"30 Days:" An EMA Diary Mobile App & Web Tool

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ABSTRACT

As HCI researchers, we are constantly searching for ways to improve the approaches in which we engage with our participants, especially when engaging with vulnerable populations about sensitive topics like online risk experiences. For this reason, we developed "30 Days," a cross-platform EMA diary mobile app and web tool that collects contextualized data by engaging and motivating teens to report on their daily online experiences. We developed 30 Days to be tailored to the needs of researchers using experience sampling with teens. This interactivity demonstration provides an overview of the "30 Days" system.

CCS CONCEPTS

• **Human-centered computing** → Human computer interaction (HCI); Interactive systems and tools.

KEYWORDS

Ecological Momentary Assessment, Diary Study, Experience Sampling, Mobile App, Web Tool

1 INTRODUCTION

Experience sampling, also known as ecological momentary assessments (EMAs) or a diary study method, is a frequently used longitudinal research method within the HCI community that involves collecting observations of participants' daily thoughts, feelings, behaviors, and/or environment over time [6]. Diary studies are an effective method for collecting contextualized data by allowing research participants to report on their conditions close in time to their experiences. Their contextual and "in-situ" nature helps diminish recall bias [7], which, in contrast, may be found in more traditional methodologies (e.g., interviews) [6]. Due to the strengths

of this approach, much of the CHI and broader HCI community has frequently used this methodology to investigate several psychological and social-related topics such as posttraumatic stress syndrome [3], suicidal ideation [4], sexual activity [5, 9], and substance use [8]. Building upon this prior work, we conducted a study [2] in which we examined whether a daily EMA diaries administered via a smartphone app could potentially be a more engaging and effective way to conduct online safety research with teens. Based on our results, we developed the "30 Days" EMA mobile app and web tool as a potential research tool for academic researchers. This paper describes our tool and development process.

1.1 Gaps within Existing Mobile Diary Apps

While preparing to conduct a 30-day EMA diary study regarding the online experiences of adolescents, we decided that a mobile application would be the best way for teens to interact with the study, since they are likely already using their mobile devices for most, if not all, of their internet usage [1]. Our main goals were to allow teens to submit daily surveys, submit screenshots of their online interactions, receive help resources, and keep track of their progress and monetary earnings to incentivize the study.

Most pre-existing mobile diary applications that we found were either focused on providing customer discovery data to companies (i.e., not tailored to academic research studies) or used in clinical research settings for assessments or trials. Yet, those we found for academic research, were focused on more physical, environmental studies, and had capabilities that we did not need, such as tracking location, weather, light, noise, and physical activity. Furthermore, these applications were missing features that were essential to our study, such as tracking incentives, behavioral phone data, or communication between researchers and participants. Given this, we decided to create our own, custom mobile application to meet all our needs. We also developed a web application for researchers to keep track of the study and manage participants' progress.

2 "30 DAYS" APP DESIGN

Our EMA diary study research tool consists of two applications: 1) a cross-platform (Android and iOS) mobile app that participants use to submit data, and 2) a web app that researchers use to manage these participants and their data. The next subsections provide information about the main features of these apps.

