

Design of an Interactive Text Messaging Platform for Problem Alcohol Use Intervention in College Students

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Abstract - College students are a highly connected population, and also one with a potential for problem alcohol use. Young adults of college age frequently have cell phones and other mobile electronic devices and spend significant time maintaining their social networks of friends via Facebook, Instagram, Twitter and other instantaneous means of communication such as text messaging. Alcohol use is not uncommon among this same group, and the newfound freedoms experienced in a college environment can lead some young adults to develop problems with alcohol use that go beyond occasional social drinking. This paper reports on the design of an interactive text messaging platform that enables therapeutic alcohol use intervention treatment to go beyond the counselor's office and directly into the mobile devices students typically carry and use. The design of this interactive system is detailed, technology decisions are discussed, and a summary of the results of a pilot study using the system is presented. Future plans for extension of the platform onto smart phone technology and with a higher degree of interactivity are explored.

Keywords: Interactive text messaging, parsing, SMS, alcohol use treatment, server-based text message processing.

1 Introduction

Interactive technology such as text messaging and other features of smart phones and older feature phones provides an appealing way for young adults to maintain interpersonal connections with a circle of friends. Because mobile device technology, and the quick communication it facilitates, is so prevalent, opportunities abound for making use of this technology in innovative ways. One intriguing possibility is as a support tool for interactive, text messaging based interventions as a therapeutic technique for reducing substance abuse in of various forms by young adults. Although generally too complex and proprietary to develop as part of a single research study, there are a number of platforms that implement a cloud application architecture and can facilitate development of an interactive, text-based protocol, including Twilio [22] and Tropo [21] (Figure 1).

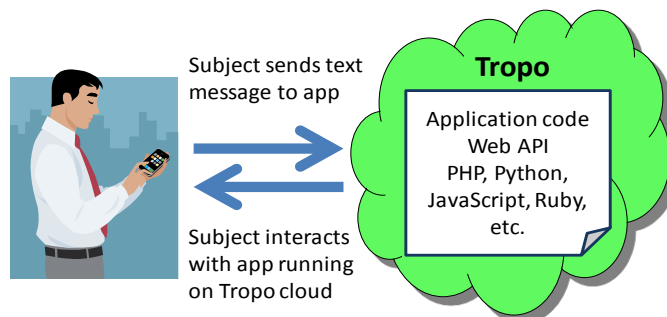


Figure 1. Tropo Cloud Application Architecture [21].

Young adults are a high risk group for many health problems including substance use, suicide, and drinking. For example, full time college students (ages 18 to 22) were more likely than their peers not enrolled full time to use alcohol in the past month, binge drink, and drink heavily [15]. Heavy alcohol consumption and the resulting negative consequences are significant risk factors for college students in the United States [8,10], with one in four college students having met alcohol abuse or dependency diagnostic criteria in the past year [16]. In 2011, over 60 percent of full-time college students consumed alcohol on a regular basis, nearly 40 percent were binge drinkers, and 13 percent were heavy drinkers. Among those not enrolled full time in college, these rates were 52, 35, and 10 percent, respectively [5,20]. Thus, not only are young adults drinking, but the way in which they drink put them at high risk for alcohol-related problems.

Motivational interviewing (MI) techniques which make use of brief and supportive interactions have shown promise for reducing alcohol-related problems [1,15,18], smoking [2,9], marijuana use [4], and substance use and drinking [11]. These MI approaches tend to focus on the goal of reducing use, rather than leading to complete abstinence. Thus, MI often serves as a stimulus to contemplation about current and future use, which is an important and necessary precursor to eventual abstinence, or in some cases, more responsible use [13,14;19].

In a previous study, the efficacy of a preventive intervention using MI for substance use and associated risk behaviors among adolescent patients was measured. A 20 minute, evidence-based session with a social network

component was performed in a study of 28 teen subjects who were recruited, provided consent/assent, screened, and randomly assigned to a treatment or control (no treatment) group. After one month, a follow-up survey showed that teens in the treatment group reported getting into less trouble related to substance abuse and were more prepared to begin substance abuse counseling than teens in the control group [14]. The success of this earlier study led to the development of a protocol for a text messaging based MI approach.

