Toward Increasing User Engagement for Mobile Data Collection Applications using Social Influence

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ABSTRACT

Engaging users is a challenging task for the producers of mobile applications. In some cases the survival of companies is dependent on the number of users that use their applications on a regular basis. In this paper, we investigate whether the introduction of social communities affect user participation rate of a crowd-source mobile application. We propose a research model based on the social influence theory to explain the connection between social community and user motivation and then describe the mobile application we designed and implemented for our evaluation. We deployed this application to a number of users toward measuring the effect of social community features on user participation. While we were not able to validate our model in our evaluation, we have outlined a detailed critique of our experiment and several lessons learned that should benefit continued research in this area. The social communities should include a minimum number of members in them in order to foster a real community. Furthermore, participants should be involved in the creation of these communities in order to feel a greater sense of group goals. Future studies should also take into account the difference in usability factors of the two versions of application.

1 Introduction

The mobile application market has grown exponentially in the past years. There are currently over 1.4 million applications available for download in the Google Play Store (“Number of Android Applications”, 2014). However, engaging users is a challenging task to the mobile application industry, especially with social networks or citizen sensing (Mackerron & Mourato, 2013; Marti Garcia et al., 2012; Fitz-Walter et al., 2011; Farzan et al., 2008).

In this paper, we explore whether the introduction of social communities we call ‘tribes’ affected the user participation rate of a crowd-sourced data collection mobile application. By asking users to self-identify with ‘tribes’ based on lifestyle, location or interests – we think that user will increase their sense of social identity and feel like they are a part of a community.

Building on existing social influence theories, we proposed a research model shown in Figure 1 to explain the factors that drive user engagement. Our key research questions are:

\[ R1: \text{How does the addition of a social community layer affect the social processes such as Identification and Internalization in the context of a simple survey application?} \]

\[ R2: \text{Does social processes such as identification and internalization have an effect on the user participation rate of a simple survey applications?} \]

The paper makes several contributions. First, we built and deployed an Android based application using the Ionic Framework that collects responses from users on a ‘question of the day’, their mood and current location. Second, we carried out an experiment with 12 test subjects using different versions of the application to validate the effect identification and internalization using ‘tribes’ had on user participation rate. Finally, we provided a list of lessons learnt from the experimentation process.

The remainder of this paper is organized as follows: In section 2, we will present some related work. In Section 3, we will present our research model and our hypotheses. In Section 4, we will describe our research method. Section 5 presents the architecture and implementation of our application. We will
present an evaluation of the results in Section 6, followed by discussion outlining the limitations of our experiment as well as some interpretation of our results. We will conclude the paper in section 8.

2 RELATED WORK

According to the summary by Lui et al (2002), there are both individual and interpersonal factors motivating community contribution. Individual factors include both extrinsic – reward and personal need – and intrinsic motivation – altruism and reputation. Interpersonal factors include affection and affiliation with the member of the community. There are several techniques that encourage user participation (Farzan et al, 2008):

- Reward – awarding users for their contribution
- Highlight Community Benefit – highlighting importance of user contribution for the community
- Goal Setting – setting a goal for the users to reach
- Reputation – increasing users’ reputation by their contribution

2.1 Mappiness

Tribe was initially conceived as a tool for collecting and analyzing sentiments across Metro Vancouver based off another application called Mappiness – a UK based project created by Drs. George Mackerron and Susana Mourato. Mappiness is a mobile application designed to collect data on people’s happiness in the UK, as well as relaxedness, wakefulness and ambient data such as noise level and location. The experiment is carried out using Experience Sampling Method (ESM) where the participants are self-selecting and recruited opportunistically. With over 21,000 participants, the sample size for this experiment is believed to be the largest ever achieved by an ESM study (Mackerron & Mourato, 2013). The paper inferred the success of the application to be assisted by coverage in traditional and social media.

2.2 Foursquare

Foursquare is another example of a successful crowd source data collection mobile application for location sharing. As of December 2010, Foursquare claims that it has over 5 million members. By positioning itself as a mobile game, Foursquare offers their users both virtual and real life rewards for users that “check-in” using their application at different locations. Its virtual rewards take the form of titles – “Mayor” of some place – while its real life rewards includes discounts at some stores. In addition, Foursquare also includes a social component by allowing users share their locations with their friends.

