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Zephyr: A social psychology-based mobile application for long-distance romantic partners

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Zephyr: A Social Psychology-Based Mobile Application for Long-Distance Romantic Partners

For the degree of Master of Science

Is approved by the final examining committee:

David M. Whittinghill

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ZEPHYR: A SOCIAL PSYCHOLOGY-BASED MOBILE APPLICATION FOR
LONG-DISTANCE ROMANTIC PARTNERS

A Thesis

Submitted to the Faculty

of

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by

Dhiraj Bodicherla

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ABBREVIATIONS

CMC	Computer Mediated Communications
ECR-R	Experience in Close Relationships-Revised
FtF	Face-to-Face interaction
LDR	Long-Distance Romantic Relationship
GCR	Geographically Close Romantic Relationship
SUS	System Usability Survey

ABSTRACT

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Long-distance romantic relationships have become quite common nowadays. With CMC tools advancing day-by-day, their usage among LDRs is proliferating rapidly. Attachment-related anxiety and avoidance can block the ability to enjoy happy relationships. During such situations, remembering happy past moments can be comforting. In this study a mobile chat application that enables LDR couples to reminisce about happy moments was developed. This study primarily focuses on evaluating the usability of this mobile application using survey-based methods. System Usability Scale was considered to discuss the outcome of the study. The overall results provide useful recommendations for further improvements in the design of this application.

CHAPTER 1. INTRODUCTION

1.1 Problem Statement

According to Hazan and Shaver's (1987) theory of adult attachment, there exists three categories in which people categorize themselves into as per their attachment style. The categories are secure, anxious and avoidant. Relationship partners with an anxious or avoidant attachment characteristic have more tendency to exercise pressure on their partners and report higher conflicts (Corcoran & Mallinckrodt, 2000). Although there has been a lot of research on conflict management in LDR, there is no application for partners to quickly and effectively resolve anxiety and avoidance related issues. In this study, a mobile chat application for LDR couples was developed that enables them to reminisce about good memories in their relationship. The usability of such a system is extremely important because LDR couples heavily rely on it. The current study focuses on evaluating the usability of the developed application.

1.2 Research Question

The major research question behind this project is:

- How usable is the mobile application developed in this study among long-distance romantic couples?

1.3 Scope

The scope of this study is primarily focused on pilot testing a mobile chat application. The study is limited to long-distance couples and included usability evaluation of two specific features in the mobile application, namely tagging and memory lane. Both the features are aimed at enabling the user to reminisce about their past happy moments during conversation with their partner. The usability is a minimum standard that must be met for an effective application. The funding for this project enabled us to design, develop and evaluate the usability of the current application. In this study the recommendations on how to improve the system are discussed.

1.4 Significance

The purpose of the study is to understand if the application is usable by testing on long-distance couples. Apart from the overall usability of the application, feedback about the tagging and memory lane is gathered and analyzed. These two features enable a person to reminisce. Reminiscing about past memories or nostalgia can improve self-esteem, control attachment related anxiety and avoidance and also has other benefits (Wildschut, Sedikides, Arndt, & Routledge, 2006a). Conflicts in relationships can be stressful. The positive effects of nostalgia can be directed towards such situations to ease them. Usage of mobile phones for communication among long-distance couples is more significant than those in GCR according to Crystal Jiang and Hancock (2013). The current study focuses on evaluating the usability of such an application. Furthermore, this study should reveal the usability issues in the mobile application and thus help improve it. Additionally, it will also bring a deeper insight about usage of communication media in long-distance relationships.

1.5 Assumptions

The assumptions for this study include:

- The participants in the study represent accurately the majority population using chat applications.
- The number of participants in the study is sufficient to arrive at a conclusion.
- Participants will answer all survey questions honestly and to the best of their abilities and knowledge.

1.6 Limitations

The limitations for this study include:

- The participants can be reluctant to use a new application because the nature of conversations can be intimate.
- The participants are aware that the application usage is monitored. Hence, this might affect their participation and usage.
- The study duration may not be sufficient for an individual to feel nostalgic.

1.7 Delimitations

The delimitations for this study include:

- The study is limited to participants with smart phones of android operating system because of the limited development time.
- The study is limited to couples in long-distance relationship.
- The study only discusses the usability issues but does not test the effectiveness of the framework used to build it.

1.8 Summary

In this chapter, the introduction to the study is presented along with its significance. Assumptions, limitations and delimitations of the study are also discussed. The relevant review of literature is described in detail in the following chapter.

CHAPTER 2. REVIEW OF RELEVANT LITERATURE

This chapter covers the concepts of usability evaluation and testing specifically for mobile application. The chapter also discusses attachment theory, adult attachment styles and long-distance relationships. Furthermore, the chapter details how the concepts of adult attachment theory and nostalgia are used in developing the mobile application.

2.1 Attachment Theory

Attachment theory describes the interpersonal relationships between humans. According to *Attachment in adults* (n.d.), psychoanalyst John Bowlby was the first to coin the term attachment theory. Ainsworth (1973) (as cited by Bergin and Bergin, 2009) describes attachment as a deep and enduring emotional bond that connects one person to another across time and space. Bowlby's work heavily concentrated on how separation from caregiver would trigger emotions like protest, despair and detachment in a child. Bowlby observed that attachment was purely characterized of the need for proximity and caregiver. Results of this theory led him to a conclusion that a child is constantly in search of stable and secure relationship. In the absence of a caregiver children tend to become more fearful. The innate attachment system in infants makes them feel secure by being close to their mothers (Hazan & Shaver, 1987).

The three phases of separation response as stated by Bowlby and James Robertson are: (1) Protest, (2) Despair, and (3) Detachment or denial (Berghaus, 2011). According to Bowlby, if infants feel threatened they seek to be closer to their caregivers (Prior & Glaser, 2006).

Mary Ainsworth's (1973) findings of the famous Baltimore study was a strong foundation to her theory of attachment that later led to the contribution to adult attachment theory. According to her research, there are at least three types of children: those who are in a secure relationship with their parents, those who are anxious-resistant, and those who are anxious-avoidant. Bonds created during childhood are responsible for their behavior in adulthood (Prior & Glaser, 2006).

2.2 Adult Attachment Theory

Hazan and Shaver (1987) are the pioneers to study attachment theory for adult relationships. They proposed that the romantic relationships between adults and infant-caregiver relationship have common biological platform. Through their research on a number of couples, they observed reactions to various situations.

The attachment types proposed by Hazan and Shaver (1987) were secure, avoidant, anxious-ambivalent that are consistent with what Ainsworth and Bowlby's research suggested. Based on the patterns created by Ainsworth, Blehar, Waters, and Wall (2015), Hazan and Shaver created a self-report study for adult relationships. A newspaper survey conducted by them revealed that participants classified themselves as secure, avoidant and anxious/ambivalent categories in the portions of 56%, 25% and 19% respectively.