In this paper, we present the motivating factors and technological foundations of an automated, interactive, text messaging system that implements an MI-based therapeutic treatment protocol. The system is designed to be easily retargeted to other domains, and in this instance is used for alcohol use intervention. The design is described using a system architecture design and accompanying detailed explanation of software design, technology decisions, messaging protocol, and message content. The results of a pilot study using the system are summarized, and future plans for extension of the platform onto smart phone technology and with a higher degree of interactivity are explored.

2 Suitability of Text Messaging

Traditionally, motivational interviewing is performed by a trained clinical psychologist as part of a treatment and intervention program [7]. It has long been used as a technique for the treatment of problem drinkers, though it has shown benefits in many other forms of motivation-dependent counseling [1,2,4,9,11,15,18]. As a technique, motivational interviewing is a client-centered counseling style that helps clients to make positive changes in their behavior by uncovering varying degrees of readiness and other internal motivation within a client in order to facilitate the desired change [1].

At the outset of this research, it was unknown if a motivational interviewing protocol using automated text messaging would be successful as an intervention technique within an overall treatment protocol, although recent research has indicated strong potential [3]. Guiding our application of text messaging as an MI approach was the Transtheoretical Model of Behavior Change (TTM), which organizes behavior change through a series of stages [17].

In accordance with what the literature suggests, and due to the ready availability of a college student population, we envisioned that our study would target heavy drinkers in the young adult population at Virginia Commonwealth University. Specifically, we hoped to be able to identify what stage of change each subject was in via interactive questions such as “Do U think it will be hard for U to reduce or stop drinking?”

During the study and based on subject responses, each subject was classified as being in one of the accepted TTM stages that are precursors to active change: precontemplative,

contemplative, or preparation. The interactive nature of the text messages allowed for the integration of consciousness raising (educated each of the participants on how much they drank in comparison with other young adults), self-reevaluation, environmental reevaluation, and self-liberation (participants were asked if they were willing to make adjustments to their drinking habits, were asked to commit to an adjustment, and then sent encouragement that they could fulfill their commitments). Although the text messages were sent via a computer program, they were designed to make the participant feel as if they had a helping relationship.

According to early work in this area, consciousness raising and environmental reevaluation are effective change processes for individuals in the precontemplative stage [17]. Self-reevaluation is an effective change process for those in the contemplative stage, and self-liberation is a helpful change process during the preparation stage. Although, a helping relationship is a change process that is not effective in moving participants to the consecutive stage of health behavior change unless they are in the action stage, this aspect of the text-messaging was a component of integrating MI with social network counseling.

Thus, based on an analysis of previous research, the prevalence and availability of text messaging capable cell phones among college students, and the highly interactive nature of text messaging as a communication medium, it became clear that there was merit in conducting a study using a text based approach to motivational interviewing. Equally important to this research was the need to evaluate the feasibility and efficacy of this text based approach as part of the overall intervention goals of the study.

3 Interactive Platform Design

The framework that was designed, implemented and deployed for this interactive, text-based approach relies on popular Linux, Apache, MySQL and PHP (LAMP) computer server technology [12] and the Tropo cloud-based platform for text-enabled applications [21], with design direction taken from several well-studied software engineering design patterns [6]. Figure 2 illustrates the architecture of this system, including cell phones, cloud-based texting platform, server and database components, and support for management, subject enrollment and system status monitoring. At a fundamental level, the solution to this design is creation of a parsing technique that is driven by a database and responds to incoming text messaging events.

3.1 Server Technology

The web server that hosted the texting application software was configured using the popular LAMP configuration [12]. This configuration is designed for efficient and cost-effective web servers, enabling a wide variety of power web-based applications.

