An e-Coaching Ecosystem: Design and Effectiveness Analysis of the Engagement of Remote Coaching on Athletes

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An e-Coaching Ecosystem: Design and Effectiveness Analysis of the Engagement of Remote Coaching on Athletes

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Abstract Nowadays, the use of mobile applications and wearable technologies to support and encourage an active lifestyle has become widespread. Several studies put in evidence that the usage of these kinds of support has to be monitored by high-qualified figures, to favor a safe and a long-term adherence to training routines. In order to investigate the impact of these professionals, this work sets out to provide an overview and an evaluation of an e-Coaching ecosystem specifically designed for runners. The platform supports and guides people toward an active lifestyle by stimulating their motivation to exercise through the engagement provided by the interactions between users and human trainers. In this study we investigate the effectiveness of the support offered by the human trainers and the engagement of the users. The results show that the support of human qualified trainers is crucial. Users tend to be more engaged to train when their trainings are developed and remotely supervised by a human coach. This has resulted in more workout sessions performed with respect to users exercising by following standard or self-made routines without direct professional supervision. Our findings show that e-Coaching systems should develop their coaching protocols always taking into account the effectiveness of the support of qualified professionals over completely automated approaches.

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1 Introduction

Nowadays, the widespread diffusion of mobile devices has favored the development of millions of mobile applications currently available for download on major digital stores[1]. An analysis of users' behavior while using mobile devices reveals that they spend 80% of the time using mobile applications, while the remaining 20% is spent mostly browsing the Internet[2].

Another emerging trend related to the previous one is represented by the increasing popularity of applications intended to support users during their daily physical activity. There exist several commercial applications that aim at supporting users during their running workout sessions. Adidas miCoach, MapMyFitness, Endomondo, Nike+, RunKeeper, and Runtastic are the most popular ones (see Section "References" for the references). The main feature they all share is the implemented real-time support policy offered to the sportsman during a workout session. Basically, the user is able to track real-time statistics of her workout session, with an overview of aggregate statistics of her workout history. In rare cases, some applications also offer the possibility to download standard workout plans but they all lack the guidance that only a human coach can undoubtedly provide. More specifically, there is the complete absence of a human coach figure that is able to guide and motivate a user before, during, and after a workout session. The lack of such a support can negatively affect users' motivation and engagement [20].

In previous research studies, in the field of Human-Computer Interaction and Persuasive Technologies for sports and health, we presented *u4fit*. u4fit is a persuasive mobile application, available for both Android[3] and iOS[4] powered devices, which implements different strategies aimed at motivating people during their training routines [24, 25]. The application allows users to create, save, and share their workout session results on Facebook and, most important, allows them to be supported during a training by what we refer to as a "virtual personal trainer". This feature, and the possibility to be supported by a "human coach", are some of the innovations that differentiate the platform from other persuasive technologies for sport and well-being. Indeed, the virtual trainer allows users both to be guided and supported in real-time according to the workout session they planned (or a human coach planned for them) by means of visual and vocal cues. During a workout session, relevant training data is collected and analyzed with users' consent. The aim is twofold:

[1] http://www.statista.com/statistics/276623/number-of-apps-available-in-leading-app-stores

[2] http://venturebeat.com/2013/04/03/the-mobile-war-is-over-and-the-app-has-won-80-of-mobile-time-spent-in-apps

[3] https://play.google.com/store/apps/details?id=com.xibio.everywhererun

[4] https://itunes.apple.com/us/app/u4fit/id1006387680

on the one hand, the collected data feeds the algorithm governing the virtual personal trainer (i.e., the training data is analyzed in real-time, in order to infer how the user is performing and give her the appropriate guidance during the ongoing workout). On the other hand, some data is sent to our back-end system, in order to investigate both the effectiveness of our persuasive method and, more important, to provide a detailed overview of user's performance to the human coach.

To fill the gap highlighted by Kuru in [20] on the lack of human support in workout sessions, we decided to add to our infrastructure the support for an e-Coaching service that enables users to be in touch with qualified human trainers. Human coaches are available in the web platform to serve athletes' requests for tailored workout routines. As we will see in more detail in Section 3, the coach, by means of a specialized web platform, is able to communicate with his pupils. Moreover, the coach can build complex user tailored workout routines that the user can follow step-by-step, guided in real-time by the virtual trainer algorithm implemented inside the mobile application. The mobile application is in turn able to interpret the routine in order to provide real-time visual and audio cues through the virtual personal trainer.

The mobile application is now able to support three main kinds of workout:

- "Free workout session": this is the simplest form of workout. Basically, the user works out with no guidance or predefined goal;
- "User-created guided workout plan": the user creates her guided workout plan, composed of several workout sessions (i.e., several trainings), according to her objectives. It is then the responsibility of the virtual personal trainer, available in the mobile application, to guide her in achieving her objectives;
- "Trainer-created guided workout plan": a human trainer, according to both user's physical profile and user's objectives, creates a guided workout. As previously highlighted, when the workout plan is downloaded by the mobile application, it is the virtual trainer that interprets a certain workout session to guide the user during the training.

