Investigating How to Measure Mobile User Engagement

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Abstract. User Engagement is a keyword employed by software companies, researchers, and developers designing user-centred applications. Indeed, designing digital experiences to engage users is a goal that is becoming increasingly important for several disciplines such as education, marketing, information systems, and much more. Since opinions concerning the definition of user engagement greatly vary, the question comes up whether it is possible to provide a universal set of metrics to equally measure the engagement in any kind of application and in mobile applications in particular. Starting from results in the literature, this paper provides a simple definition of user engagement and a related set of metrics. Such metrics will be evaluated in a pilot study with more than 300 teenagers in four European countries.

Keywords: Mobile engagement · Web engagement · Mobile analytics · Web analytics · User engagement metrics

1 Introduction

For the case of mobile technology, successful technologies are not simply usable but they should engage users [16]. However, there is not consensus on what engagement is and how to measure it. In the past few years, web sites and web applications are the kind of applications in which more studies have been conducted to define and measure user engagement. Websites need to be engaging in order to achieve their purpose, which might be sharing knowledge, selling advertisement, providing customer support, etc. Independently from the specific purpose, if the website is not engaging, it is probably not achieving its goal [14]. Very similar goals and issues are present in the world of mobile applications. Our research project provides an ecosystem of apps and services, the definition and metrics of user engagement that we are seeking should be scalable and distributed (having multiple and variated sources of data) but nevertheless be summarized by a unique score.

Several definitions of user engagement exist. This variability is due to the difficulty in limiting this concept to a specific domain. In fact, user engagement ranges from psychology to marketing, from technology to services. In the marketing context, user engagement is often referred to as customer engagement.

2   Background – User Engagement Definitions

A simple definition can be found in [5], in which Chapman describes the engagement as something "*that attracts and holds our attention*". A more complex and widely used definition is based on the research of O'Brien and Toms [16] and reads *"Engagement is a category of user experience characterized by attributes of challenge, positive affect, endurability, aesthetic and sensory appeal, attention, feedback, variety/novelty, inter-activity, and perceived user control."* Quite similar are the conclusions of Attfield et al. [2], whose definition is based on existing literature concerning user engagement: *"User engagement is the emotional, cognitive and behavioural connection that exists, at any point in time and possibly over time, between a user and a resource."* Our project grounds part of its behavior change techniques on serious games and gamified applications [4]. In this domain, engagement is frequently related to the *flow state*, defined as "*an experience in which interactions cause intrinsic pleasure while an individual is involved in an activity*" and users are completely absorbed and immersed in the activity as presented in [6, 15]. However, as stated by Jennett et al. [9], in games and gamification user engagement can be associated to *immersion,* which can be a less intense experience than flow. In particular, Brown and Cairns [3] consider engagement as the first level of immersion (being engrossment and total immersion the deepest ones). These definitions present the concept of user engagement highlighting its different facets. However, our approach is based on operative and measurable definitions. Haven and Vittal [8] provide a more operative definition if compared to the strictly psycho-physiological approaches. Authors aim to provide a business-centred framework in which engagement can be described as: *"the level of involvement, interaction, intimacy, and influence an individual has with a brand over time."* Ensuing from this definition, Haven and Vittal provide a simple framework called the *4 I's*. While the study provides very useful and simple measures, they have been designed for businesses and marketing purposes and focusing in the web app field. Hence, the type of engagement may differ from the one found in mobile and pervasive applications.

Again in the domain of web apps, Peterson and Carrabis in [17] focus on websites and their visitors, and define engagement as follows: *"Visitor Engagement is a function of the number of clicks, the visit duration, the rate at which the visitor returns to the site over time, their overall loyalty to the site, their measured awareness of the brand, their willingness to directly contribute feedback and the likelihood that they will engage in specific activities on the site designed to increase awareness and create a lasting impression."* In contrast to the previously mentioned definitions of engagement, this approach is based on web metrics only. Tools like Google Analytics and others can be used to simply gather visitor data and derive their engagement while browsing a web service. Nowadays, the same tool and other very similar tools (e.g., Amazon Mobile Analytics [1]) can be used to measure similar parameters for mobile applications.

Finally, to the best of our knowledge, the only research papers that exclusively focus on mobile user engagement are [10] (authored by Kim et al.) and the work by Tomaselli et al. [18]. In their study, Kim et al. build a model to describe mobile user engagement (focusing on smartphone engagement) categorized into the three dimensional stages of human attitude: Cognitive stage, Affective stage and Conative stage. They try to define

mobile user engagement via four different factors: Mobile engagement motivation (classified into three groups: Functional/Utilitarian motivation, Social motivation and Hedonic motivation), Perceived value, Satisfaction, and Engagement intention. Unfortunately, as in most of the previous definitions, authors do not provide operative measures that can be automatically acquired simply using an application as our project requires. Therefore, we propose our metrics in this paper.