2.1 Mobile App (For Participants)

Upon installation of the app, the participant is asked to sign in with their email and a temporary password (provided by the research
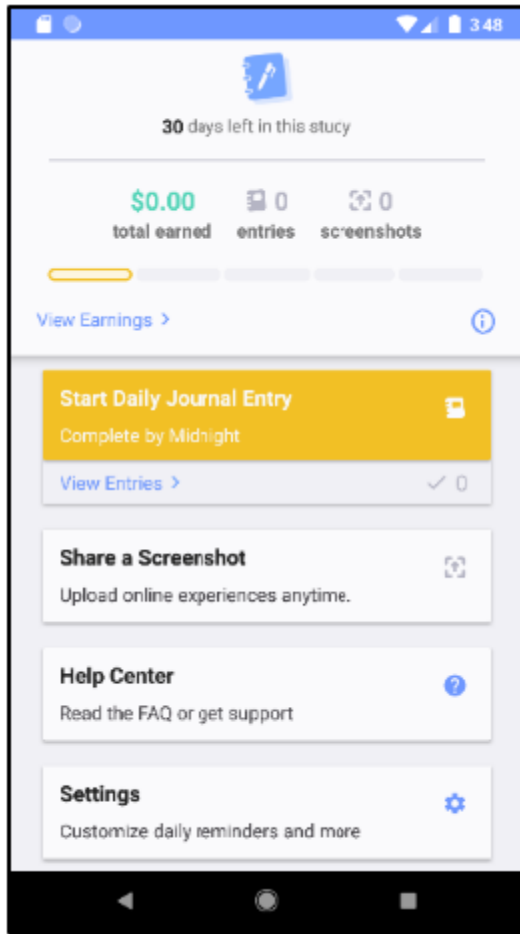
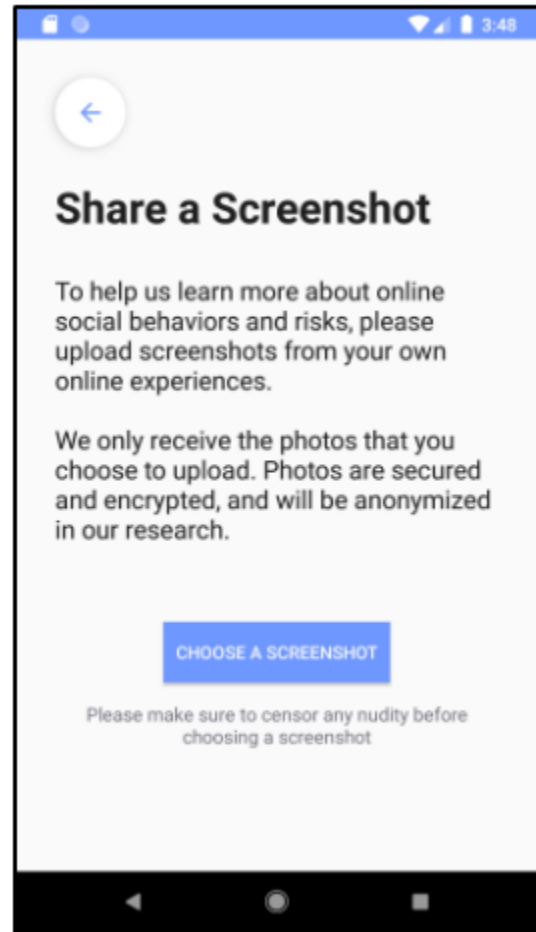Figure 1: Screenshot of "30 Days" Mobile App Dashboard

Figure 2: Screenshot of "30 Days" Mobile App Share a Screenshot Feature

team via email). They are then asked to enter their own password to replace the temporary one. Next, they are given the option to enter a 4-digit passcode to lock the app. This serves as form of authentication, without the need to sign into the app with an email and password every time it is used.

Next, the participant is asked to grant the researchers access to their device data and usage. On Android, this data includes a list of all apps installed on their device (the app manifest), the time they spend using each app, and the total time they spend using the device (screen time). On iOS, this data includes a list of some installed applications (due to technical limitations) and total screen time. To collect screen time data on iOS, participants must set location access to Always, allowing the app to continuously run in the background. However, no location data is collected. This device data will be collected from participants when granting access and each time they submit a diary entry.

2.1.1 Main Mobile App Features.

- **Dashboard**: At the dashboard, participants can see their study progress and the amount of money they have earned.

They can also submit diary entries (daily journal entries), submit images (screenshots), view their daily journal entry and screenshot submission history, access the help center, and customize app settings.