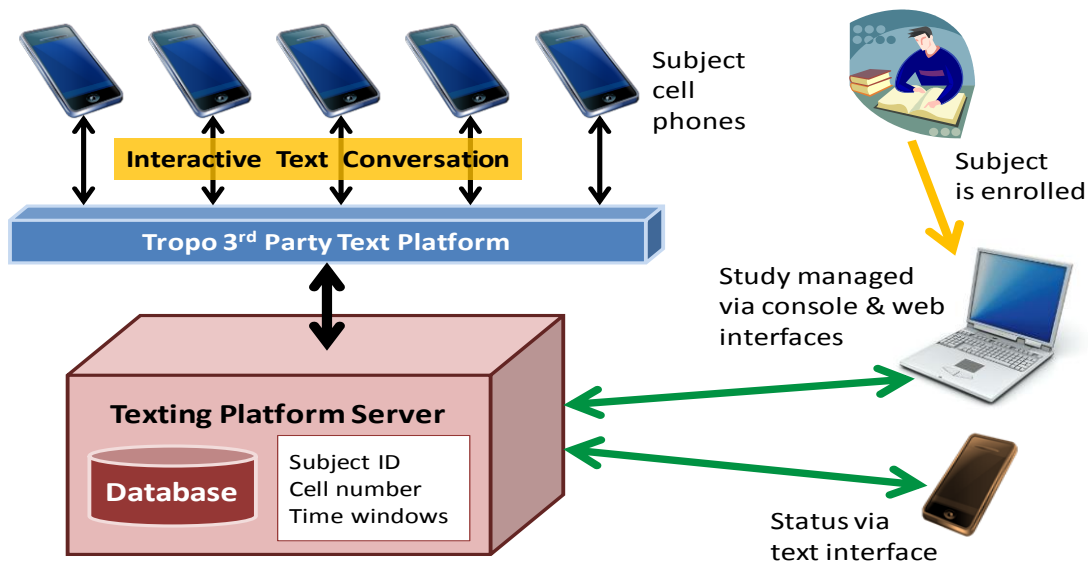


Figure 2. Design of interactive text messaging platform.

The text-based software that drives our study was implemented in the PHP programming language, which is widely used for web-based application development. PHP was selected for its broad adoption, availability of example programs, and support within Tropo, the cloud-based, text messaging platform that was selected for this project. The server was configured to use a high level of security to insure that data integrity was maintained.

3.2 Software System Design

The overall design of the text messaging software system was engineered using three well-known design patterns [6] to describe the structural, behavioral and concurrency aspects of the system. The Front Controller structural design pattern was used to centralize control of this combined web-based and server-based application. The State behavior design pattern was used to guide development of the state-machine algorithm that tracked progress of each subject within the study, including which of the many possible messages was the next appropriate message to be sent to each subject. To support the significant concurrently used in the application, the Event-based Asynchronous concurrency pattern was implemented in order to marshal incoming requests and manage the corresponding system state changes.

3.3 SMS System Design

The Short Message Service (SMS), or text messaging service, component of the system was implemented using a commercial cloud-based Application Programmer Interface (API) called Tropo. Tropo provides web-application developers an API for designing software that supports voice and SMS communication in a variety of popular programming languages [21]. The Tropo system enables

unlimited, free use of the text-messaging platform for web-applications during the development and testing phase and a cost-effective pricing structure during the production phase of a project. Tropo was selected over its main competitor, Twilio [22], because of its more favorable pricing structure and comparable feature set.

Application design began with an event and data parsing algorithm definition phase, during which appropriate design patterns were identified and implemented and test programs were developed to experiment with the features of the Tropo platform. Because the initial proof-of-concept was designed to be easily modified, a text-based approach for storing data and tracking subject progress was used to enable more convenient data collection management and data-format changes. Due to numerous modifications made to the data collection strategy and data management needs, the choice to use a text-based approach was fortuitous as database table modifications can be cumbersome when data management is complex.

The production version of the text-based software system used this less complex text-based data system, consisting of individual comma-separated-value files for each subject to support this ease of support during ongoing development. In future uses of this platform, the MySQL database platform will be incorporated to provide more flexible and robust programmer support for data management.

Subjects were entered into the study on a rolling basis, resulting in subjects being in various states of the study simultaneously. To enter a new subject into the study, the subject's unique subject ID and cell phone number were inserted into the database. Note that subject IDs were used

to identify subjects on the web server in order to maintain and protect the privacy of each subject. No identifying information was stored on the web server, and it was only after data was gathered and securely downloaded by researchers that data could be linked with subject identities for further analysis.

Text message sequences were sent over four days, with the initial message of each day sent to each subject initiated using a daily, time-triggered “cron” job. Table 1 describes the breakdown of text messages for each day, and how the messages were designed to support a particular approach and motivational interviewing focus. For each day, Table 1 also explains the intent of each model component of the text messages for each day.

The initial text message sent to each subject was done so during an individualized time permission window during which the subject indicated it was okay to receive a text message. Subsequent message interactions were handled asynchronously based on individualized interactions with each subject. When a subject replied to a given message, the text-messaging platform prepared a customized, outgoing message based on that subject’s current progress, or state, within the study. Figure 3 shows the sequence of text messages sent each day, including placeholders where a subject’s first name (SUBJECT_NAME), typical of number of days per month the subject drinks alcohol (NUMBER_OF_DAYS), percentile raking of alcohol use as compared with peers (ALCOHOL_USE_PERCENT), risk level of the subject’s peer network (RISK_LEVEL), and finally email (EMAIL_CONTACT) and telephone (PHONE_CONTACT) contact information.