3 Measure User Engagement

Starting from the previous definitions. We have realized a small survey on the different metrics that have been adopted so far for technological applications. The measure of user engagement appears in various forms. Depending on the aim that a company or research team is targeting, the metrics and the measuring approaches to capture user engagement clearly differ from each other. We base our taxonomy on the works of Lehmann et al. [12] and Lalmas et al. [11]. Summarizing their findings, the approaches to measure user engagement can be divided into three main approaches. **Self-reported Engagement.** In this group the way of capturing user engagement is by reporting the individual's perceptions, which can be done with questionnaires, interviews and think-aloud protocols. **Cognitive Engagement.** This approach uses task-based methods in combination with physiological measures to evaluate the cognitive engagement; in other words, this approach uses tools, such as heart rate monitors, eye trackers, etc. while a user is completing a predefined task. This approach is typically more objective than the former group, and can provide emotional and attentional information, which are not available in the conscious awareness. However, due to the complex setup needed, this method is not applicable in large-scale. **Interaction Engagement.** The preferred approach to measure user engagement is to exploit (web) analytics tools indicating information about the user's behaviour on a website. Such tools measure the user engagement based on a predefined set of metrics, e.g., the number of clicks, time spent on a site, return rate, etc. Although these metrics cannot explain why users engage with a service, it can be used to collect objective data from millions of users over a long period of time. Since this scenario is close to our needs, this paper focuses on this approach.

3.1 Measuring Metrics

According to Lehmann et al. [12], the engagement of a user strictly depends on the online services at hand and thus cannot be used for all kinds of web applications, e.g., the engagement of a user on a news portal differs from that on a search engine. On the contrary, Peterson and Carrabis [17] claim that the engagement measure can be unique otherwise this is like saying that *"every car will need a different measure of velocity or fuel consumption"*. In our opinion, both views might be right: we can define one set of metrics that can be used in different applications, but we need to interpret the engagement based on the type of the application, e.g., comparing a search engine with a gaming site indicates large differences regarding the dwell-time; but a short dwell-time on a search

site does not imply low engagement; on the other hand, a gaming site with long dwell-times does not imply high engagement when it has a small number of visitors. The most widely used web analytics tool on the Internet is Google Analytics, a service that generates detailed statistics about the visits to a website [19]. Among a variety of metrics, which can be used by site owners for retrieving various kinds of visitor information, it provides three metrics that are commonly used to compute the engagement: *Page Views Per Session, Average Session Duration, and Bounce Rate* [7]. Once visitors come to a website, they will either read the page, click to more pages linked on the site, or leave the website. Previous, engagement metrics focus on the actions visitors are taking, and how good the website is at keeping the visitors there [4]. Other commonly known metrics used as measures of engagement are *Visits Per Visitor* and *Customer Satisfaction*. However, also these metrics have some limitations and can be inappropriate for use [17]. Under the assumption that a visitor will be considered engaged as long as she/he is paying attention to a website, Peterson and Carrabis [17] provide the following formula to calculate the engagement:

$$\sum (C_i + D_i + R_i + L_i + B_i + F_i + I_i)\big/ 7. \tag{1}$$

Each of these component indices represents a metric that is calculated based on a predefined threshold. Such thresholds are strictly depending on the corresponding website to be measured. In order to demonstrate the diversity of user engagement, authors analysed a large number of online sites of various types, and then derived models of engagement by clustering the sites against the criteria 'user type' and 'temporal aspect'. As proxy for online user engagement they measured the web usage assuming the higher and the more frequent the usage, the more engaged the user. The considered metrics to measure the user engagement cluster in three groups that reflect the *popularity*, *activity*, and *loyalty* of users. Therefore, a highly engaging site is one with a high number of visits (popular), where users spend lots of time (active), and return frequently (loyal). In order to effectively measure user engagement, authors propose of eliminating metrics that are too correlated. Their results show that metrics of the same groups mostly correlate, whereas metrics from different groups correlate only weakly or even not at all. Based on their results, Lehmann et al. claim that *Users, Click-Depth, DwellTimeA, and ActiveDays* are the most significant metrics that can be combined to obtain different models for different web applications.