- **Daily Journal**: Once per day, any time from 2:00 PM to midnight, participants are prompted to fill out a Qualtrics survey about the online interactions and experiences they had during the day. Upon completion of the survey, the participant is redirected to the dashboard and their device data is uploaded.
- **Earnings**: Participants can view a breakdown of the money they have earned throughout the study, which describes where the money is coming from. This 30-day study is split into 6 "periods" of 5 days each. For every journal entry that is approved by the researcher, the participant will receive $1.50. If all 5 entries within a period are approved, the participant receives a $5 bonus. If one or more screenshots are submitted within a period, the participant receives a $5 bonus. Submitting multiple screenshots will not result in multiple bonuses.
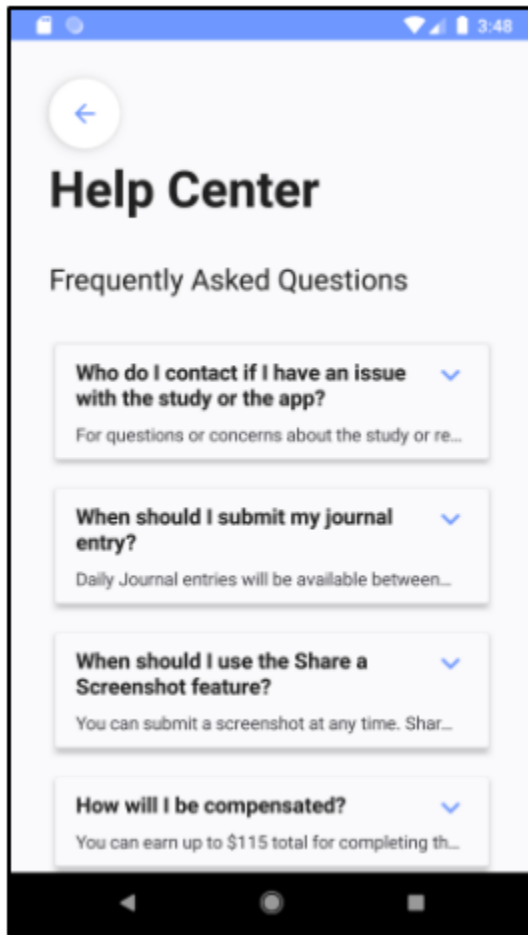
Figure 3: Screenshot of "30 Days" Mobile App Help Center Feature (FAQs)

Figure 4: Screenshot of "30 Days" Mobile App Help Center Feature (Get Support)

A total of $17.50 can be earned each period, meaning a participant can earn a total of $105 from participating in the study.

- **Share a Screenshot**: Participants have the option to upload a screenshot of their online interactions at any point during the study, as many times as they like. However, they are encouraged to upload at least one screenshot every five days. After selecting a screenshot, participants must enter a text description before submitting.
- **History**: Once a participant has submitted a daily journal entry or screenshot, they can view their submission history for either. This includes when an item was submitted, the submission status (missed, submitted, accepted, or rejected) and when the status was updated, and an optional message from the researcher regarding the submission.
- **Help Center**: The Help Center includes frequently asked questions about the study and the mobile app. These explain several potential concerns, such as what type of data the app collects, why the study is being conducted, and how money
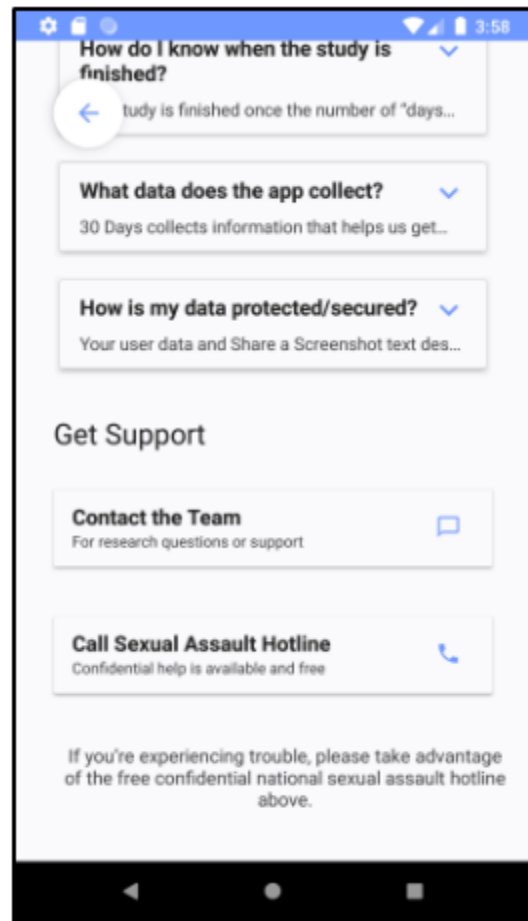
is earned. The Help Center also lets participants contact the research team and the National Sexual Assault Hotline for proper support throughout the study, directly from the app.

- **Settings**: In Settings, participants can set the time of their daily journal reminder. By doing so, they will receive a push notification every day at the specified time, reminding them to complete their journal entry for the day. They can also enable, disable, or change their 4-digit passcode used to lock the app, or they can sign out of the app.