2.3 Adult Attachment Styles

Securely attached children feel more comfortable and secure with their primary caregivers and are likely to be the ones securely attached with their partners in adulthood. Bartholomew and Shaver's study (as cited in Tamamura, 2004) states that secure adult attachment is characterized by the combination of a positive self model and a positive model of others, and are usually more confident about themselves and their relationship. They often report higher satisfaction, intimacy and comfort in their relationship.

A child develops anxious attachment style if their primary caregivers are inconsistent and unpredictable in their interaction with the child (Segrin & Flora, 2011). Such children tend to become distrustful, suspicious and attached at the same time and eventually become insecure and self-critical in adulthood.

Avoidant attachment style is common among children whose parents ignore or reject them most of the times (Benoit, 2004). Under such circumstances children tend to act more independent and mature by suppressing natural desire to seek out for comfort. These children grow up to become adults who are more isolated, aggressive, unsympathetic and less involved in their family.

2.4 Stability of Adult Attachment

Research shows that attachment style is unaltered over a period of time ranging from few weeks to several years unless there is a life changing event (Lopez, 2003). According to Bowlby (1969), adult attachment styles are presumed to reflect relatively stable and enduring relationship orientations. About 30% of participants have reported a change in their attachment style and researchers have concluded instability in self-report as the main cause (Pielage, Barelds & Gerlsma, 2006). Various studies have examined the stability of adult attachment. Using the revised experience in close relationships scale, Shaver and Brennan (1992) reported stable attachment style over a period of 8 months. Using the same measure, Kirkpatrick and Hazan (1994) reported stable attachment styles over a period of 4 years. The developed mobile application is trained to behave according to the attachment style of an individual. Given the stability of adult attachment style, it is hoped that the mobile application will also be effective as long as the style is stable.

2.5 Long-Distance Relationship

Relationships in which partners live far apart from each other with limited communication opportunities but still are in a close relationship are long-distance

relationships (Stafford, 2005). LDRs have become common nowadays. According to the statistics provided by Ferk (2005), about 3 million Americans live apart from each other in long-distance relationships. He further states that about 25-50% of college students are currently in long-distance relationship, and up to 75% of them have engaged in a LD relationship at some point in college. Nowadays due to increasing career demands, couples live away from each other for long periods of time. Some of these careers include professional athletes, military, offshore oil workers, mariners, etc (Neustaedter & Greenberg, 2012).

Even though LD relationships are considered problematic, Sahlstein (2004) argued that distance could enhance relationship. Despite the distance, LDR among college students is more stable than GC relationships (Stafford & Merolla, 2007a, 2007b). Although this would seemingly make LD relationships inherently difficult relationships (see Sahlstein, 2006, for a discussion), the research reveals that LD relationship partners, on average, report equal or higher levels of relational stability than GC relationship partners (Dainton & Aylor, 2002). According to Canary and Stafford (1994), depending on the type of relationship, several maintenance behaviors are required for the health of a relationship. One such maintenance behavior that Guldner and Swensen (1995) state is spending time with one's partner. LD couples use a wide range of computer-mediated communication tools to remain in close contact with each other.

2.6 Computer-Mediated Communication

Even before the Internet, many relationships have sustained by media like letters and the phone (Utz, 2007). According to Utz, even though communicating via letters and phone calls can bridge boundaries, the asynchronicity of email and other CMC tools is far more advantageous. Since the advent of the Internet, the way that people communicate with each other has drastically changed. Internet has revolutionized the way we communicate. The number of CMC tools available for LD

relationships is rapidly increasing. Studies have shown that CMC can ease loneliness and increase feelings of closeness, relationship satisfaction, trust and commitment, while lowering jealousy (Aguila, 2011). Additionally, different forms of CMC tools can enable people to communicate in different ways (Walther & Parks, 2002).

The use of media is very specific to the nature of conversation. In her research, Aguila (2011) claims that modern CMC tools are preferred over traditional communication tools like landline. Examples of different forms of CMC are email, texting, instant messaging, social networking, tweeting, blogs, cell phone calling and video chat. Some of the commonly used tools for communicating among long-distance relationship partners are Text, IM, Whatsapp, Skype and Google Hangouts. Mobile applications like Avocado, Couple, and Between provide features like IM, collaborative task lists and calendars.

2.6.1 Texting/E-mail

In her research, Lenhart (2012) says that, about one in four teens report owning a smart phone and 63% of overall teens are reported to communicate via text every other day. Texts are used for short greetings such as "Good Morning", "How are you?" or "I love you". Empirically, studies have shown that relative to face-to-face, text-based interaction are more frequent among LD couples (Tidwell & Walther, 2002). Even though texting is the most used feature, the contextual intimacy it offers is relatively little.

92% of teenagers aged 12 through 17 had been using the Internet sending or reading emails in a recent study conducted among 754 youth (Amanada, n.d.). Using modern CMC tools like email is more prevalent among college students with 72% checking email at least once a day and two-thirds use at least two email addresses (Jones, 2008). According to Rabby and Walther (2003), email is the easiest and most convenient way in which a couple can sustain their relationship and accomplish their goals.

In the CMC literature, email has been portrayed as a "lean" medium, used for exchanging "mundane information" in relationships (Harwood, 2000, p. 5). Because of its asynchronous nature, e-mail is typically used to share stories or while one of the partners is at work. Even though texting and e-mail are so widely used, they do not enhance a "shared presence" feeling among couples. Telephone conversation is preferred over other methods if there is a need for a very short and quick talk or prolonged conversation and emotional talk. Phone calls are predominant, however, the partners would prefer to "see" the other person over a video call rather than just hearing them.

2.6.2 Video Chat

Video chat services like Skype are growing in popularity because video allows people to see and hear each other. A feeling of being there and a sense of togetherness for the remote person is possible via video chat (IJsselsteijn, de Ridder, Freeman, & Avons, 2000). This is an advantage over the other communication media. Recent study conducted by Neustaedter and Greenberg (2012) shows that regardless of the relationships situation, video chat affords a unique opportunity for couples to share presence over distance, which in turn provides intimacy.

Their research explains the following about how video chat is used by LD relationship partners:

- To share day-to-day activities like sharing meals, fall asleep together.
- For a sense of presence with their partners by video chatting for extended period of time and working on parallel activities.
- To showoff new dresses, new hair cuts and newly purchased things.
- To see their partner's body language and expressions and also to avoid miscommunication.

- To do activities together like watching movie, playing online collaborative games.
- To express love by showing intimate acts like hugging and kissing.

