User Requirements for Gamifying Sports Software

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***Abstract*—Sports tracking software for casual exercising has become popular with smart phone users who are concerned about their health and fitness. Nevertheless, there is limited research on the user requirements for sports tracking software, which needs to be fun and easy to use in order to appeal to a broad set of users. For this purpose, we employed a four-week long experiment with five users who were asked to perform multiple workouts with two levels of gamification. The first treatment stands for "no gamification" and the second treatment provided rich visual feedback, such as speed, distance, elapsed time, map. At the end of the experiment, we asked users to describe the devices. Both devices included GPS sensor, so we also measured the distance covered for each one of the workouts. We found that augmented feedback from mobile self-tracking devices can promote working out, but there is also a trade-off of increased anxiety and disorientation. Thus, we suggest that sports tracking software should be modest about how much and what type of visual information it provides to the user. In particular, we found that the only piece of visual information that had an impact on performance was average speed, which indicates a connection with gamication. Further research should consider additional levels of gamification beyond score, such as graphics, sociability, rules.**

***Index Terms*—Interaction styles, evaluation, augmented feedback, human factors.**

I. Introduction

The use of computing devices has drawn the attention of not only computer scientists, but also physicians and psychologists to investigate whether the use of specific systems can promote or/and improve individuals' well-being and affect their way of thinking and behaviors.

In addition, the advantages of working out are well known among people, while lack of physical activity is a factor to blame for various diseases and body malfunction. Important questions to be answered are how, why and what invokes people's attitude and behavioral reactions.

Personal informatics describe systems that strive to help people collect and reflect on behavioral information to better understand their own behavior (e.g. step counting and self-tracking). Persuasive technologies are technologies aiming the change of people's behavior and "persuade them to improve an aspect of their way of thinking, exercising etc.

Consecutively, the question that research on these technologies tries to answer is if computational systems can actually be designed in a way to influence people's behavior actions.

As our results showed, gamification can be an important factor when designing such devices. Gamification represents the use of game mechanics in areas that seem unrelated at first and its origins come from the industrial sector. Specifically, in [1] the term "gamification" is defined as "the use of game design elements in non-game contexts".

The above observations bounds together with the continuously developing technology, both in hardware and software level. Towards this direction, several technological advances and frameworks are now widely implemented in the development of successful systems enhancing the contextual information someone can process.

Thus, this study along with its experimental results can offer much towards this direction. In particular, our main outcome is that feedback truly affects the physical activity. As a result, the types and the volume of feedback from self-tracking devices should play an important role when designers implements their systems and devices of this kind.

To summarize, in this work the aim was to experimentally examine whether exercising with real-time augmented feedback to the user can promote and encourage casual athletes to improve their performance.

II. Related Work

Since working out is vital for someone's well-being and has to do his personal attitude and behavior [2] and in [3]. Persuasive technologies are, also, in strong relation with our work [4]. In [5] the promotion of physical activity through handheld mobile computing devices and technologies is explored. The same concept is studied in [6] where teen girls are the target group, developing software to conduct survey on participated girls, named "Chick Clique, as well.

A thorough work in relation with GPS systems during occurred in [9]. They examined experimentally the how-to of using such systems. In [8] they investigated the association between gamification and location-based systems. There they presented several thoughts and questions upon this matter and they discussed it from a cognitive engineering standpoint.

Gamification as a research branch is established in [1] [7]. In [10] there are interesting case studies of applied gamification in the actual market (e.g. Foursquare). The most relevant work upon gamification and software design associated with self-tracking applications is studied in [11] and [8].

In [11] a framework under which the exercising routine can be transformed into a game-like activity is proposed. In particular, they proposed a strategy combining new technologies and gamification for users' benefit.

The purpose of this work is to examine whether a device providing visual, live feedback to the user can inspire and motivate them to optimize their performance. The hypothesis tested is that a device with visual feedback can persuade the user to achieve better results.

III. Preparation

Our experiment took place in two Greek towns, specifically in Edessa and Corfu and it lasted approximately 4-5 weeks in the autumn of 2012. The equipment used for the purposes of this set up consisted of two devices using GPS technology.