Lindqvist et al (2011) investigate several reasons that contributed to the success of Foursquare. Through interviews and surveys, they discovered that by including both the gamification and social factors in the application – it caused users to be initially attracted through badges and fun and increased loyalty to the application as they built their social networks. This multi-value strategy not only attracts new users rapidly, it also ensures that users do not abandon the application in the long-term.

2.3 Noise Pollution Monitoring

Using a similar “Citizens as Voluntary Sensors” concept, Marti Garcia et al. (2012) implemented a mobile application for monitoring noise pollutions. In order to provide an incentive to users to perform a
repetitive boring task, the paper proposes a noise pollution monitoring application based on gamification techniques. Although they did not conduct an experiment that identified the effect of gamification, this paper identified four key concepts to a good gamification process: user status, access, power and stuff.

2.4 **Calibration Games**

In this paper, Flatla et al. (2011) developed calibration games to gather calibration data in an engaging and entertaining matter. Their results show that gamification does indeed add to the enjoyment of the user experience and did not produce significantly different data that standard calibration tasks. This suggests that game-based calibration solves motivation problems of standard calibration procedures.

2.5 **Orientation Passport**

Orientation passport – an application designed to help freshman’s participate in their orientation event, takes a similar approach in engaging its users: by implementing an achievement system which rewards virtual badges. The pilot study by Fitz-Walter et al. (2011) involving 26 students showed that although the participants received the game elements as a welcome addition, the data does not support a sustained user engagement. Once the participant has unlocked all the achievement related to an action, most participants stopped using the applications. This suggests that gamification itself does not support sustained user participations rate.

3 **Research Model and Hypothesis**

User engagement in crowd-sensing and other interactive mobile applications has been the subject of many studies and research in the recent years. Motivating user participation is dependent on several factors which include the task, the application as well as the user characteristic (“When the experiment is over”, 2008). There is extensive research on the use of gamification to encourage user participation (Flatla et al., 2011; Fitz-Walter et al., 2011; Marti Garcia et al., 2012). Some studies investigate various theories including technology acceptance model (Koh et al., 2007), trust theory (Ridings et al, 2002), commitment theory (Jang et al., 2008), social cognitive theory (Hsu et al., 2007) and social network theory (Toral et al, 2010). Other studies also examined the effect of social influence theory in the context of existing online social networks like Facebook, Renren, Mop and Baidu Tieba (Zhou, 2011).

The social influence theory states that individual behaviour is affected by three social processes: compliance, identification and internalization (Kelman, 1958). Compliance refers to when an individual acts to comply with the opinions of other people who are important to him/her. Identification refers to an individual identification with a community, such as a sense of belonging and attachment. Internalization reflects that an individual accepts the influence due to the congruence of his/her values with those of group members. These three social processes are often represented by subjective norm, social identity and group norm (Dholakia, 2004 & Shen et al., 2011). As the conditions of this experiment do not support the compliance process, we will examine the effects of two of the social processes, identification and internalization on user participation intention and behaviour in the context of a mobile crowd sensing application.
When the Tribe version of the application is in use, users are provided with tribes related to interests or lifestyle that they are able to join. The addition of a community related to the user’s interest and lifestyle should increase the connection that users have with the tribe. Thus, we propose:

\[ H1: \text{The existence of Tribes will increase the sense of social identity.} \]

\[ H2: \text{The existence of Tribes will increase the sense of group norm.} \]

Social identity reflects an individual’s identification with the group so that the individual perceives themselves as a member of the community (Dholakia et al, 2004). Social identity implies emotional involvement within a group in the form of commitment or loyalty which will encourage users to actively participate in a community (Zhou, 2011). Therefore:

\[ H3: \text{Social identity has a positive effect on user participation rate.} \]

Group norms refers to the agreement among members about their shared goals and expectation (Shen et al, 2011). When users find that their values and goals coincide with those of the group, they will encourage participation:

\[ H4: \text{Group norms has a positive effect on user participation rate.} \]

Figure 1 shows the research model.