In this work, we are presenting a series of analyses on the training statistics of real users that exercised using trainer- and user-created workout plans. In particular, we investigate how this supervised form of support is able to provide an effective engagement on users and, most importantly, a safe and more controlled way to train with respect to the non-tailored workouts offered by the aforementioned commercial platforms. Our research work aims at answering the following research questions:

RQ1. Is there any quantitative evidence that the trainer-created guided workout sessions are the ones preferred by the users? If so, how much do they prefer the direct human support or to what extent does the application's virtual trainer satisfy their needs?

RQ2. Do the users train more often when supervised by a real personal trainer?

RQ3. Is there a difference between the percentage of completion of user-created and trainer-created guided workout sessions?

This work presents and analyzes how the u4fit e-Coaching platform affects users during their running routines. The platform and the remote coach methodologies supported contribute in the field of e-Coaching by augmenting users' adherence, involvement, and motivation to exercise. In particular, our experiments answer the aforementioned research questions that point up how the human coach is crucial with respect to a totally automated training protocol. Moreover, users tend to train more and more frequently while supervised by a real coach and with higher percentages of workout sessions completed when compared to users training by using self-made workout sessions.

The paper is organized as follows: in Section 2, we provide an overview of the state of the art regarding the technological supports developed to help people achieve a more active lifestyle; Section 3 describes the e-Coaching platform, primarily focusing on the platform-mediated interaction between users and coaches. In Section 4, we present the experimental framework and the results. Section 5 contains conclusions and future work.

2 Related Work

This section presents related work, by focusing both on the technologies that have been developed to support people during physical activities (Section 2.1) and on the works that study the engagement provided by physical activity tracking products (Section 2.2). We will also draw some conclusions that highlight the difference between this study and those proposed in the literature (Section 2.3).

2.1 User Support During Physical Activities

Over the last few years, there has been a sudden spread of persuasive technologies for health and wellness. For a recent and detailed survey on the topic, readers can refer to [28]. This section provides a background on the most relevant of these technologies, i.e., those most related to our study.

The support to users in physical activities has been offered from different perspectives. Indeed, there are technologies that focus on a specific target of users, such as *Chick clique* [30], which tries to encourage teenage girls to adopt a correct lifestyle, or the study performed by King et al. [19], which propose three behavior-changing mobile applications to promote a regular physical activity and reduce sedentary behavior of adult people.

Other approaches, such as *TripleBeat* [27] focus on the technological aspects that lead to an effective support. The application aims at providing users with feedback about their activity by means of physiological and device's sensors: indeed, it uses ECG and an accelerometer to monitor aspects such as the heart rate frequency to give feedback to the users.

Some other strategies exploit gamification techniques to motivate people to be more physically active. In *MarioFit* [18], users physically interact with the game, by playing Nintendo's Super Mario Bros on a PDA, using body movements as inputs. *Your Shape Fitness Evolved* [7] is a game for Microsoft Kinect. It allows users both to customize their indoor workouts and to support them in reaching a fitness goal. Berkovsky et al. [10] put forward some new game design recommendations to motivate people in changing their playing habits.

The relevance of the social aspects in this area has also been studied from several perspectives. *Houston* [12] is a mobile application that allows the users to share daily statistics with a group of friends. In [16], the authors take into account social influence, recognition, reciprocal benefit, network exposure, attitude, and intentions, in order to infer how social motivations can predict the use of gamification services. In [22], the capability of social and exertion interactions to affect users while running at a distance has been studied.

In addition to the academic research studies and prototypes listed above, several other commercial applications specifically designed for mobile devices exist. One of the most used applications is Nike+ [6]. Some of its main strengths are: the vocal cues and music management system, the availability of several social features, the support of a web community where users can create their training plans and socialize with other people, in addition to the possibility to enrich the training experience through ad-hoc devices. Along with Nike+, there exist several other applications. Among the most popular ones are Adidas miCoach, Endomondo, MapMyFitness, RunKeeper, and Runtastic (see Section "References" for the references). All applications roughly offer the same main features, i.e., user's position tracking, statistical reports, and support for common social interactions.

2.2 Creation of Engaging Experiences in Physical Activity Tracking Products

Several studies in the literature have been devoted at finding ways to engage users of physical activity tracking products. Regarding the aspects that lead to user engagement, the most valued ones are fun [29], challenge, positive effect, endurability, aesthetic and sensory appeal, attention, feedback, variety/novelty, interactivity, and perceived user control [26]. Other studies, such as [11], do not link user engagement to a feature offered by a product, but consider its capability to inspire more frequent, active, and intense interactions, by studying ways to keep users' interest. User engagement has been studied also by monitoring the experience of the users with a product, by analyzing their feedback over time [8], by studying the generated curiosity [14], or by providing quality data and information to avoid abandonment [13]. IJsselsteijn et al. [17], propose a study on intrinsic motivation enhancement; the research is based on an experiment with a virtual coach system and users that cycled on a stationary bike.