Once the day’s defined messages for a given subject were exhausted, any subsequent messages from that subject were responded to with a generic message reminding the subject that additional messages of support were available.

All of these interactions were gathered in per-subject logging files and an overall study logging file to enable both individual and summary post mortem analysis of interactions and to provide data redundancy.

At any time, a subject could request a “booster” message by simply texting back the word “boost.” These booster messages (Figure 4) were designed to be simple messages of encouragement and support, written in the form of interactions used in motivational interviewing.

Upon completion of the four day sequence, subjects were sent reminder text messages at days 23, 29 and 30 after they entered the study. These reminders provided information to subjects about the online follow-up survey they were asked to complete in order to conclude their involvement in the study and to receive a small stipend. Subjects were encouraged to complete the online follow-up survey one month after entering the study, and were sent a single, daily text message reminder each day after that point until they completed the survey.

For study administrators, text-based system support was implemented. By texting single word commands such as “help,” “start,” “stop,” or “status,” the text messaging system respectively would provide a summary of available commands, start the system to enable sending of messages, stop the system to disable sending of messages, and report on the current status of the system including a summary of progress of the enrolled subjects. This simple administrative interface was also available from the Linux command-line and provided administrators with a straightforward way to control the system and verify its status. Two web-based interfaces were developed to enable researchers to verify each subject’s cell phone during the initial interview phase of the study, and to indicate when a given subject had officially completed the study, thereby stopping any reminder messages that were being sent.

Table 1. Description of text message design and model components based on focus of Motivational Interviewing stages.

Day	Texts	Approach & MI Focus	Model Components
1	6 texts boost texts	Rapport building <i>MI acceptance & engagement</i>	Asked about general well-being Asked about difficulty to stop/reduce drinking Asked what they like and dislike about drinking
2	4 texts boost texts	Presenting feedback <i>MI acceptance</i>	Drinking is reviewed & compared to national norms Asked to reflect and consider future in light of current drinking
3	5 texts boost texts	Presenting information & feedback <i>MI acceptance</i>	Information about social networks is presented Personal social network quality is reviewed Asked to reflect on their social network
4	4 texts boost texts	Summary of session <i>MI encouragement</i>	Texts are summarized Asked if they would consider making small changes in their social network Asked to consider with whom in their network they would like to increase or decrease time with & where Reminded about follow-up telephone interview

Day 1

Message 1: "Hi SUBJECT_NAME. This is the VCU Psych Study. What up? How U feeling today? Txt back: good, ok, bad."

Message 2: "B-4 we start, do U think it will be hard for U to reduce or stop drinkin? Txt back: no way, maybe, or def."

Message 3: "Let's talk about sum of your responses from the survey. U reported drinkin NUMBER_OF_DAYS days in past 30 days. Can U tell me what U like about drinkin?"

Message 4: "OK, thanks I appreciate it. Can U also tell me what U dislike about drinkin?"

Message 5: "Sometimes there are pluses & minuses to drinkin. What are U doing now?"

Message 6: "Thanks for your responses. I appreciate it. I hope U can think over what we discussed. Bye. Need some extra support? Txt: boost"

Day 2

Message 1: "Hey SUBJECT_NAME. How are U feeling? Txt back: good, ok, bad."

Message 2: "Let's talk more about ur drinkin. Did U know that ALCOHOL_USE_PERCENT of other 18-23 year olds drink less than you? How's that for you? Txt: surprised, unsure, upset."

Message 3: "Can U tell me how U see your life in light of your current drinkin?"

Message 4: "Ok, thanks for Ur response, I really appreciate it. Need some extra support? Txt: boost"

Day 3

Message 1: "Hey SUBJECT_NAME. How r u doing? Txt back: good, ok, bad. Then, let's talk about your friends."

Message 2: "Your network is RISK_LEVEL risk to affect your drinkin. How do U feel about Ur network? Txt back: ok, need to change, need lots of change."

Message 3: "How would U rate Ur craving right now? Txt back: Intense, pretty strong, under control."