4 Research Method

In order to answer our research question, we have built a native Android application with the Ionic Framework with HTML5. The design and development of this application was carried out in three phrases. In the design phrase, the existing application and structure was evaluated and new requirements for the Tribe application were defined. Several mock ups were created. The second phase included implementing both the backend and frontend features for the Tribe application. The third phase of the development process included testing and debugging of the features as well as a release to the experiment group.

The research model includes 4 hypotheses. 12 test subjects were divided into two categories for experimentation purposes. The test subjects were selected from friends and fellow colleagues. All users were given a set of instructions to install and initialized the application with the right version as well as a summary of features in the application that they can try. At the end of the experiment, the test subjects
were given survey items that are used to determine the effect of group norm and social identity on their participation behaviour.

Item were adapted from Dholakia et al. (2004) to this experiment. The final items in the survey are listed in Appendix 1. The participation metrics were determined by the number of questions that each triber had answered over the experimentation period as well as the number of mood inputs received.

To analyse the data in Excel, we conducted t-tests to determine whether the effect of the Tribe layer on Group Norm and Social Identity were significant, then we used correlation test to determine the effect that these two factors have on user behaviour.

### 5 Architecture and Implementation

#### 5.1 Architecture

The architecture of the Tribe application is separated into two distinct components. The majority of the processing occurs on the backend servers which stores information about tribers and their activities – their mood and their responses to questions. The mobile application front end provides a graphical interface with which tribers can respond to questions, participate in chats, log a mood value and view conglomerated results of their responses. A diagram of the Tribe architecture is shown in Figure 2.

**Backend Server**

![Diagram](image)

*Figure 2: High level architecture of Tribe*

#### 5.1.1 Backend Server

The backend server was developed using Node.js, MongoDB, ExpressJS and BackboneJS. It was set up to expose a RESTful API that the mobile application connects to. It consists of several component including tribers, questions, moods, tribes, notification and a firebase connection.

**5.1.1.1 Triber**

The backend server creates a user with a unique uuid from the triber’s device in order to persist the mood input and responses created by the triber. It also include demographic data (birth year, gender, income) and a nickname supplied by the triber on initial install. For the purpose of experimentation, a tribeEnabled flag is also included to identify which version of the mobile application is being used. The API endpoint for this include: creating triber, getting triber information, and getting tribe information by triber.
In the web application UI for the backend server, the developer is able to view a list of users and their demographic information. The developer is able to delete tribers and change the version of the application that they are using.

5.1.1.2 Questions
The developer is able to define the Question of the Day (QotD) which comprises of the question string, possible responses, provide on date and the time range that the question is active for in the web UI. The possible responses can be in several forms: multiple choice, exclusive multiple choice and numeric range. The server then releases the question on the date specified by the developer as well as a time span to determine the time when the question expires. Tribers are not allowed to answer the QotD after the expiry timestamp.

There are several API endpoints that allow the client application to query the database for responses.

5.1.1.3 Moods
The mood inputs from Tribers are stored as an integer value from -100 to 100 along with the device’s unique uuid, the latitude and longitude collected as the location, and time stamp at which the mood was logged. The endpoint for retrieving mood inputs can include several filters like a range of time and tribes.

5.1.1.4 Tribe
Tribes can currently only be defined by the developer on the web UI and consists of an icon images, a summary field and a name for the Tribe. There are endpoints for getting the average mood data of a tribe as well as the responses for the QotD limited to tribers’ response.

5.1.1.5 Notification
Tribe notifies the user when the question are available by scheduling notification via Google Cloud Messaging at a specific time during the day – specified by the developer. If the device is not online at the time, Google Cloud Messenger queues the notification until the device has access to the internet.

5.1.1.6 Firebase
The chat feature in the application is implemented using Firebase. Firebase is a backend server entity for real-time applications that syncs data whenever data is changed.

5.1.2 Mobile Application
The mobile application communicates with the server using AJAX, sending requests to the server’s API endpoints to retrieve data from the database. It was implemented using Ionic, a superset of Apache Cordova, which offers a library of mobile-optimized HTML, CSS and JS components for building native applications.

For the purpose of experimentation, there are two versions of the application – one with the Tribe layer, one without.
5.1.2.1 Program Flow
The program flow of the Tribe application is shown in figure 3.