2.3 Our Contribution

Our e-Coaching ecosystem provides runners with two main support features. As stated in Section 1, unique in the field of real-time modern technological supports for runners, u4fit favors a high degree of engagement and motivation for users, by exploiting a direct interaction with real personal trainers in conjunction with the guidance offered in real-time during a training by the virtual personal trainer.

3 The e-Coaching Ecosystem: an Overview

In this section, we provide an overview of the e-Coaching ecosystem by putting forward a typical interaction flow between a coach and a sportsman. We do not provide any technical details about the implementation of the software infrastructure [9,15], given that it is built entirely using a standard distributed software architecture with well-known cutting-edge technologies. The ecosystem is made up of three main actors: the business logic, a web application, and a mobile client available for both the Android and the iOS mobile platforms that records training statistics exploiting mainly devices' GPS sensor and external ECGs. The web application, in addition to providing users with a personal area with workout management facilities and general workout session statistics, also serves as a trainers' dashboard. By means of the dashboard, trainers are provided with all the functionalities needed to handle requests of tailored workout plans made by the athletes through either the mobile application or their personal web area.

In the following, we will analyze how a user and a trainer can connect, in order for a user to be supported by a specific trainer (Section 3.1), then we will present how a trainer can create a workout plan by means of the dashboard (Section 3.2), followed by the details of how a user receives support during her training (Section 3.3), ending with how the results of a training can be analyzed (Section 3.4).

3.1 Connection between a User and a Trainer

Let us now consider the most frequent interaction flow between a sportsman using a mobile client and a coach (the request of a tailored training plan made through the web application works the same way) as depicted in Fig. 1. By means of the mobile application, a user can choose one of the available personal trainers that best suits her needs (see Fig. 2).

Before a user can actually finalize the subscription to the personal training service[5], she is requested to fill in a questionnaire of about thirty questions needed to acquire both basic information about her current physical profile and what she is aspiring to achieve with the supervision of a personal trainer

[5] Note that a subscription has a duration of one month and no renewal requirements.

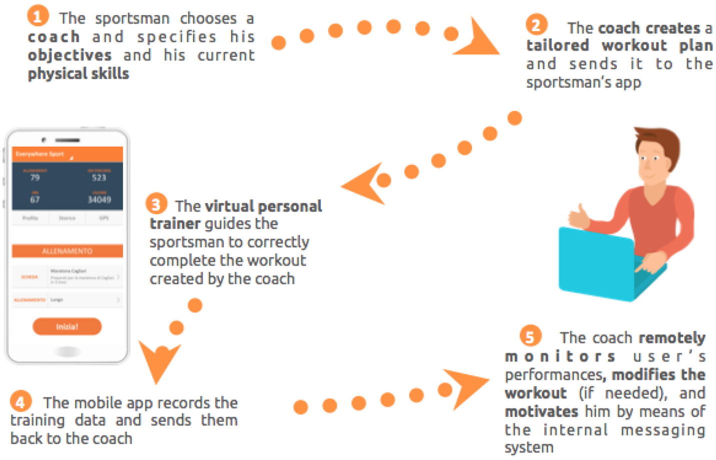

Fig. 1: User-trainer interaction flow

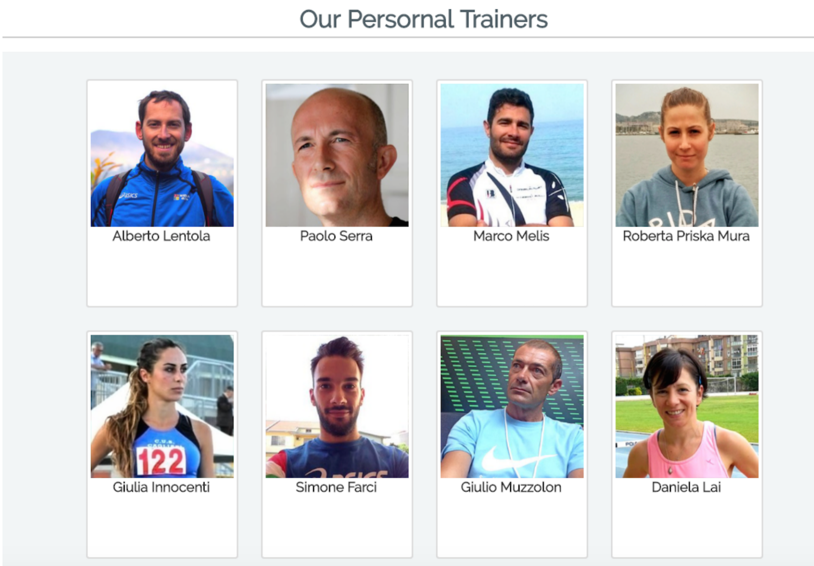

Fig. 2: Personal Trainers by www.u4fit.com

(see Fig. 1, point 1). The questionnaire has been supervised and approved by three different personal trainers in order for the SW clients to acquire the most important information trainers generally need to know to prepare the very first workout routine. This is the minimal information that trainers generally need to know in order to trace a user's basic physical profile. In most of the cases more information is needed, so the user profile is gradually enriched with ad hoc questions the trainer asks to the user directly through the platform's mes-

