participant 15), “chatting with friends” (Participant 36), or “watching the television” (Participant 39).

In order to gain a better insight on the type of information that had been contributed by the participants, we analyzed the comments they contributed from our data logs. They had contributed a total of 262 comments (M = 6.55). The comments were coded into different categories. In all, we identified the categories shown in Figure 10. Here, we will describe the categories that are noteworthy.

The participants contributed the largest number of comments about food. The content that was shared by the participants was in the form of reviews and recommendations of meals that they had. For instance, A participant shared that the “Japanese food here is good” after having a meal at a popular Japanese restaurant.
Comments that described the emotional state of the participants were also found. The comments varied from the verbose (e.g. “feeling sleepy:( having loads of wrk to do:( god pls help me...”) to the succinct (e.g. “sad”, “emo”).

Another notable category is places of interest. Comments in this category contained descriptions of places that included tourist attractions, stores and shopping malls. Some plainly described a place (e.g. “there is a hib office on level 2”) to notify others of its existence. Other comments had emotions attached to the description (e.g. “nice and romantic place”) indicating that perhaps SPLASH was seen as a platform to preserve a fond memory of the place.

Surprisingly, there were also random comments that were contributed. These were short, nonsensical comments such as “tg”, “abc”, which did not have any meanings attached. Closer inspection revealed that these comments were created consecutively within a short span of time. One possibility is that the participants contributed these comments when they had just started using SPLASH and were trying out the functionalities. Another reason could be that they might be contributing such comments just to earn in-game currency.

The participants also contributed comments that were related to school. This corroborates with our earlier finding on the places that SPLASH was used. This could also be due to the fact that most the participants were students and spent most of their time on the campus. Next, comments related to participants’ current status were also contributed. These reflected their current state (e.g. “waiting for meeting”, “super surprise to bump into my old classmate from poly at can a bus-stop...going to take a nap now hehe :S”).

Further, comments that were created about commuting were also discerned. The comments contained lament from the participants during their journey on the public transport (e.g. “very crowded train”). Finally, comments about SPLASH were also found. The comments were about how the participants felt about SPLASH. For instance, a participant gave feedback about the map in the application (“the map seems good”). Another participant expressed delight after enjoying a game (“I just won balloon shooter”).

C. Usability

Here, we examine the usability of the features in SPLASH elicited from the post-study questionnaire. First, general features constitute the navigation, buildings and virtual rooms of the application. Table 1 presents the results of the participants’ perspectives. They found the virtual room to be intuitive to use as they were able to interact with the items (“The virtual room is interesting with items that I am able to interact with it”) – Participant 16. The navigation aspect deals with the ability to access the features easily. While many found it to be easy to do so, some felt that the features could be further improved as they had problems with the response of the device touch screen display (“Hard to navigate, basically, it’s about a problem (with the) display’s responsiveness” – Participant 37). The participants also found SPLASH’s map to be easy to navigate as they were familiar with maps on other applications.

Next, information sharing features includes the information sharing and comments mechanism available in SPLASH (Table 1). The participants found that information sharing was easy as they were able “to communicate with friends”. For comments, they liked the idea that it was related to a real location (“People can post their comment with place information, so we can know where (the) comment is located. That’s fun.” – Participant 18).

Finally, gameplay features constitute the users’ avatar, in-game currency as well as the mini-games that are available (Table 1). The participants enjoyed using the avatar due to its uniqueness (“I like the avatar best as it is different from other social applications” – Participant 6). A segment of the participants felt that it would be more useful to expand the range of items available for customizing their avatars. They also found that they concept of in-game currency was easy to understand and knew the various ways that it could be earned (“Can earn through playing games and sharing information” – Participant 8). At the same time, they felt that more transparency in the mechanism of earning the currency is needed as they did not know how much of the currency that they had obtained from the games or by contributing to comments were added to their earnings. The participants did not find the mini-games that were available favorable. First, they felt that there was a lack of variety in the games. Secondly, they found that the games are “not challenging” (Participant 20) and were “not interesting enough” (Participant 23). Thirdly, there were issues with the responsiveness of the mobile device touch screen that caused the less tolerant participants to feel frustrated.