Since CMC tools is the only way for LDR couples to communicate, it is highly likely that their usage bring good and bad memories. Remembering those good memories can make an individual happier especially when they are in a conflict. In the following section, more details about reminiscing or nostalgia is presented.

2.7 Nostalgia

The term nostalgia was introduced by the Swiss physician Johannes Hofer (Boym, n.d.). Early conceptualizations of nostalgia were linked to negativity. By the 20th century, it was associated to psychological disorder and depression (Vess, Arndt, Routledge, Sedikides, & Wildschut, 2012). However, modern studies show that nostalgia is considered a positive experience with bittersweet elements and also reports to have more positive than negative effects (Wildschut, Sedikides, Arndt, & Routledge, 2006b). Also, nostalgia contributes to psychological health and well-being (Routledge, Wildschut, Sedikides, & Juhl, 2013). Wildschut, Sedikides, Routledge, Arndt, and Cordaro (2010), predicted that individuals with low avoidance can have benefits because of nostalgic experiences. However their research was limited to non-romantic relationships. An empirical research was conducted by Juhl, Sand, and Routledge (2012) showing evidence that the earlier prediction was valid for romantic relationships for low avoidance individuals. The research also provides evidence that nostalgia can negatively affect those with high avoidance.

2.8 Usability

Usability has various definitions depending on the context and intended goal. Usability is the degree of how easily a user can understand and interact with a system. According to Nielsen (2012), usability is defined by 5 components.

- Learnability: Accomplish basic task for the first time.
- Efficiency: Performing tasks quickly after learning.
- Memorability: Reestablishing proficiency after a period of inactivity.
- Errors: Recovering from severe errors.
- Satisfaction: The satisfaction of using the product.

Another definition of usability by Shackel and Richardson (1991) is "the capability in human functional terms to be used easily and effectively by the specified range of users, given specified training and user support, to fulfil the specified range of tasks, within the specified range of environmental scenarios" (p. 24).

Usability evaluation is a process that evaluates the usability of a product. Evaluating the usability can improve the quality of the product. It also has short-term and long-term benefits in the product development life cycle with increased ROI (Marcus, 2002). Nielsen (2012) states that usability problems can exist in any system that will be used by humans and should undergo usability testing. Usability is an integral part of system development. Because a fully functional, highly performant, reliable and cost efficient system with poor usability would defeat the entire purpose of the system (Mayhew, 1999). Shneiderman and Plaisant (2005) describe 8 principles for designing an interface that are widely credited.

- Strive for consistency: All the components in a system should be designed identically following similar conventions.

- Cater to universal usability: Knowing the audience and designing a system suitable to their needs is important.
- Offer informative feedback: Every action a user takes should be complemented with an immediate feedback or response.
- Design dialogs to yield closure: Designing components to give a sense of closure and happiness is essential.
- Prevent errors: Data validation in systems help the user to enter correct data without altering the system state.
- Permit easy reversal of actions: Making errors is common. The system should be able to reverse such actions without disrupting and returning to previous state.
- Support internal locus of control: Tedious sequences of data entry should be avoided as much as possible. The user enjoys to be able to control the system more than being controlled.
- Reduce short-term memory load: Avoid overwhelming the user by presenting excessive information to process and remember.

2.9 Usability Evaluation for Mobile Devices

With the increasing number of mobile applications in the market, usability evaluation has become one of the key factors for success. The needs and characteristics of the mobile user, the usage context of the mobile devices are factors which can influence the interaction and should be considered in the design of the interfaces, as well as in the usability evaluation (Betiol & de Abreu Cybis, 2005).

Usability testing for a mobile application is increasingly complicated compared to computers because of the variety of mobile devices available. Many

platforms that aid the development of mobile applications are available, however, tools for usability evaluation are limited. Conducting usability testing on mobile application is a relatively difficult task (Balagtas-Fernandez, Forrai, & Hussmann, 2009). Interfaces for mobile applications can be built in limited number of ways but can be complicated because of size limitations which can result in many usability issues (Ali, Jain, Lal, & Sharma, 2012). Compared to computers, phones offer other features (like GPS, accelerometer, etc), which provides the scope to develop wider variety of applications (Chittaro, 2011). Zhang and Adipat (2005) discuss the challenges in mobile usability evaluation.

- Mobile context: The mobile user could be interacting with anything.
- Connectivity: Wireless communication strength.
- Small screen size: Each device can have a different size.
- Different display resolutions: Each device can have a different resolution compared to a computer.
- Limited processing capability and power: Mobiles have far lesser computing capacity.
- Data entry methods: With increasing phone accessories input methods have also increased.

2.10 Summary

Evaluating usability for mobile applications is a challenging task. However, it yields deeper insights into user interaction experience. Such insights can be used to improve the mobile application and increase user retention. This chapter provides a review of the literature relevant to usability of mobile applications, adult attachment styles, long-distance relationships and various communication media

that effect intimacy and satisfaction in relationships. The chapter also covers particular advantages of nostalgia.

CHAPTER 3. FRAMEWORK AND METHODOLOGY

This chapter presents the complete method used to develop the mobile application. The application includes text messaging, audio messaging, sharing media (e.g., pictures). The current application enables the user to record happy moments experienced with their romantic partners during conversation and reminisce them at a later stage when they feel low. In this study, a simple way to tag messages, store them, generate timeline of moments is presented and implemented.

3.1 Theoretical Framework

In this section a theoretical framework is proposed that is implemented in the mobile application. The framework is divided into collection phase and retrieval phase. The collection phase includes completing ECR-R questionnaire, creating hashtags and tagging messages. Retrieval phase includes generating and retrieving timeline of relevant moments.

3.1.1 Collection Phase

Collection phase starts with user completing the ECR-R questionnaire. ECR-R is a 36-item scale that measures an individual's attachment style on two subscales: Avoidance and Anxiety (Fraley, Waller, & Brennan, 2000). Each item is a seven point Likert scale ranging from "Strongly disagree" to "Strongly agree". Based on the user's responses attachment style is evaluated and three items with highly endorsed values are selected. For each of the selected items, the user enters a positive hashtag that reminds them of good moments in their relationship. The items along with their corresponding hashtags are stored in the database as

Table 3.1: Sample ECR-R to hashtag

ECR-R Item	Hashtag
I'm afraid that I will lose my partner's love.	#love
I often wish that my partner's feelings for me were as strong as my feelings for him or her.	#feelingloved
I worry a lot about my relationships.	#us
I rarely worry about my partner leaving me.	#togetherforever

key-value pairs. Once a message is tagged with a hashtag, the message ID, time at which the message was created, hashtag ID are stored in the database as a key value pair. This phase only considers three items with endorsed values because having more than three items would overwhelm the user. Overwhelming with too much information to process is not be a good practice as suggested by Shneiderman and Plaisant (2005). The researcher also believes that more than three items would be harder to implement into the mobile application in the given time limit.