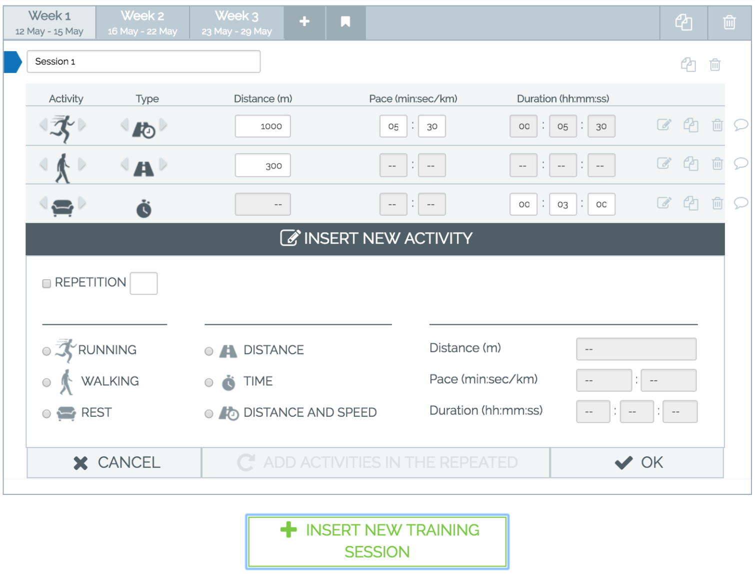

Fig. 3: Workout plan creation menu

saging service and, most importantly, by analyzing the performance achieved by the sportsman.

3.2 The Workout Plans

When the trainer deems to have enough information about the user, she can build the workout plan always from her personal web dashboard (see Fig. 1, point 2). As can be seen in Fig. 3, the trainer is given tools to create and organize a workout plan. A workout plan can be composed of multiple workout sessions per week for several weeks. A single workout session is in turn made up of what we refer to as "activities"[6] and, if needed, it is also possible to group them into a so-called "repetition" that denotes a certain number of activities the user has to repeat a certain number of times. Fig. 3 shows a three-week-long workout plan. In particular, the first week is made up of a workout session called "Session 1" that in turn contains three activities. The first one (starting from the top) denotes a running activity of one kilometer that the sportsman has to perform at a pace of five minutes and thirty seconds. The second activity specifies a three-hundred-meter long walk, whereas the third and last activity of the figure denotes that the user has to rest for three minutes. The lower part of the figure, instead, shows the activity creation menu through which the coach is able to create various types of activities by combining the different

[6] An activity represents the basic building block of a workout session. It expresses a single type of exercise, as for example, "run for 3km at a pace of 6 minutes per km".

creation options available. The editor menu also gives trainers the possibility to assign each activity a comment the user can read before starting the training or even hear directly in real-time during the workout session just before the execution of that particular activity. For each kind of activity it is possible to associate a type (available types are: "distance", "distance and speed", "distance and time", and "time") and also a label that represents the particular kind of physical activity the trainer wants the sportsman to perform. At the moment, there are three kinds of labels available: "running" and "walking" with obvious meaning, and "rest" to denote a recovery activity where the user should stay mostly still to perform, for example, stretching exercises. The combination of types and labels points up the powerful capability of the platform to support the composition of complex workout regimes in order to satisfy the needs of runners of all levels, form beginners to the most advanced ones[7]. When the trainer completes the workout plan creation, she publishes it so that the user is able to download it inside her mobile client.

3.3 Support to the Users during the Workout Plans

A sportsman, after receiving the workout plan inside the mobile client, can start the training supported by the mobile application's virtual personal trainer, instructed to guide her step-by-step by means of the coach made training plan (see Fig. 1, point 3).

Fig. 4 depicts the ongoing workout screen and how the virtual trainer is graphically represented. Starting from the top of the screen, the user is provided with an indication of the current trait/activity being performed (in this case, she is executing the first out of three traits/activities). Just below the trait indicator there are two circular widgets that change according to the type of activity currently being executed. As can be seen from the "Target" section, the current goal is to cover one kilometer at a pace of five minutes and thirty seconds per kilometer. In this case, the widget on the left indicates the total amount of distance covered so far by the sportsman, whereas the widget on the right is clearly indicating that she has to speed up given that she is keeping a pace slower than the target pace planned by the human trainer. Under the Target section, two widgets allow the user to choose among various statistics such as, for example, the total distance covered, the average pace, current heart rate frequency, and the total elapsed time so far (just to name a few).

3.4 Analysis of the Results

Just after the completion of the workout session, all the session statistics are sent automatically to the back-end. At this point the human trainer is notified,

[7] Note that not every combination is clearly possible. For example, it is not possible to create a distance-speed activity with a label of type rest.