In particular, the first device is a small GPS logger, called I-gotU (model GT-600) [12]. It is a stand-alone portable fitness tracking device collecting the kind of data necessary for this study. It does not have any screen or speakers to provide augmented feedback of user's statistics and thus, having as the independent variable the feedback from the instrument, this device has the value NO.

The other tool used in this research is actually a sport tracker software, called Endomondo [13]. To avoid any technical miscalculations or drawbacks due to the use of separate mobile phones, all users were given the same single device equipped with the latest version of Endomondo.

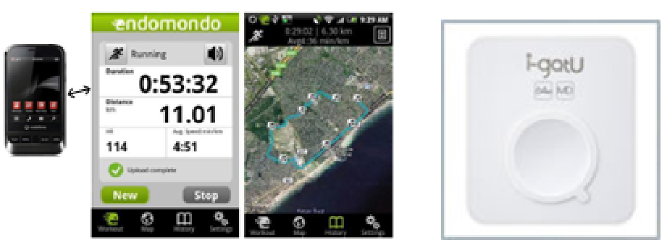

Fig. 1. The tools used in our experiment.

Moreover, all of them were familiar with smartphones. Using one such application, a user can obtain real-time results of his training along with map visualization. Also, audio instructions are available. Consequently, the phone using Endomondo has the value YES for the independent variable of providing feedback.

Both of these materials are able to log various attributes, such as time, distance, speed (mean and highest), calories, elevation, and show of athlete's route on Google Maps (the I-gotU device needs specialized software to import its data and show its logged data). The variables measured in our experiment were the covered distance, the time, the average speed and the elevation of each exercising round.

The participants were 5 irregularly exercising young individuals (3 females and 2 males) with their age ranging from 21 to 28 (with mean value 23.4 and std. deviation 2.7). We intentionally studied irregular trainees, since professional athletes follow their standard routine and their needs don't keep up with our concept.

Map visualization was shown in 3 out of 5 users. There were 40 tries in total with both measuring devices (8 tries for each participant; 4 with each device) and all of the participants answered questionnaires after each quadruplet of tries about the use of each device to evaluate their feelings.

The number of the participants seems limited but it is counterbalanced by the size of the collected data, as mentioned in the previous paragraphs. Although the sample consists of only ve users, each one of the users performed four workouts with each one of the treatments, thus, we have collected twenty data points for each one of the treatments, which is a typical threshold in user requirements studies for interactive software.

Data of each exercise were collected after the finish of each workout. Use of specific software was necessary to obtain the data from the logger, provided by the vendor of this device. Data from the mobile phone were automatically uploaded in the web through the Endomondo app and then, they were obtained by signing-in the right web-site.

The use of each device was consecutive in order to offer us the capability to test our hypothesis properly. Also, we decided to provide our users with the I-gotU device for their fist 4 trials to hide any live feedback to them about their performance.

Distance, time, average speed and elevation were recorded for every trial. Elevation results proved pointless, since almost every subject was using the same route for their work out. All the information were inducted, processed and visualized in MS Excel for every user and every trial. As we mentioned before, 40 tries were recorded, in total.

Users were encouraged to keep up training in the same routes they were used to, having the option to alter them (except from selecting tracking fields around stadiums as the measurement would be pointless). The scenario described to users was carefully misleading in order to obtain objective and accurate results by not affecting their perception.

Specifically, users were told to try their best because the experiment's aim was the launch of a web-site containing exercising paths along with logging data derived from real tracks. Furthermore, the questionnaire contained misleading questions to support this plot.

IV. Results

A. Trials' Results

In Figure 2 the average speed of the participant is illustrated. It is clear from the Figure 2 that the first 4 trials with the GPS logger did not reveal any constant increase in subjects' performance. On the contrary, the use of the second instrument, the one with the augmented feedback, showed affection on users to achieve better results.

As someone can observe, the increase in users' performance does not have any upper bound. Future research with more iterations might shed light on the existence of such bounds.

Next, in Figure 3, instead of the mean speed, the distance covered of each trial for all the participants is appeared in km.