4   Mobile Engagement

So far we have seen which metrics are widely used to measure user engagement in web applications. As the goal of this paper is to investigate the engagement in mobile applications, and as the topic of mobile user engagement is young, and therefore no profound investigative knowledge is available, we try to gain some new insights. In order to derive mobile engagement from web engagement, we first need to point out the differences between mobile and web usage. Based on these differences we then try to assess what metrics, which we defined for web engagement, can be used in mobile applications to

measure user engagement. According to Isensee [13], the difference between mobile and web usage is in their concepts: while the mobile world follows the concept of users, the web world focuses on the concept of a visitor. The user concept states that the mobile phone is ubiquitous, much more personal than a PC which entails that if we want to measure the engagement of a certain mobile user we only need to know the device ID since mobile devices, in particular the mobile phone, are not shared among different people. However, this is not the case with PCs since they can be used in workstations, coffee shops, or shared with other family members. Hence, to figure out which person is behind the computer screen, we need to authorize the user, such as with a login, or in case the site does not provide authorization, just look to the IP address, which is often not easy. Another difference between mobile and web is that in web applications we can open several tabs in a browser, or even use multiple browsers simultaneously. This problem entails that we cannot know to which site the user behind the screen is really focusing its attention on. Even if we use a browser function that notifies us that the user switched the browser tab, we still cannot prove whether the user is consuming the open site or if it is doing something else, like cooking or talking on the phone. In contrast to this, in mobile applications there is the restriction that only one application can be launched at a time. If the mobile user is not focusing its attention to the mobile phone and does not interact with it, the screen would turn off within seconds.

5   Recommendations

As we stated in the Background Section, the metrics to measure user engagement must be based on the definition of engagement. In this section, we try to provide a set of metrics, which can be used to measure the user engagement in mobile applications based on the definition that *a user is engaged as long as he/she is actively paying attention to the application*. As this definition can be considered as a general mobile user engagement definition, it allows us to provide a set of metrics that has a universal character. This entails that our set of metrics is applicable to any kind of mobile application, regardless the definition of the user engagement. A mobile application owner who differently defines user engagement, only needs to change the weights of single metrics, e.g., in a news app the number of screen views typically must be more weighted than in a search engine app. Therefore, we propose the following metric:

$$ScreenView = \frac{\#Visit_i(Screens_i \geq T_{sv})}{\#TotalVisit_i}, \tag{2}$$

$$VisitDuration = \frac{\#Visits_i(Duration_i \geq T_{vd})}{\#TotalVisit_i}. \tag{3}$$

$$UserLoyality = \frac{\#Days_i \geq T_{ul}}{\#TestDays_i}, \tag{4}$$

Where: *n = number of users of the app; i = user-index; M = metric.*

Equation 2 Rationale. *ScreenView* computes the number of screens viewed by user *i*, which were over the threshold T_{sv} divided by the total number of visits by user *i*. Consider the following example: Customer sets threshold to $T_{sv} = 3$. The mobile user visits 3 times the app: visit 1: 3 screen views; visit 2: 8 screen views; visit 3: 2 screen views. As result *ScreenView* = (1 + 1 + 0)/3 = 67%.

Equation 3 Rationale. *VisitDuration* computes the number of visits by user *i*, which lasted at least T_{vd} minutes, divided by the total number of visits by user *i*. Consider the following example: Customer sets threshold to $T_{vd} = 5$. The mobile user visits 4 times the app: visit 1: 4 min; visit 2: 5 min; visit 3: 100 min; visit 4: 2 min. As results *Visit-Duration* = (0 + 1+1 + 0)/4 = 50%.

Equation 4 Rationale. *UserLoyalty* computes the number of days on which user *i* at least visited the app T_{ul} times, divided by the number of days of the considered timeframe for measuring the engagement. Again, consider the following example in which a customer sets the threshold to $T_{ul} = 2$. On a timeframe of 30 days, the mobile user visits every day the app, but only on 10 days it is visited more than once. As result, we obtain *UserLoyalty* = 10/30 = 33%.

If each metric is equally weighted, we have an Engagement of $User_i = (67 + 50 + 33)/3 = 50\%$.

The above equations represent the user engagement in the per-user-scope. In order to compute the engagement in the per-app-scope, we propose Eq. 4, which averages the results over *n* users for a certain metric *M*:

$$EngagementPerApp_M = \sum_{i=1}^{n} \frac{M_i}{\#users}.$$ (5)

Where: *n = number of users of the app; i = user-index; M = metric.*

6 Conclusion

This paper provides recommendations for measuring user engagement in mobile applications following the interaction measuring approach. We have investigated different definitions of user engagement and related metrics. Based on differences between web and mobile application nature and usage, we have defined our own set of metrics, which should be able to measure the user engagement in mobile applications. In addition to our recommendations for mobile metrics, we also have pointed out an important issue that asks whether it is possible to measure user engagement with a universal formula, or does every application need to be measured differently. These metrics will be evaluated in a pilot study involving 400 teenagers in four European countries (England, Italy, Scotland, and Spain).

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