3.1.2 Retrieval Phase

In the retrieval phase, user selects "what's on your mind" option in the mobile application. This would lead them to another screen that contains the memory lane. Memory lane is a list of messages that have been previously tagged by the user with various positive tags. Once the messages are fetched from the database, they will be sorted based on the time at which they were sent, oldest to earliest. Retrieval phase is responsible for rendering the nostalgic experience to an individual.

3.1.3 Nostalgia

The framework relies on ECR-R to understand if an individual is anxious or avoidant. As mentioned earlier, according to the empirical research conducted by Juhl et al. (2012), nostalgia can negatively affect individuals with high anxiety or avoidance. The same research suggests that individuals with low anxiety or avoidance can find nostalgia beneficial. The current research focuses on engaging LDR individuals with low anxiety and avoidance in a nostalgic experience through the use of the developed mobile application.

Since each message in the memory lane is associated with a hashtag that was created based on a happy memory, it is hoped that a list of such messages would make the user feeling nostalgic. Through such an application an individual would be able to surround themselves with good memories of their relationship and their partner anytime they wish to.

3.2 Technical Framework

3.2.1 Introduction

Given the time limitation and limited human resources, a third party open source platform called Surespot (*Surespot*, n.d.) was chosen and extensively modified to cater to the current study needs. Surespot offered many features that were essential for this study, for instance, end-to-end encryption, voice messaging and basic chat functionality. Other components that have been developed and integrated to host this chat application are detailed in the following sections.

3.2.2 Backend Component

The server-side scripting is written on Node.js. Node.js is an open source server-side JavaScript environment (see <http://nodejs.org>). Node.js offers high

performance and low memory usage. Unlike in most other modern environments, a Node process does not rely on multithreading to support concurrent execution of business logic; it is based on an asynchronous I/O eventing model (Tilkov & Vinoski, 2010). Coffeescript was preferred over JavaScript as it offers quick and easy way of development. Coffeescript is an open source language that compiles to JavaScript during runtime (Erasmus, 2012).

3.2.3 Database

The databases used to store data and enable communicating are Datastax Cassandra and Redis. Cassandra is an open-source NoSQL distributed database management system designed to handle large amounts of data and provides high performance, scalability, availability and low latency (*Apache Cassandra*, n.d.). Because a chat application can have multiple users sending many messages per second, it is essential that the database is capable of handling multiple transactions and is always available. For this reason, Cassandra database was chosen. In order to have a database that is always available, multiple Cassandra instances have to be running. For this purpose, a third party service called Instacluster that provides a cloud-based Cassandra service was used. A three node Cassandra cluster plan was created to ensure 100% availability and reachability at all times. Instacluster was the only service that was easy to configure based on the study's requirements.

Redis is an open-source data structure server that stores key-values (*Redis*, n.d.). Simple information like the time at which a user registers and their security key are stored in Redis. Because each value is stored as a key and a value, fetching the values is faster. This is important for a mobile application usage experience.

3.2.4 Hosting

The backend server was hosted on Amazon Web Service cloud server because of its high reliability, security and ease-of-use. A t2.medium instance with four GB

memory was chosen because of its low-cost nature, high security, good balance of computational power, memory and network resources. A strict security policy was enforced to make sure no malicious attacks would compromise the data.

Static content like images, audio messages were stored on cloud CDN provider Rackspace. Rackspace offered an inexpensive storage plan that was suitable to the current study needs.

3.3 Procedure

Experiment started with the researcher publishing on online flier (see Appendix 5.2) on Reddit and Amazon mechanical turk. Friends and family were also invited to participate. Twenty four people downloaded, installed and registered on the application. Few participants dropped out during the study and seven participants completed successfully. The seven participants were between twenty and thirty years of age and in a long-distance relationship during the study. Most of these participating couples were friends and one couple was recruited through Amazon mechanical turk. Participants used their own android smart phones for the study.

After registering on the application, the consent form (see Appendix 5.2) was prompted and it required participant's acceptance before proceeding. Upon accepting, participants were instructed to complete three questionnaires that included background information, ECR-R survey and relationship satisfaction survey (see Appendix 5.2). Completing the questionnaires would enable the participants to invite their partners. If both the partners completed the surveys, they would be able to communicate with each other. Each couple had to communicate and use the tagging feature for a period of five days before the memory lane feature activated. Memory lane feature would lead the participants to three questionnaires that included nostalgia survey, ECR-R survey and relationship satisfaction survey (see Appendix C). Completing the last three questionnaires

would award the participant with a \$5 Amazon gift card. To evaluate the usability of this application, system usability scale questionnaire (see Appendix D) was given after the final set of questionnaires. Usability evaluation supported the study by providing data about participant's satisfaction with the mobile application.

3.4 Android Application

The android application is hosted on Google Play Store for participants to easily download, install and use. As mentioned earlier the application was build based on an open-source third party chat application framework. Extensive modifications were done for the current research needs. Google Cloud Messaging service was used in order to deliver notifications to users in real-time.

The android application is closely integrated with ACRA (Application Crash Report for Android), an open-source project that instantaneously reports any bugs that occur using the application usage. The bugs are reported to another application called Acralyzer which was provided by a third-party service provider called Cloudant. Acralyzer helped in instantaneously reporting bugs so that they can be fixed and improve the application to enhance the usability experience. Each screen in the mobile application is divided into a module. The following sections describe how each module has been implemented.

3.4.1 Registration Module

This module allows a user to register themselves into the mobile application. To register, a username and password are required. Upon registration the user is assigned an ID which uniquely represents the user. This ID is later used at different stages. Figure 3.1 illustrates how a user can register.

identity/create

Please enter a username and password, or [restore an identity](#) from the menu. **Uppercases are case sensitive** so be aware of this when sharing them with others. The password should be at least 8 characters long and contain symbols. **WARNING: There is ABSOLUTELY NO WAY to reset your password or username in zephyr so make sure you remember it!** Contact dbodiche@purdue.edu for questions **DO NOT REGISTER WITH YOUR REAL NAME.** Please use code name.

username
di12 ✓

password
.....

confirm password
.....

create identity

Figure 3.1.: Registration Module

3.4.2 Login Module

After a user has successfully registered themselves to the mobile application, the same credentials are used to log the user into the application and thus giving access to all the features.

3.4.3 Home Screen Module

After logging in the, user is prompted to complete the survey which is illustrated in Figure 3.3. "Take survey" link navigates the user to a page where they can complete the survey. The responses on survey page are communicated with the backend component to analyze and store in databases. Three of the items from ECR-R survey with most endorsed values either from anxiety or avoidance, depending on which is higher, are prompted to the user for creating hashtags.