5.1.2.2 Features
The Tribe application provides two sources of data collection for the users. User are able to submit a numerical value (a linear value between -100 and 100) representing their current mood at any time during the day. Users are also able to answer a QotD, provided in the form of a multiple choice question. In both versions of the applications, there is a Chat Room that tribers will be able to participate in.

5.1.2.2.1 Mood Mapping
The application allows the user to input a numeric value representing their current mood as many times as they want (Figure 4), these values are then plotted onto a map allowing users to see how their moods change depending on the location they are in (Figure 5). Users can also see the mood map of all mood inputs across Vancouver in the pass 24 hours.

Users using the Tribe Version of the application will also be able to see a numerical average for all tribers in each tribe.
5.1.2.2.2 Question of the Day

Tribe releases a QotD that Tribers are able to answer each day (Figure 6). For the purpose of this experiment, the questions are set to be released at 10 AM each day. When the tribers answer the question, they are able to see the conglomeration of results from other tribers in the form of a pie chart (Figure 7). However, if the tribers fails to answer the question before the question expires (end of the day for the period of this experiment) (Figure 8), they will not be able to see the answers from other tribers that day.

In the Tribe version of the application, tribers will also be able to see the breakdown of the responses by tribe.

Figure 4: Submit Mood
Figure 5: Mood Map

Figure 6: Unanswered Question
Figure 7: Results Question
Figure 8: Expired Question
5.1.2.2.3 Chatroom

In both versions of the application, an anonymous chat room was implemented (Figure 9). Tribers will be able to messages other tribers under a nickname that can be changed at any time in the settings. The non-tribe version of the application implements this as a global chat – where all users using this version have access to the chat room.

In the Tribe version, the chat rooms are specific for the tribe and can only be accessed if the triber is a part of the tribe.

![Figure 9: Chat Room](image)

5.2 Future improvements

Due to time constraints, there were many features and improvements that were not implemented in this version of Tribe. There were many usability problems, such as responsiveness of an application, that were not addressed in the prototype used for experimentation.

When Tribe loads, the responsiveness of the server in returning user specific variables causes some features in other version of the application to show up. The QotD and its state (answered, not available, etc) as well as chatroom messages take 1-2 seconds to load, causing a significant impact on user experience. We suggest that these issues be remedied in the next release of the application by including loading screens/modals and implementing local storage so that unchanged data do not have to be fetched from the server every time the application is opened.

In addition, several features for Tribe have not yet been implemented. This includes the ability for developers to create questions that are specific to a tribe. There is also a lack of connectivity between the mood mapping feature and the tribe element. We suggest replacing the current mood map with a better visualization to display the mood data submitted by the triber. The current data visualization for mood mapping is tacky and relatively meaningless to the tribers.

There are also many potential features that can be implemented to augment Tribe. An algorithm can be used to analyze the data provided by tribers to provide more meaningful and interesting information for
the users. This information can include metrics like average mood at time of day, or happiest location on average. An incentive system awarding both virtual rewards (badges) and real life rewards (discount for stores) could also be built as an attempt to improve user participation rate.

6 Evaluation

6.1 Experiment Design

To evaluate the effect of adding a “tribe” layer in the application, we compared the data collected from the survey and the participation rate from the number of times users participated in the applications in both versions of the application.

The data collected from the survey was averaged for each question among each subject group (tribe vs. non-tribe). The p-value was found using a two sampled student’s t-test.

6.2 Results

The data collected from the survey showed that the subjects using the Non-Tribe version of the application felt that they had an increased sense of group norm (Table 1) than the subjects using the Tribe version of the application. However, none of these rows met the significance level of 0.05 (Biddix).

<table>
<thead>
<tr>
<th>Likert statement (5-point scale)</th>
<th>Tribe</th>
<th>Non-Tribe</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>GN1 By participating in the application I feel I am helping to achieve a shared group goal.</td>
<td>3.00</td>
<td>3.67</td>
<td>0.207</td>
</tr>
<tr>
<td>GN2 The shared group goal was important to me.</td>
<td>3.00</td>
<td>3.33</td>
<td>0.515</td>
</tr>
<tr>
<td>GN3 I felt that the shared group goal was important to other members of the group.</td>
<td>2.83</td>
<td>3.5</td>
<td>0.235</td>
</tr>
</tbody>
</table>

Similarly, there seem to be a general trend with the subject using the Non-Tribe version of the application reporting a high level of social identification than the Tribe version of the application (Table 2).