2.2 Web App (For Researchers)

When visiting the web app, researchers are asked to sign in with the email and password assigned to them ahead of time. After logging in, they are brought to a dashboard where they can get an overview of study activity, manage participants, manage submissions, and sign out.

2.2.1 Main Web App Features.

Figure 5: Screenshot of "30 Days" Web App Dashboard

- **Study Activity:** Researchers can see how many participants are in the study, how many days the study has been running, the combined amount of money all participants have earned, the number of submissions pending review, the total number of journal entries submitted, and the total number of screenshots submitted. They can also see the distribution of Android and iOS users in a pie chart, and download data related to the study for later analysis, including Qualtrics survey (daily journal entry) data, screenshots and associated data, and device usage data collected from participants. Furthermore, they can leave a number of notes on the study for later reference.
- **Participants:** Researchers can see actively enrolled participants, participants who were invited but have not started the study, and participants withdrawn from the study. They can add a new participant by entering their email, age, gender, and race. At this point, the participant will receive an email with a temporary password to log into the mobile app. Researchers can resend the email or remove the user from the study. Participants appear as inactive until they sign in for the first time, at which point they appear as active. Researchers can also view a participant's profile, which includes their email, demographic information, operating system (Android or iOS), how many days until they complete the study, the money they have earned, and the number of journal entries and screenshots they have submitted. They can also see a list of the participant's submissions, and view, approve, or reject each one. Furthermore, they can leave their own notes on a participant for later reference.

- **Submissions:** Researchers can also see a list of all participants' submissions, and view, approve, or reject each one. Viewing a journal entry will show the responses in Qualtrics and viewing a screenshot will show the image. When approving or rejecting a submission, the researcher can enter a text message to explain to the participant the reason for the decision. They can also leave their own notes on a submission for later reference.

3 TECHNICAL IMPLEMENTATION OF "30 DAYS" APP

The following subsections discuss the technologies we used to create each application.

3.1 AWS Backend

Our mobile and web applications shared a backend, built using Amazon Web Services (AWS). We used AWS Cognito User Pools to store users' account information, such as passwords, privately from the researcher. We used AWS Relational Database Service (RDS) to host a password-protected MySQL database instance that stored other user information (such as survey completion state) and connected this information to the Cognito user accounts. We created AES-256 server-side encrypted AWS Simple Storage Service (S3) buckets to store files containing sensitive information (such as user screenshots and device usage data). We created a REST API with AWS API Gateway, in which endpoints executed AWS Lambda functions. These functions both modified the data in our RDS database instance and uploaded data to our S3 buckets, and served as the means of connecting Cognito user accounts to the RDS database instance. We used AWS EventBridge to schedule daily

journal reminders and trigger a Lambda function that sends push notifications to Android via Google Firebase. We used AWS Key Management Service to encrypt environment variables in Lambda functions to achieve at-rest and in-transit encryption on sensitive information, such as database passwords. We used a virtual private cloud (VPC) to further protect the RDS database so that only our Lambda functions and a single AWS Elastic Compute Cloud instance (used for database maintenance) had access.

3.2 Client Applications

The web application was built using Angular.js. We used AWS Amplify to host the application and automatically configure user accounts for each researcher. Both the Android and iOS applications were built natively. The Android app was developed using Android Studio 3.5.1 and written in the Java programming language. The iOS app was developed using Xcode 11.0 and written in the Swift programming language. Upon account creation and first-time login, users were prompted to grant access to the data on their phone. The Android app used UsageStatsHelper, PackageManager, and UsageEvents to collect the daily screen time, the app manifest, and how long each app was used in a daily context. The iOS app used location services, NotificationCenter, and the canOpenURL function to collect the daily screen time and a list of installed social media apps. The client app architecture uses our REST API to modify and display data from the backend. When the user makes a submission, views personal data, etc., their identification is verified using API Gateway Authorizers and any data is uploaded to the appropriate table, using the user ID generated by AWS Cognito upon account creation as a primary key.

4 CONCLUSION

Developing new research tools that support researchers' goals to measure participants' real-world experiences as well as participants' engagement and privacy is important for tackling real, significant societal challenges. We believe "30 Days" not only serves researchers with an academic tailored research tool, but it also provides their participants, specifically teens, with an engaging app that allows for tracking their incentives.

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