One extra test was the evaluation of performance of some of the users that were shown a map visualization of their workout

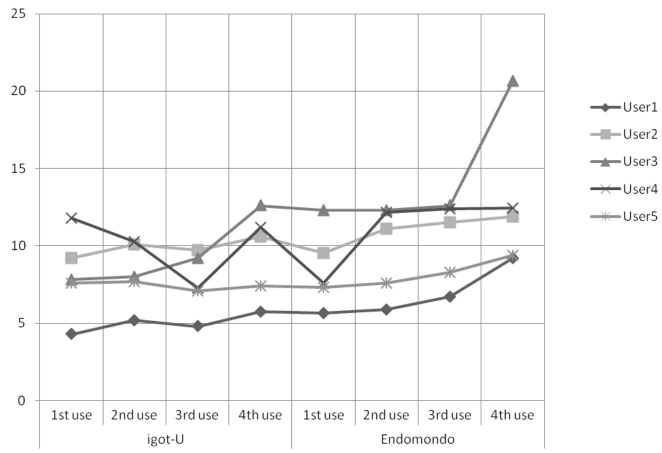

Fig. 2. Results of the experiments. In the horizontal axis is each use of a device, whereas the vertical one depicts the average speed of each try (km/h).

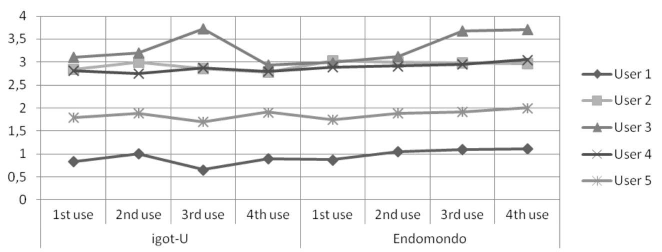

Fig. 3. More results of the experiments. In the horizontal axis is each use of a device, whereas the vertical one shows the distance covered in each try (km).

route after every try with both instruments. 3 out of the total 5 users were shown the visualization (user 2, 3 and 5).

Their isolated results are shown in Figure 4 and Figure 5 for I-gotU device and Endomondo application, respectively.

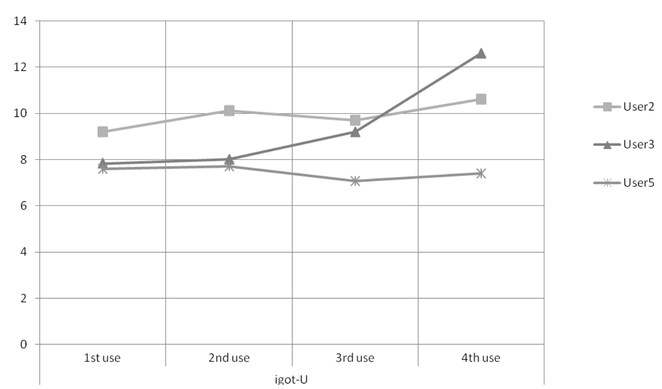

Fig. 4. In horizontal axis each use of I-gotU is shown, whereas the vertical one depicts the average speed of each try for the 3 users shown map visualization of their routes (km/h).

Some interesting information someone can extract from these figures, is the fact that the cycler, actually, achieved increase in his performance with both of the measuring instruments.

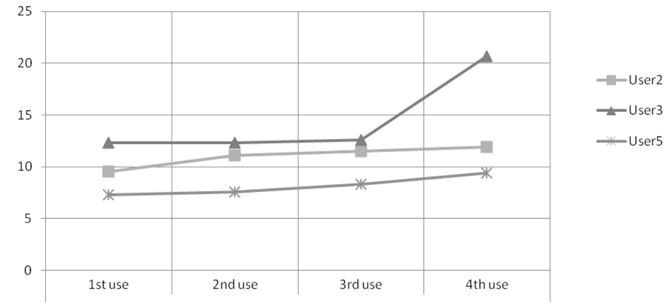

Fig. 5. Like Figure 4, instead of I-gotU device the usage of Endomondo is shown.