<table>
<thead>
<tr>
<th>Likert statement (5-point scale)</th>
<th>Tribe</th>
<th>Non-Tribe</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>SI1 My personal identity and the community identity overlapped.</td>
<td>3.50</td>
<td>4.00</td>
<td>0.270</td>
</tr>
<tr>
<td>SI2 I feel a strong sense of belonging to the community.</td>
<td>3.17</td>
<td>3.67</td>
<td>0.296</td>
</tr>
<tr>
<td>SI3 I am a valuable member of the community.</td>
<td>3.17</td>
<td>3.50</td>
<td>0.401</td>
</tr>
</tbody>
</table>

Due to the fact that not all participants started using the application on the same date, the participation data were normalized using the number of days that subjects had access to the application. There were two normalized participation metrics that was used to obtain the result. The first was the number of questions answered per day. The second was the number of mood inputs per day. These two metrics – calculated for all 12 participants – was compared to the survey results obtained for group norm and social identity to find a correlation coefficient and the p-value for each metric (Table 3).
The average normalized results separated by the different version of the application is shown in Table 4. The p-value for each row is once again calculated using a two sampled student’s t-test.

**Table 3: Correlation between survey result and participation rate**

<table>
<thead>
<tr>
<th>Metric</th>
<th>GN1</th>
<th>GN2</th>
<th>GN3</th>
<th>SI1</th>
<th>SI2</th>
<th>SI3</th>
</tr>
</thead>
<tbody>
<tr>
<td>QoTD r</td>
<td>0.1448</td>
<td>0.3859</td>
<td>0.2973</td>
<td>-0.0870</td>
<td>-0.0437</td>
<td>0.2001</td>
</tr>
<tr>
<td>p-value</td>
<td>0.651</td>
<td>0.210</td>
<td>0.344</td>
<td>0.787</td>
<td>0.892</td>
<td>0.5304</td>
</tr>
<tr>
<td>Mood r</td>
<td>0.760</td>
<td>0.824</td>
<td>0.843</td>
<td>0.933</td>
<td>0.758</td>
<td>0.717</td>
</tr>
<tr>
<td>p-value</td>
<td>0.0982</td>
<td>0.0718</td>
<td>0.0640</td>
<td>-0.0271</td>
<td>-0.0992</td>
<td>-0.1164</td>
</tr>
</tbody>
</table>

Due to the fact that data collected and analysed does not reach a significance level of 0.05, we are unable to draw any conclusions regarding the validation of our research model.

7 Discussion

7.1 Experiment Critique

There were several limitations with this project that affects the interpretation of the data that was collected.

First, there were several problems with both the selection and number of test subjects in this application. The Tribe application intended to discover the effect of social influences on the user participation rate. However, the limited number of test subjects clearly affects the degree to which these social influences can affect users. Moreover, a sampling bias exists because the test subjects were selected from friends and classmates thereby causing the demographic variety of the subjects to be severely limited.

Second, due to time constraints, we were unable to perform a pilot study to eliminate some unnecessary obstacles in the experimentation process such as usability issues, release of bug fixes for application notifications and clarity of survey questions.

Lastly, the tribes for the Tribe version of application were based on a quick survey of existing student clubs at the University of British Columbia as well as some common knowledge. This could have affected the test subjects’ sense of belonging to the tribe as they might be missing a connection to all of the Tribes provided. A survey of the test subject should have been carried out before the experiment to determine their interests and living style.

According to the results obtained from the survey and the participation metrics obtained from the survey, we are unable to draw any statistically significant conclusions with regards to the validation of
our research model. Even so, we can start to identify some general trends and lessons learnt from the subjects of this experiment and the data collected.