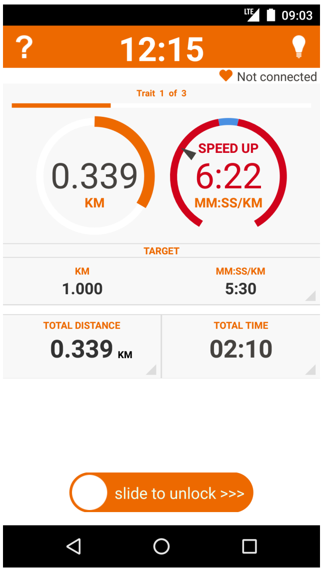

Fig. 4: Mobile client: the virtual personal trainer

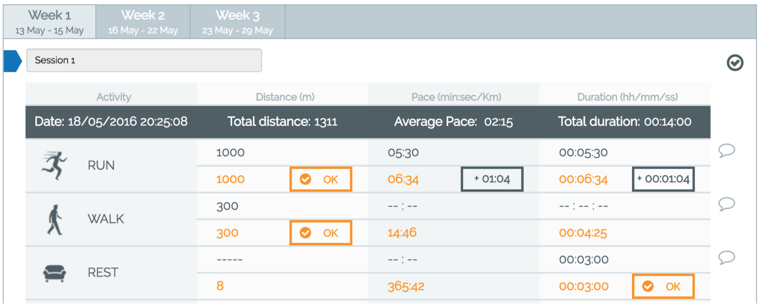

Fig. 5: Trainer's results dashboard

in order for her to analyze the sportsman performance (see Fig. 1, points 4 and 5). Fig. 5 shows the menu the trainer is provided to analyze how the sportsman is performing. In particular, Fig. 5 shows the results associated with "Session 1" depicted in Fig. 3. The results section has been designed to provide the trainer with an easy to read overview of the performance. As can been seen, starting from the top of the image, the trainer is provided with aggregated statistics of the whole workout session, like the total distance covered, the average pace, and the total duration of the workout session. Just below the aggregated statistics, the trainer is given the details of each activity executed in terms of the planned objective vs the actual user performance. The row on the top reports the target, whereas the row below reports the actual results in terms of distance, pace, and duration with also a graphical widget that signals the positive (orange boxes) or negative (gray boxes) result for each of the reported metrics. To further clarify how to interpret a row (i.e., the objectives and results associated with an activity), consider the first row from the top: this activity is a running activity of type “distance and speed” and the sportsman covered the planned distance of one kilometer but she did not adhere to the target pace of 05:30 minutes per km in fact, she kept a pace slower than 02:50 minutes per kilometer. Such a kind of result is a clear signal for the trainer that indicates a sportsman that has probably overvalued her physical abilities. The very first result sent by a user is very important for the trainer given that it is clearly not subject to the bias introduced by the questionnaire that in some cases is influenced by the personal feelings of the user. To this end, the platform lets the trainer refine and re-send a more suitable workout plan by exploiting both actual obtained user’s results and, most importantly, trying to interpret the sensations experienced by the user before, during, and after the workout.

4 Experimental Framework

This section describes the experiments performed to validate our proposal. In Section 4.1 the dataset employed for the evaluation is presented, in Section 4.2 we describe the experimental strategy, Section 4.3 illustrates the metrics, and Section 4.4 contains the results.

4.1 Dataset and data preprocessing

The dataset collected to perform this study involved all the workout sessions performed by the users who bought the personal training service (publicly available for Italian users starting from April 1, 2015) from the date of their first subscription to the coaching service itself (i.e., the first time they subscribed to the coaching service) to their last registered training at April 14, 2016. This time span has been chosen because we wanted to understand the users’ behavior during a subscription period and understand the differences with the behavior during the periods when the user had no active subscriptions (i.e., periods when she does not have an ongoing subscription and thus no support by a personal trainer).

We excluded from this study all the users who subscribed for a short period only: in particular, we excluded all the users who subscribed to the training service for just one week because we wanted to observe the users’ behavior during a longer subscription period. The final sample we are considering is made up of 103 users, 62 of which are male users (average age of 41.35), and 41 are female users (average age of 38.80). This analysis considered a total of 1601 performed workout sessions (15.54 on average per user), a total duration of 1245.46 hours (12.09 on average per user), and a total covered distance of 10205.03 kilometers (99.07 on average per user). See Fig. 6 for a