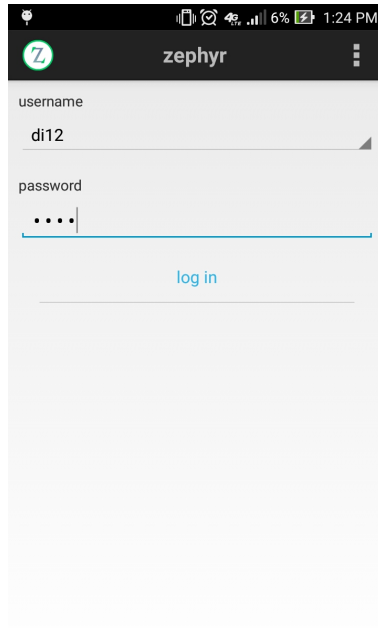


Figure 3.2.: Login Module

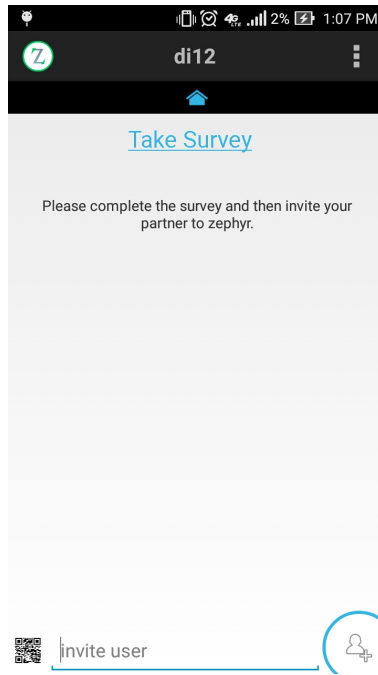


Figure 3.3.: Home Screen Module

survey/di12

About me

We would like to know you better

What is your current age(Enter a number)

How many romantic relationships have you had in the past? (Enter a number)

Describe your current relationship

We are married
 We are engaged
 We date only each other
 We date each other more than we date others
 We date others as much as we date each other

How far away are you from each other? (Enter a number)

_____ Miles

Figure 3.4.: Survey Module

3.4.4 Chat Module

This module illustrates how a chat conversation between the partners would look like. Anytime during the conversation, user can select a particular message and assign hashtags to it. These hashtags are predefined by the framework and user can only select from those. Figure 3.5 shows how a user can add hashtags to the selected message.

3.4.5 Memory Lane Module

After "what's on your mind" option (memory lane) is selected then a collection of messages (text, audio) is generated. The collection of messages will engage the user in a reminiscing experience and help revisit the past happy memories in their relationship. After the user visits memory lane module (see Figure 3.7), post-test survey can be completed by clicking the button "Proceed to

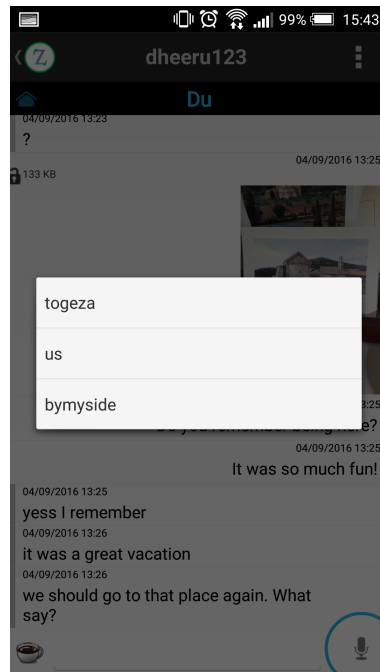


Figure 3.5.: Tagging a message with hashtags

Completion”. Upon completing the survey, the application will give the user a \$5 Amazon gift card (see Figure 3.8).

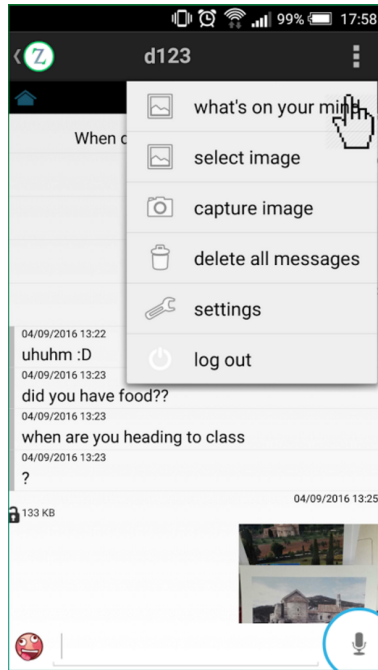


Figure 3.6.: Accessing Memory Lane

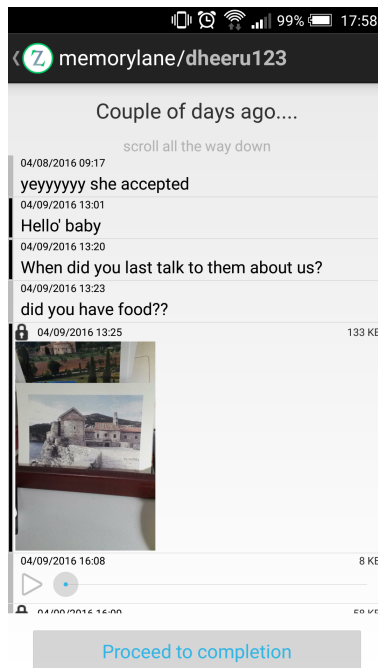


Figure 3.7.: Memory Lane

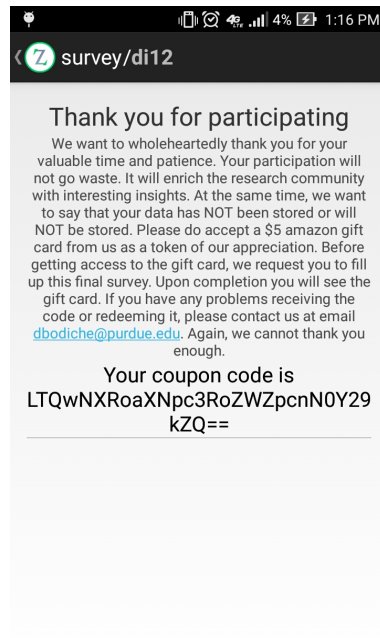


Figure 3.8.: Displaying Amazon gift card after completion

3.5 Summary

This chapter provides detailed research methodology for this study. The various components involved in creating the mobile application are discussed. Procedure used to conduct the research is explained.

CHAPTER 4. RESULTS

In this chapter, data collected through the application usage, surveys and usability testing is reported. The chapter also presents results and analysis of data. Along with the data, suggestions to overcome issues are also presented.