B. Questionnaires' Results

The findings from post-exercise questionnaires follow. The questions were simple and short, containing misleading questions to support experiment's scenario.

Questionnaires allowed users to express their feelings about the experience of using both devices, rating them in a scale 0 to 5 for some characteristics (0 for zero effect and 5 to ultimate feeling). The results are shown as word-clouds in Figure 6 and Figure 7, for I-gotU and Endomondo, respectively.

Fig. 6. A word cloud containing the frequency of adjectives users used to describe their experience with the I-gotU device. Also, the right frame shows the intensity of observing or thinking of the device.

Fig. 7. Like Figure 6, instead of I-gotU device the usage of Endomondo is shown.

Users described both as safe, comfortable and handy. I-gotU device was portrayed as dull, in the contrary to the other one. Endomondo received many positive ranks, but acquired some criticism about stressfulness and disorientation. The motivating factor has a mean value about 3, whereas the same value for I-gotU is almost 0.

Safety, comfort and handiness are the prime characteristics assigned to both devices. Users described I-gotU device as dull, while the other one, not. It is clearly seen that Endomondo received a lot of positive ranks from the subjects, but acquired some criticism about stressfulness and disorientation.

Another variable measured throughout the questioning process was the number of times participants thought and took a look on these devices. The aim was to test if the users were consulting the tools and, perhaps, if they were over-observing them, causing potentially discomfort and/or disorientation.

The smartphone drew users' attention more often, a rational fact since the other device lacks visual feedback. The ratio between thinking and observing is almost uniform for both.

V. Discussion

This work was an effort to examine the hypothesis that augmented feedback can persuade and improve peoples physical activity. The need for constant and experimental evaluation seems necessary [14].

Our findings seem quite prominent, confirming our hypothesis about the relation between augmented feedback and promotion of physical activities. Moreover, gamification traces were observed, a fact that can potentially affect software design of such systems. The most interesting outcome by far is the remarkable increase in the average speed of the subjects using the cell phone equipped with Endomondo. This observation was the key that lead us to discuss the connection to the framework of gamification [1] [7].

Gamification is a factor that was revealed after the analysis of the collected data. It is associated with the parameter of the average speed. As our study showed, users achieved to overcome themselves in terms of average speed after they receive feedback of their performance.

Average speed stands for "score" in a game that the users try to beat themselves and probably others. Since gamification includes more features than just "score" we suggest that further research also explores the impact of rules, graphics, and sociability

The analysis of the current literature and the industrial trends unveiled the fact that gamifying activities is not a single sided concept. Game mechanics appear in our daily life and some of them are not easily spotted. Our work contributes towards this direction since we detected hidden factor that motivated users and potentially it gamified their fitness activity

In [11] the distance and the time of a training route were discussed as a model for self-motivation. Our work experimentally showed that the average speed can be used, as well. Furthermore, our study provides not only information on a basis of a logical hypothesis, but also quantitative results which can contribute through tangible implementation.

As our findings indicate, interaction between GPS-enabled sport tracking systems and trainees has to be simple (to avoid disorientation and anxiety). This is a potential solution to the trade-off between providing feedback and the provocation of undesirable feelings such as anxiety and disorientation.

We showed that the key factor which persuaded users, was the average speed of the trainees. The rest of the measured variables did not have any significant impact on participants' performance. Thus, we propose that, as far as software requirements are concerned [15], designers should engineer in a minimal manner, offering, for example, an empty screen showing solely the average speed, without any redundant undesirable information.

Besides its academic scope, our work contributes in the practical application of HCI (Human-computer interaction) mechanics into sport-tracking systems, as HCI plays a major role in software engineering. It is a fact that a fully working systems is a user-friendly system and, as our work showed, there is a constant need for evaluation.

Altering the type and the "quantity" of feedback to the users of GPS devices for exercising routines can incentivize them and engage them into more training. This potential acts as an intriguing motive for the designers of hardware/software for self-tracking devices.

Future studies can be conducted on the effects of showing route visualization to irregular bicycle athletes. Another point to be explored is the existence of an upper bound of physical activity for "irregular" trainees and whether this limit can be reached faster or be extended using augmented feedback.

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