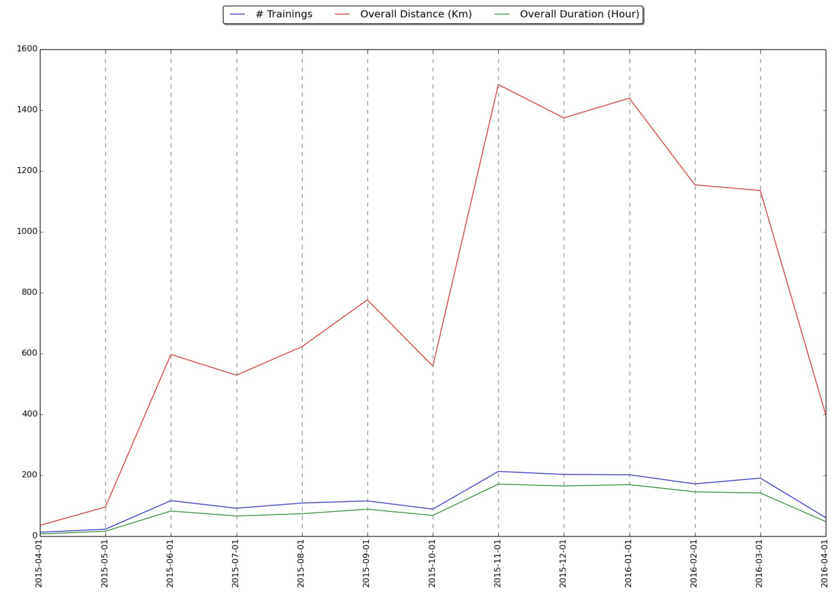

Fig. 6: General sample training statistics

more comprehensive overview of the considered data. Moreover, given that the training period before the first subscription is longer than the period after their first subscription (being the personal training service introduced recently), our statistics would have suffered this difference by showing that the users did much less workout sessions with a human trainer than by using a self-made workout plan. Considering only the workout sessions performed after the first subscription is a way to balance these factors.

4.2 Experimental Strategy

In this section, to answer the research questions provided in Section 1, we describe in detail three different kinds of aggregated data we considered in order to analyze the influence of the proposed support features the platform provides. We performed three sets of experiments:

1. *Engagement towards the coaching types*: in order to answer the RQ1, we need to understand how much the users exercise with each type of workout session, i.e., if they complete those given by the trainer, those created by themselves (i.e., user-created workout sessions), or if they simply perform free workout sessions.
2. *Engagement towards the trainer*: in order to answer the RQ2, we need to understand if users tend to train more when they have active subscriptions (i.e., when they have a human trainer to refer to). We provide also some

qualitative data about users of the mobile application that never subscribed to the personal training service. We will see how they compare, in terms of trainings frequency, to users that bought the personal training service.

3. *Adherence to the planned workout sessions*: in order to answer the RQ3, we need to understand the amount of workout sessions the users completed, with respect to those they planned to do (related to user-created workout plans) or they were given (related to trainer-created workout plans). We also need to understand how the users behave during both periods with an active and an inactive subscription.

4.3 Metrics

Here, we present the metrics employed to perform each set of experiments previously described.

4.3.1 Engagement Towards the Coaching Types

In order to measure the user engagement towards each coaching type (human trainer or virtual trainer) and towards free workout sessions, we will quantify the influence of each type of completed workout session on the total completed workout sessions count for each user. The relevance of each type of workout session in a user's training can be inferred by defining the following variables:

– TOTAL_WORKOUTS: the total number of workout sessions completed by the user;
– TOTAL_<COACHING_TYPE>_WORKOUTS: the total number of workout sessions related to a workout plan created with a specific type of coaching. Therefore, <COACHING_TYPE> = {TRAINER, USER_CREATED, FREE}, so that the quantity indicates the number of workout sessions either: (*i*) created by a trainer that were completed by the user, (*ii*) both created and completed by the user, and (*iii*) completed by a user without following any predefined planning.

We are able to calculate the first metric. In this way, we can measure the engagement of a user with respect to each of the three coaching types, as follows:

– TOTAL_<COACHING_TYPE>_WORKOUTS / TOTAL_WORKOUTS

4.3.2 Engagement Towards the Trainer

The second goal of our experiments is to measure the engagement of a user towards a trainer, i.e., how important it is for a user to be guided and supervised while training. This form of engagement will be measured by calculating the number of weeks in which a user had a workout while subscribed, divided by the number of weeks in which the user trained. This will be done by defining the following variables:

- ACTIVE_WEEKS: the number of weeks during which the user completed at least one workout session after her first subscription;
- ACTIVE_SUBSCRIPTION_WEEKS: the number of weeks during which the user completed at least one workout session during her subscription period.

Based on these variables, we compute the following metric, which will allow us to evaluate the engagement of a user towards the trainer:

- ACTIVE_SUBSCRIPTION_WEEKS / ACTIVE_WEEKS.

4.3.3 Adherence to the Planned Workout Sessions

To understand to which type of workout plan the users adhere the most, we compute the ratio between the completed workout sessions and the total amount of created workout sessions. We will consider only workout sessions related to workout plans created by a trainer and those created by users (free workout sessions are not planned by definition). In order to compute the ratios, it is necessary to define some variables for each user of the sample:

- TOTAL_SESSIONS_<COACHING_TYPE>: the number of workout sessions created for the user after her first subscription with a specific coaching type;
- COMPLETED_SESSIONS_<COACHING_TYPE>: the number of all the workout sessions completed by the user with a specific coaching type, which were created *and* completed after the user's first subscription.

In both cases, <COACHING_TYPE> = {TRAINER, USER_CREATED, ALL}, so that the measured quantities refer to the number of workout sessions: (*i*) created by a trainer, (*ii*) created by the user, or (*iii*) in general (i.e., we calculate the number of completed sessions, no matter who created them).