Message 4: "Remember, very small adjustments in ur network can have big effects w/ ur drinkin. What are U doing now?"

Message 5: "K, thx. I hope U can think over what we discussed. Hang in there, bye. Need some extra support? Txt: boost"

Day 4

Message 1: "Hey SUBJECT_NAME. Howz life? Txt back: good, ok, bad."

Message 2: "Based on what we have been texting about, would U consider making any small adjustments to Ur drinking at this time?"

Message 3: "An option is to spend slightly more time with non-drinkers and less with drinkers, and spending more time at non-drinking locations. What do U think?"

Message 4: "What do you think U would like to do about your drinkin?"

Message 5: "Thx for Ur texts. Hope U can think over what we discussed. Questions? EMAIL_CONTACT PHONE_CONTACT. Complete follow-up survey in 1 mnth & get \$20"

Figure 3. Text messages

Booster messages

Boost 1: "Ask for support from a non-drinking friend, find out what they are doing tonight."

Boost 2: "Mix up Ur routine so U won't be tempted to drink, do different things."

Boost 3: "Try to spend less time at places that remind U of drinking. U can do this!"

Boost 4: "Hang in there, U are doing great! Go work out, see a movie, have a meal."

Boost 5: "Go to a coffee shop, go to a bookstore, study, improve Ur GPA!"

Boost 6: "Hang in there, there are lots of students who are interesting, fun, cool, and sober, like U!"

Figure 4. Booster messages

4 Results

Our primary feasibility finding centered on the development and application of our computer program that organized, scheduled, maintained, and delivered our text-messaging intervention. We found that the automated and individualized text messaging protocol was successful in delivering text messages to the correct individual (97%), in the correct sequence (100%), with appropriate responsiveness to each participant's replies (98%). The sequencing of text messages was accurate in the day sequence as well as within day interactive texts based upon participant response.

To determine the efficacy of the text-based approach to delivering motivational interviewing support, we analyzed the response data collected during interactive sessions as well as pre- and post-study survey assessments. In comparing the results for the intervention and control groups, we found two promising trends. The intervention group had increased intentions to reduce alcohol use in three months following the text protocol, while the control group had decreased intentions to reduce alcohol use the same period. Due to the pilot nature of the study and a relative small population, statistical significance was marginal ($p < 0.10$). However, texting responses and other interactions with both groups of subjects provided qualitative support for these results. Similar results were seen in actual steps taken to reduce alcohol use, with the intervention group showing a slight increase while the control group showed a decrease.

The results from this small feasibility trial are promising on multiple fronts. First, the strong negative correlation between readiness to change and perceived difficulty stopping drinking provides support that our measures fit our unique intervention. This could also be evidence that we are accurately tapping into the readiness for change construct with this initial text item. Although we did not see significant changes in social stress outcome scores between groups, the strong positive correlation between anxiety and need to change their social network due to drinking issues provides support for further

exploring the social-psychological consequences of college student problem drinking. These findings mirror other social network research that has demonstrated strong relationships between mental health outcomes such as anxiety and depression and social network quality among adolescents [13]. Socially based interventions that can address peers, mental health, and drinking behavior may be warranted.

5 Conclusions

The development of an automated computer program that can accurately remind, send, respond, track, and maintain a text-messaging intervention is a promising finding. Having the ability to reach populations of interest at an extremely low cost has implications for a public health approach towards substance use prevention and treatment. Effect sizes would not have to be large to justify the further testing on this type of intervention on problem alcohol use for a high-risk population such as college students. The cost-benefit ratio is fairly clear, even from this small trial. This entire program can now be tested for accuracy in a larger scale trial as well as to continue to evaluation implementation improvements.

In all, this trial piloted an innovative study that utilized automated text-messaging computer programming and evidence-based text intervention and produced promising enough results to warrant further study. The future of mobile behavioral health interventions has just begun with an exponential increase of text-based interventions over the last 7 years. It is clear that for the young adult population, mobile phones will continue to be a very close part of their lives, and thus integrating interventions into this platform makes good scientific sense.

In the future, the system will migrate the data collection component to a true database system rather than the current text-file-based approach. Other uses of this system will be explored, including use in similar health behavior intervention studies as well as more general information and customer support systems that can use artificial intelligence techniques to respond to user interactions.

6 Acknowledgment

The work reported in this paper was partially supported by the Institute on Drug and Alcohol Studies, Virginia Commonwealth University.

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