7.2 Lessons Learnt

7.2.1 Confounding Variable
We can see that the subjects using the Tribe version of the application did have a higher participation rate using the QotD feature than subjects that were using the Non-Tribe version of the application. The negative correlation between group norm values and social identity suggests that:

\[ L1: \text{There were other factors other than group norm and social identity that influenced a higher participation rate for the application.} \]

7.2.2 Community Building
In the survey results, we observe a trend where subjects that use the Non Tribe version of the application reported an increased feeling of group norm and society identity than the Tribe version. Although the inclusion of tribe was intended to increase the triber’s sense of belonging – the low number of participants in each tribe did not promote the creation of a community. This sense of belonging may have manifested better in the Non-Tribe because there was more people participating in one “global” tribe.

\[ L2: \text{A social community needs to have a minimum number of participants in order to foster a sense of belonging among the participants.} \]

In addition, although users are able to view how the breakdown of the QotD answers by tribe as well as mood average for the past 24 hours, the tribe component of the application seemed unnecessary. According to one subject, the “purpose of joining tribes is not obvious to [her]”.

\[ L3: \text{There needs to be a greater connection between the features of the applications and the tribe component implemented.} \]

The application provided 15 default tribes that tribers were able to join in the application. However, as the groups were pre-defined for the tribers – there was very little sense of group goal among the people who joined the application.

\[ L4: \text{Users need to be involved in creating the communities associated with the application so that they feel a greater sense of group goal.} \]

7.2.3 Usability
There were also several usability issues that may have affected the results collected from the test subjects. The Tribe version of the application was slightly harder to navigate than Non-Tribe version with significantly more clicks required to reach each specific Tribe chat that the global chat in the Non-Tribe version.

\[ L5: \text{The variation in application flow could affect the user participation rate of the application.} \]

We observe another interesting trend from the test subjects about the difference in numerical mood input and QotD answers. Although users are limited to answering the QotD only once per day and the mood input as many times as they want, there was significantly more inputs per day for the QotD
feature. One possible explanation for this phenomenon could be the lack of a mood notification for users or the fact that the QotD and the results of participation was highlighted on the first page of the application while the mood mapping functionality was not.

L6: Highlighting certain features in the application through notifications and on the first page of the application cause increased use of that particular feature.

7.2.4 Summary
As an initial study, there were many lessons learnt that can be carried out in future experiments regarding the addition of the social communities in mobile application. Tribers need to feel that the features of the application were connected to the tribes that they participate in. With an increase in the number of test subjects, we should also see an increase in the number of tribers in each tribe. A community will improve in quality as the number of people in the community increases. Usability issues affecting the application’s ease of use are also important factors that influence the user’s participation rate.

8 Conclusion
Extant research show that social processes including compliance, identification and internalization are important factors affecting user motivation to participate in online communities. In this project, we designed a system and performed an initial study to examine how the addition of a social community may affect social influence factor like internalization and identification, which in turn affects user participation rate. While we were not able to obtain any statistical significant conclusions with the data collected, we were able to deploy a working system that gathers data toward answering these questions. The social communities that were implemented in this prototype were ineffective as there were few participants in each community. Moreover, users did not feel a connection with the tribes defined as they were not a part of the tribe creation process. Due to the limited number of participants, we are unable to draw any conclusion from our data, however, we have a better understanding of experimental design and usability issues that need to be addressed for future versions of the system and follow on experiments.

9 References


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10 Appendix

10.1 Appendix 1: Measurement Items

10.1.1 Usability and Engagement
This section of the survey is for us to collect some feedback on how we can improve the application in future releases. What is the extent you agree with the following statements?

The application was easy to use.

The application had an engaging interface.

The application was interesting and/or useful.

What feedback do you have to improve the application?

10.1.2 GroupNorm
I am investigating the effect of internalization as a social process represented as group norm on user participation rate. Group norm can be defined as an agreement among members about their shared goals and expectations. With relation to the Tribe application, the shared goal can be defined as participating in the application.

By participating in the application I feel I am helping to achieve a shared group goal.

The shared group goal was important to me.

I felt that the shared group goal was important to other members of the group.
10.1.3 Social Identity

I am also investigating the effect of identification as a social process represented as social identity on user participation rate. Social Identity reflects one’s conception of self in terms of the relationship to another group or person.

My personal identity and the community identity overlapped.

I feel a strong sense of belonging to the community.

I am a valuable member of the community.