With these values, we computed the third metric for each user, which will evaluate her capability to adhere to the planned workout sessions:

$$\frac{\text{COMPLETED\_SESSIONS\_} < \text{COACHING\_TYPE} >}{\text{TOTAL\_SESSIONS\_} < \text{COACHING\_TYPE} >}$$

4.4 Experimental Results

4.4.1 Engagement Towards the Coaching Types

In order to answer the first research question, we measure the engagement of the users towards each type of coaching. To this end, we performed the first experiment presented in Section 4.2 for each type of workout session, by considering three different time periods:

- Since the very first subscription (i.e., considering the timespan ranging from the first subscription to the last recorded workout session performed before 04/14/2016);

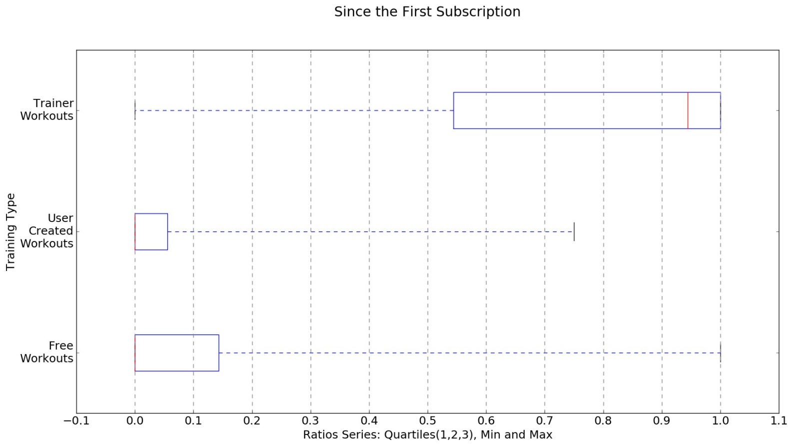

Fig. 7: User ratios computed by considering all the workout sessions completed since their first subscription

- While the user had an active subscription to the personal training service[8];
- While the user did not have any active subscription.

This will allow us to evaluate the engagement of the user during the whole considered timespan (i.e., with or without an active subscription to the personal training service).

To properly show and interpret the measured values (e.g., the relevance of the user-created workout sessions during the subscription periods), we present them by means of a box plot. This kind of graph has been chosen since it is simple to analyze and it gives information about how many users had their ratios in a given range, while avoiding the disclosure of private industrial data as well as protecting users' privacy. A box plot is structured as follows: the red line represents the median value, while the blue box ranges from the first quartile to the third quartile. The dashed lines represent the lowest (left) and the highest (right) values of the distribution. The left and right extremes are, respectively, the minimum and the maximum observed values.

The results are shown in Fig. 7 (types of workout session chosen by the users during the whole period since the first subscription), Fig. 8 (types of workout session chosen by the users during the subscription periods), and Fig. 9 (types of workout session chosen by the users when there is no active subscription).

When considering the whole timespan (Fig. 7), the results show that in the first box plot 75% of the users performed 54% or more of their workout sessions by completing those assigned by the trainer. Half the users performed 94% or more of their workout sessions assigned by a trainer, while the remaining 25% trains only with trainer-created workout sessions. Trivially, given the

[8] Note again that the subscription to the personal training service can be renewed from month to month.

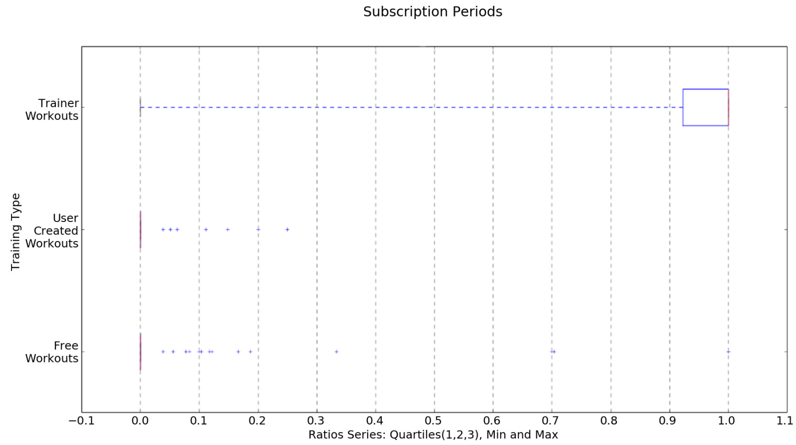

Fig. 8: User ratios computed by considering all the workout sessions completed while having an active subscription