![Types of content shared](chart.png)

**Figure 10.** Categories of content contributed using SPLASH.

<table>
<thead>
<tr>
<th>TABLE I. USABILITY OF VARIOUS FEATURES</th>
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<tbody>
<tr>
<td><strong>General features</strong></td>
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<tr>
<td>Virtual room</td>
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<td>General navigation</td>
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<tr>
<td>Map navigation</td>
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<td><strong>Information sharing features</strong></td>
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<td>Information sharing mechanism</td>
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<td>Comments</td>
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<tr>
<td><strong>Gameplay features</strong></td>
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<td>Avatar</td>
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<td>In-game currency</td>
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<td>Mini-games</td>
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VI. DISCUSSION

To reiterate, the first aim of this paper is to introduce SPLASH, a mobile application which blends content sharing with gaming activities. Users in SPLASH are able to share location based content and play games while interacting with other users in virtual rooms. The application is similar to other work like Indagator [10], CityExplorer [14] and Eyespy [2]. SPLASH was evaluated to understand actual usage and the users’ perspectives of the application. The lack of quality content in Gopher is mitigated in SPLASH by the availability of rating feature for comment. At the same time, the virtual rooms in SPLASH provide a platform for users to socialize, which is in contrast to Indagator and CityExplorer. SPLASH also offers a myriad of games to overcome the repetitive tasks found in other games. The second aim of this paper highlights the actual usage and user perceptions of SPLASH arising from the user study.

Our study has yielded the following findings. First, the games in SPLASH seemed to encourage the participants to contribute location-based information. Our finding has reaffirm that games could motivate users to contribute location-based [8]. We found that the participants’ interest in SPLASH continued to be sustained which enabled them to contribute to more information. For example, Participant 33 commented that “it’s easy to share information with friends while it is entertaining with the help of incorporating game features and scoring and reward systems.”

Next, we found that SPLASH was used during the participants’ leisure time and pockets of free time in different situations. Also, information sharing activities occurred more consistently throughout the day than gameplay activities indicating that with SPLASH, information creation could be done anytime, anywhere [8]. It could be due to two reasons. First, perhaps it took less effort for the participants to share information than playing games in SPLASH due to the issues that they encountered. In addition, another reason could be that it was easier for them to earn the in-game currency by creating comments than playing games. It is also interesting to note that the participants were able to adapt the use of SPLASH into their daily activities [e.g. 1].

Thirdly, the scores obtained for the usability of the features indicated that the features in SPLASH were able to support the objectives of information sharing with gameplay on mobile device. There were features, like the map, avatar and location-based comments, that the participants found to be useful and these could positively influence the participants to contribute. However, the unchallenging games and mobile hardware problems could have probably affected the participants’ perception in usability.

Finally, the type of content that was shared did not only include typical comments about food and shopping that had been found in other studies [e.g. 12]. It included comments that contained the current emotional state of the participants at that point in time. This is noteworthy as location-based sharing seems to include factual information as well as a person’s feelings at a particular time and place.

VII. CONCLUSION

Some design implications arise from our findings. First, applications that combine content sharing and gaming have to address the twin challenges of overall usability design as well as game design. Consequently, it would be prudent to consult and adhere to establish game design guidelines (e.g. [15]) even though content sharing may the primary focus.

Second, different types of games could be included to accommodate the varying interests of users. Examples include action, puzzle and strategy games. The number of genres could engage more users to use the application and sustain their interest to contribute more information.

Next, designers could implement a mechanism that limits the viewing of shared content to certain people in the users’ social network. This is because the comments that were contributed might be more valuable to users who are intimate with the contributor.

Also, as the application is used during interstitial periods, users could be prone to interruptions that are both external (e.g. phone calls, people, arriving at destination, network problems) and context related (e.g. short of time). Designers should be mindful that the tasks may not be completed due to these factors and measures should be put in place in order to accommodate the interruptions.

Finally, usability of the application is crucial in maintaining the interest and usage of the application. Thus, in addition to adhering to usability and gaming design guidelines [e.g. 5, 15], users should be informed that while they are playing games in SPLASH, they are also contributing to content that could be beneficial to others [16]. This would persuade users to contribute more content.

There are a few limitations to this study. First, our results were obtained through participants who were largely undergraduates and postgraduate students that could reduce the generalizability of our findings. A study that involves users with different profiles (e.g. more diverse age groups, and working backgrounds) or in specific domains (e.g. tourism) could understand more on users’ behavior and perception of SPLASH. Next, although the present study had made use both diaries and questionnaire to elicit the actual usage and perceptions, more could be done with other methodology such as observations, fieldwork or data logs.

Finally, another study could involve the comparison between SPLASH and other non-gaming mobile application to understand users’ attitudes and behaviors.

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