4.1 Data Collection and Analysis Process

The data about application usage along with initial and final surveys is stored in Cassandra databases on the backend component. This includes number of people registered, participant responses to background questionnaire, pre and post ECR-R questionnaire, pre-test and post-test relationships satisfaction questionnaire and nostalgia questionnaire. This stored data is exported to files in a comma-separated value format and later analyzed. System usability survey was administered on Qualtrics.com and data was downloaded through the website for analysis.

4.2 Participants

As mentioned earlier, a message regarding the research was posted on Reddit and Amazon Mechanical Turk. Friends and family were also invited to participate. Significantly fewer couples participated than expected despite extensive advertising.

The below figure clearly shows how the participants dropped out at every stage of the study. Twelve participants completed the initial survey and only four people filled the final survey.

The below table presents data about the seven participants who completed the SUS survey.

Table 4.1: Recruitment Statistics

Source	#Recruited
Friends & Family	22
Amazon Mechanical Turk	2
Reddit	0

Table 4.2: SUS Statistics

Gender	Age	Years in relationship	Other chat applications used	Hours per day communicating
M	25	2y	Whatsapp	12
F	25	1y 6m	Facebook, Google, Whatsapp	8
M	25	2y 2m	Facebook, Whatsapp	6
F	24	7y	Whatsapp	1
F	20	2y 9m	Facebook, Whatsapp	3
M	25	1y 10m	Facebook, Google, Whatsapp	10

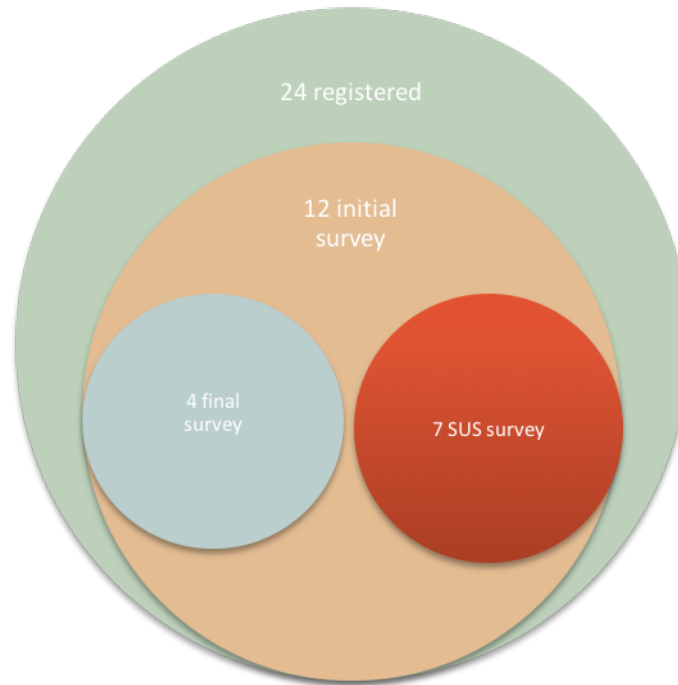


Figure 4.1.: Registration Statistics

Majority of the participants are friends of friends who have been in a LDR for approximately three years on an average.

4.3 Patterns in Collected Data

Participants were asked to fill SUS questionnaire along with answering set of open-ended questions regarding each feature in the mobile application.

- Question 1: Feedback on tagging feature and its usefulness. This question focuses on analyzing how much the participants are aware of the system. In order to use tags, a message item had to be long pressed to see tagging options. Patterns observed are:
 - 6 out of 7 answered that they had used this feature and also stated that they found it useful.
 - 2 participants reported that it was cumbersome.

- Three participants suggested that the tagging feature should allow more tags to be created.
- 5 out of 7 participants stated that if popular messaging application like Facebook/Whatsapp/Google Chat had tagging feature, they would be willing to use it.
- Question 2: Feedback on memory lane. Similar to the previous question, this question focuses on how much the participants are aware of the system. Memory lane extensively depends on tagged messages. If more messages are tagged, the memory lane is longer and there is more scope for reminiscence. Patterns observed are:
 - 4 out of 7 participants reported to have used this feature and all four found it useful.
 - 2 out of 7 participants stated that they did not know it existed and it was complicated/confusing.
 - Most participants liked the way memory lane was constructed.
 - One of the suggestions was to create a new lane for every tag and a gallery of images for the selected tag.
- Question 3: Overall application experience feedback. Patterns observed are:
 - Most participants seemed to have used text messages over other media which is expected behavior.
 - When asked to compare the current application to other chat applications, majority said it was no different and was just like another chat tool.
 - Participants were asked to describe how secure they felt while using the application, 5 out of 7 stated it was comfortable.
 - Two participants expressed interest in video calling as a feature.

- Two participants suggested that the UI should be improved.
- Two participants expressed concerns about the application being slow when sending messages.

4.4 System Usability Scale Testing

The System Usability Scale (SUS) is an easy to use and highly reliable tool for measuring the usability (Nielsen, 2012). It is a 10 items questionnaire with a five point Likert scale ranging from "Strongly disagree" to "Strongly agree".

According to Jordan, Jordan, Thomas, McClelland, and Weerdmeester (1996) each item value ranges from 0 to 4. For items 1,3,5,7 and 9 the contribution is item index minus 1 and for items 2,4,6,8 and 10 it is 5 minus item index. The sum of all these scores multiplied to 2.5 is the usability score.

Five days after publishing the application, all the users were requested to complete SUS questionnaire. The survey was administered on Qualtrics.com website. The benefit of using SUS is its reliability, an alpha of 0.91, even on very small samples such as in the current study (Sauro, 2011). The average of SUS score is 70.

Table 4.3: SUS Scores

Participant #	SUS Score
Participant 1	92.5
Participant 2	80
Participant 3	40
Participant 4	80
Participant 5	60
Participant 6	90
Participant 7	50

4.5 Data Analysis

Upon analyzing the data, it can be said that the application seems to be fairly easy to use. However, this might contradict the fact that the study had drop-out rate as high as 70%. The application was missing accurate guidelines which a user could use to get more familiarity with the features. In the current study, we could not test the effectiveness of the underlying theoretical framework because of the limited number of participants. The surveys used in the mobile application had 58 questions in total which was considered too many by the participants. Few of the participants also found it cumbersome to tag messages with a hashtag. The mean SUS score is 70. Interpreting the results of SUS scores based on Bangor, Kortum, and Miller (2009), the current application can be considered between "ok" to "good". Since most of the participants are friends and were willing to participate, this does not represent the population of LDR couples. Hence the results can be biased. Usability issues will be discussed in the following section.

CHAPTER 5. CONCLUSIONS AND FUTURE WORK

5.1 Discussions and Conclusions

From the inception of this project till the completion, drastic changes occurred in the field of modern mobile applications. The existing chat applications have become far more advanced and offer a wide variety of features like video chat, live video streaming, real-time picture morphing and many more. Even though the existing applications are feature-rich, they still lack some qualities that the current study was able to implement. For example, memory lane is one feature that has not been implemented in any existing chat application for long-distance couples. The current research is at a nascent stage of development. However, it can still work as a guideline for further studies in long-distance romantic relationships. The current application is a robust and simple framework that can be easily integrated into any existing mobile application for long-distance romantic partners and also proximally close romantic relationships.

Usability is essential for a chat application such as current one. Usage of similar chat applications on mobile phones is increasing day by day and so people's communication pattern is also changing. Delay in response to messages is likely to increase anxiety, especially in those who expect instant replies (LIN, 2012). This anxiety can lead to a bad experience in the relationship. The application has to be capable of delivering message instantaneously without any time lag. Usability evaluation methods will help in revealing potential issues if they exist.

In this study the data about usability of the developed application was collected. Even though only few couples participated, the usability data does have interesting insights that if implemented, can make the application more

user-friendly. As stated earlier, the developed mobile application was only used by LDR partners. It was essential that the participants use the mobile application before completing the system usability scale questionnaire.

5.2 Future Work

The current framework presents a novel way of experiencing reminiscence for couples in LDR. The mobile application developed for this research can further be improved to enhance the user experience. The following are some recommendations for future work in this framework and mobile application.

- Responses from few participants in SUS questionnaire did suggest that there was scope for improvement in providing more hints about each feature. For example, a walkthrough for the entire application.
- Feature to send video messages and video chat would increase user engagement and usage.
- The study can also be extended by testing it on more people. Also, people in geographically close relationships.
- Participants also stated that tagging messages was cumbersome. That can also be improved.
- Few other participants encountered network related issues. That as well can be improved.
- One participant expressed interest in a feature to allow multiple tags, gallery for each tag and simple method of tagging.
- Enhance the UI (for example: chat layout, buttons and icons).
- Make survey forms more concise.

Improvements can also be made to parse custom hashtags added by the user and understand the emotion using sentimental analysis. The validity of the current framework needs to be verified by an empirical study.

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LIST OF REFERENCES

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APPENDICES

Appendix A: Consent Form

Approved on 21-MAR-2016 Purdue IRB Protocol #: 1602017151 - Expires on: 20-MAR-2017

Research Project Number 1602017151

RESEARCH PARTICIPANT CONSENT FORM (C)

Zephyr: Mobile application for long-distance relationships

Dr. David Whittinghill, Principal Investigator

Purdue University, Computer Graphics Technology Department

What is the purpose of this study? Long-distance relationship partners have limited physical interactions, because of which they are more dependent on computer-mediated communication tools like mobile phones. This research will pilot test a custom-made mobile chat application. The aim of the current research is to understand how the mobile application can effectively make an individual reminiscent about past happy moments in their relationship and thus affect their attachment style and relationship satisfaction.

What will I do if I choose to be in this study? How long will the study take? You and your partner will download and install a mobile chat application and use it to communicate with each other for a 1-week period. The application will administer a survey measuring characteristics of an individual and their romantic relationships. You create a list of positive hashtags and assign them to as many messages as possible while communicating. Completing all the surveys involved in this study should take approximately 30 minutes.

Payment: You will be paid \$5 Amazon gift card if all the surveys are answered, tags are successfully created and at least 25% of all the messages are tagged.

What are the possible risks or discomforts? There are minimal risks and no greater than those ordinarily encountered in daily life. Most of the questions are about you and your relationship. The mobile application is just a chat client that aids communication between the partners. You are not obligated to answer any questions that make you uncomfortable. You are also not obliged to continue to use the application in case it fails to serve its purpose of communication. Breach of confidentiality always is a risk in any such research study; safeguards will minimize this risk (see the confidentiality section).

Are there any potential benefits? Although there are no direct benefits to participating in this research, this experience may provide an opportunity to learn about how research is conducted in the field of social psychology, and you may see the types of tasks and questionnaires that are used in research on close relationships.

Will information about me and my participation be kept confidential? This research employs strict standards of confidentiality. The project's research records may be reviewed by the Office for Human Research Protections and by departments at Purdue responsible for regulatory and research oversight. Only Dr. Whittinghill or his research team will have access to de-identified responses, which will be stored securely and kept indefinitely.

What are my rights if I take part in this study? Your participation in this study is voluntary. You may choose not to participate or, if you agree to participate, you can withdraw your participation at any time without penalty or loss of benefits to which you are otherwise entitled.

Who can I contact if I have questions about the study? If you have questions, comments or concerns about this research project, you can talk to one of the researchers. Please contact Professor David Whittinghill, Principal Investigator, 494-1353, dmwhittinghill@purdue.edu or Dhiraj Bodicherla, Graduate Researcher, dbodiche@purdue.edu. If you have concerns about the treatment of research participants, you can contact the Institutional Review Board: Purdue University, Ernest C. Young Hall, Room 1032, 155 S. Grant St., West Lafayette, IN 47907-2114, phone number: (765) 494-5942, email: irb@purdue.edu. Documentation of Informed Consent I have had the opportunity to read this information sheet, ask questions about the research project and am prepared to participate in this project. If you agree with the above statement, please click on the "I Consent" button below to begin the survey.

Appendix B: Experiment Description

Amazons Mechanical Turk & Reddit Experiment #1602017151

Hello, my name is Dhiraj Bodicherla. I am a graduate student at Purdue University in the Computer Graphics Technology Department. I am conducting a research on how reminiscing past happy memories can help individuals in long-distance relationship partners. In order to conduct the research, a custom-made mobile chat application has been built specifically for long-distance partners. I am inviting you to participate.

Participation in this research includes downloading the mobile chat application and using it for communicating with partners over a 1-week period. If you agree to participate, you will complete a survey on day 1 and day 7, which will be administered in the mobile application. Each of these surveys will take approximately 30 minutes to complete. Before using the mobile application, a list of questions will be prompted to which you will give a one word answer, you can associate with happy moments of your relationship. While communicating with your partner, you will assign (text/picture) messages with above created hashtags. A successful completion means answering all surveys completely, create tags, use tags in at least 25% of all the messages. Participants who completed the experiment successfully will be given a \$5 gift card on Amazon website.

If you have any questions or would like to participate in the research, I can be reached at dbodiche@purdue.edu.

Restrictions:

- In a long-distance dating/romantic relationship for 12 months or more.
- Both partners should be willing to participate.
- Participants should use smart phones.

Appendix C: Survey Questions

Background information

What is your current age? (Enter a number)

How many romantic relationships have you had in the past? (ENTER A NUMBER)

___ Number of past romantic relationships (where both of you considered it a relationship)

If yes, how would you describe your relationship with that person?

- We are married
- We are engaged
- We date only each other
- We date each other more than we date others
- We date others as much as we date each other

How far away are you from each other? (ENTER A NUMBER)

- ___ miles OR
- ___ hours by road OR
- ___ hours by flight

How many hours a day do you communicate with each other? (ENTER A NUMBER) ___
hour(s)

What is the most frequently used medium of communication in a day?

- Phone call
- Video call
- Text (SMS)
- IM

Which platform do you use to communicate? (CAN SELECT MORE THAN ONE)

- Facebook messenger
- Google chat
- Whatsapp

- Other (please specify) ___

How long have you been in a relationship with you current partner? ___ Years, ___ Months, ___ Weeks

What is your gender/sex? Female / Male

Who are you most likely to date? Men / Women

What is your year in college?

- Freshman
- Sophomore
- Junior
- Senior
- Other ___

Is English one of your primary languages?

- Yes
- No
- Not sure

Are you in a long-distance relationship (that is, does your partner live in a different town, state, or country)? Yes / No

Thoughts On My Relationship

Take a few moments to consider your current relationship. To what extent does each statement describe how you feel about your relationship? Please use the following scale to select your answers. Record your answer on the line to the left of the statement. You can use the same number more than once.

Response Scale:

0	1	2	3	4	5	6	7	8
Do Not Agree				Agree			Agree	
At All				Somewhat			Completely	

1. ___ I feel satisfied with our relationship.
2. ___ My relationship is much better than others' relationships.
3. ___ My relationship is close to ideal.
4. ___ Our relationship makes me very happy
5. ___ Our relationship does a good job of fulfilling my needs for intimacy, companionship, etc.
6. ___ The people other than my partner with whom I might become involved are very appealing.
7. ___ If I weren't dating my partner, I would do fine - I would find another appealing person to date.
8. ___ My alternatives to our relationship are close to ideal (dating another, spending time with our friends or on my own, etc.).
9. ___ My alternatives are attractive to me (dating another, spending time with friends or on my own, etc.).
10. ___ My needs for intimacy, companionship, etc. could easily be fulfilled in an alternative relationship.
11. ___ I have put a great deal into our relationship that I would lose if the relationship were to end.
12. ___ Compared to other people I know, I have invested a great deal in my relationship with my partner.
13. ___ Many aspects of my life have become linked to my partner (recreational activities, etc.), and I would lose all of this if we were to break up.

14. ___ My relationship with friends and family members would be complicated if my partner and I were to break up (e.g., partner is friends with people I care about).
15. ___ I feel very involved in our relationship – like I have put a great deal into it.
16. ___ I am committed to maintaining my relationship with my partner.
17. ___ I want our relationship to last a very long time.
18. ___ I would feel very upset if our relationship were to end in the near future.
19. ___ I want our relationship to last forever.
20. ___ I am oriented toward the long-term future of my relationship (for example, I imagine being with my partner several years from now).
21. ___ I feel very attached to our relationship – very strongly linked to my partner.
22. ___ It is likely that I will date someone other than my partner within the next year.

Experience in close relationships

The following statements concern how you feel in romantic relationships. We are interested in how you generally experience relationships, not just in what is happening in a current relationship. Respond to each statement by indicating how much you agree or disagree with it. Write the number in the space provided, using the following rating scale:

Response Scale:

1	2	3	4	5	6	7	
Disagree							Agree
Strongly							Strongly

1. I'm afraid that I will lose my partner's love.
2. I often worry that my partner will not want to stay with me.
3. I often worry that romantic partners don't really care for me.
4. I worry that romantic partners won't care about me as much as I care about them.
5. I often wish that my partner's feelings for me were as strong as my feelings for him or her.
6. I worry a lot about my relationships.
7. When my partner is out of sight, I worry that he or she might become interested in someone else.
8. When I show my feelings for romantic partners, I'm afraid they will not feel the same about me.
9. I rarely worry about my partner leaving me.
10. My romantic partner makes me doubt myself.
11. I do not often worry about being abandoned.
12. I find that my partner(s) don't want to get as close as I would like.
13. Sometimes romantic partners change their feelings about me for no apparent reason.
14. My desire to be very close sometimes scares people away.
15. I'm afraid that once a romantic partner gets to know me, he or she won't like who I really am.
16. It makes me mad that I don't get the affection and support I need from my partner.
17. I worry that I won't measure up to other people.

18. My partner only seems to notice me when I'm angry.
19. I prefer not to show a partner how I feel deep down.
20. I feel comfortable sharing my private thoughts and feelings with my partner.
21. I find it difficult to allow myself to depend on romantic partners.
22. I am very comfortable being close to romantic partners.
23. I don't feel comfortable opening up to romantic partners.
24. I prefer not to be too close to romantic partners.
25. I get uncomfortable when a romantic partner wants to be very close.
26. I find it relatively easy to get close to my partner.
27. It's not difficult for me to get close to my partner.
28. I usually discuss my problems and concerns with romantic partners.
29. It helps to turn to romantic partners in times of need.
30. I tell my partner just about everything.
31. I talk things over with partners.
32. I am nervous when partners get too close to me.
33. I feel comfortable depending on romantic partners.
34. I find it easy to depend on romantic partners.
35. It's easy for me to be affectionate with my partner.
36. My partner really understands me and my needs.

System Usability Scale

Response Scale:

Strongly disagree				Strongly agree
1	2	3	4	5

1. I think that I would like to use this system frequently
2. I found the system unnecessarily complex
3. I thought the system was easy to use
4. I think that I would need the support of a technical person to be able to use this system
5. I found the various functions in this system were well integrated
6. I thought there was too much inconsistency in this system
7. I would imagine that most people would learn to use this system very quickly
8. I found the system very cumbersome to use
9. I felt very confident using the system
10. I needed to learn a lot of things before I could get going with this system

Responses to Software Feedback

1. What username did you use when you registered on the application? (optional but would really help if you answered)
2. Did you use tagging a message feature?
3. If you answered Yes to previous question, did you find it useful?
4. If you did not use tagging feature, please explain why.
5. How can we improve tagging feature?
6. If whatsapp/facebook/googlechat had tagging feature in it, would you use it?
7. Did you use "what's on your mind" /memory lane feature?
8. If you answered Yes to the previous question, did you find it useful?
9. If you did not use "what's on your mind" feature, please explain why.
10. How can we improve "what's on your mind" feature?
11. Was it easy navigating through the application?

12. If you answered no in the previous question, please explain.
13. What other features of the application did you use ? (text message, audio message, images)
14. Compared to other applications, did you think this application was better or worse or equal? Please explain.
15. Did you feel comfortable using the application in terms of security?
16. Did the application have the features that you wanted? What other features would you like to see?