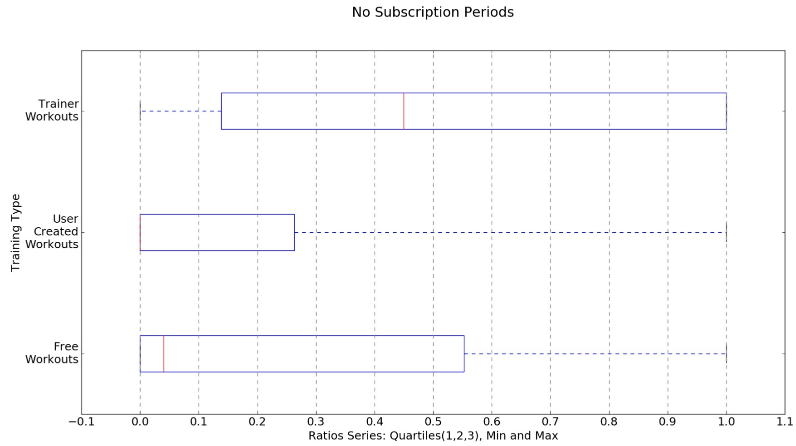

Fig. 9: Users ratios computed by considering all the workout sessions completed while not having any active subscription

great engagement that the users have toward trainer-created workout sessions, the rest of the results show a lower relevance for the other types of workout sessions. 75% of the users do not exceed 5% of the trainings with a user-created workout session and 14% of their trainings with free workout sessions.

A one-way between subjects ANOVA was conducted to compare the effect of the type of training on the amount of completed workout sessions since the first subscription, considering the trainer workout sessions, the user-created workout sessions, and the free workout sessions. There was a significant effect of the type of training on the amount of completed workout sessions remembered at the $p < .05$ level for the three conditions [$F(2, 189) = 117.58$, $p < .0001$]. Post hoc comparisons using the Tukey HSD test indicated that the mean score for the trainer workout sessions condition ($M = 0.76$, $SD = 0.31$) was significantly different than the user-created workout sessions condition ($M = 0.12$, $SD = 0.23$), with $p < 0.01$. Also when comparing the mean score of the trainer workout sessions condition and that of the free workout sessions condition ($M = 0.25$, $SD = 0.19$), the results were statistically different ($p < 0.01$). The same holds when comparing the user-created workout sessions condition and the free workout sessions condition ($p < 0.01$). Taken together, these results suggest that trainer-created workout sessions really do have an effect on the amount of completed workout sessions. Specifically, our results suggest that when the users train using trainer-created workout sessions, they perform more workout sessions with respect to the other two conditions. Moreover, when they perform free workout sessions, they train more than when they set a goal.

If we consider just the subscription periods, Fig. 8 shows that 75% of the users do at least 92% of their workout sessions by following a trainer-created workout plan. Moreover, the users did not perform any free workout sessions nor user-created workout sessions, except for some outliers. This result shows an even greater engagement toward the trainer and the type of e-Coaching that involves her in the subscription periods.

A one-way between subjects ANOVA was conducted to compare the effect of the type of training on the amount of completed workout sessions during the subscription periods, considering the trainer-created workout sessions, the user-created workout sessions, and the free workout sessions. There was a significant effect of the type of training on the amount of completed workout sessions remembered at the $p < .05$ level for the three conditions [$F(2, 186) = 702.85$, $p < .0001$]. Post hoc comparisons using the Tukey HSD test indicated that the mean score for the trainer-created workout sessions condition ($M = 0.91$, $SD = 0.22$) was significantly different than the user-created workout sessions condition ($M = 0.01$, $SD = 0.05$), and the free workout sessions condition ($M = 0.04$, $SD = 0.13$) since in both cases $p < 0.01$. However, the user-created workout sessions condition did not significantly differ from free workout sessions condition. Taken together, these results suggest that during subscription periods trainer-created workout sessions really do have an effect on the number of completed workout sessions. Specifically, our results suggest that when users train with a trainer-created workout session, they perform more workout sessions with respect to user-created or free ones. However, it should be noted that when other types of workout sessions are performed, there is no significant difference in the amount of completed workout sessions.

Let us now consider the workout sessions performed in periods without an active subscription. As Fig. 9 shows, 25% of the users do all the workout sessions by following a workout plan created by a trainer. Another 25% of the users did them for the 45-100% of their workout sessions. For the 25% of the users, the percentage of user-created workout sessions rises to 26%, while the percentage for free workout sessions rises to 55% of the total workout sessions.

A one-way between subjects ANOVA was conducted to compare the effect of the type of training on the amount of completed workout sessions during the periods in which the users are not subscribed, considering the trainer-created workout sessions, the user-created workout sessions, and the free workout sessions. There was a significant effect of the type of training on the amount of completed workout sessions remembered at the $p < .05$ level for the three conditions [$F(2, 189) = 19.77$, $p < .0001$]. Post hoc comparisons using the Tukey HSD test indicated that the mean score for the trainer-created workout sessions condition ($M = 0.48$, $SD = 0.44$) was significantly different than the user-created workout sessions condition ($M = 0.12$, $SD = 0.25$), with $p < 0.01$. Also, when comparing the mean score of the trainer-created workout sessions condition and that of the free workout sessions condition ($M = 0.29$, $SD = 0.27$), the results were statistically different ($p < 0.01$). The same holds when comparing the user-created workout sessions condition and the free workout sessions condition ($p < 0.01$). Taken together, these results suggest that trainer-created workout sessions really do have an effect on the amount of completed workout sessions even when the users are not subscribed to the personal trainer service. Specifically, our results suggest that when the users train with the workout sessions created by a trainer, they perform more workout sessions with respect to the other two conditions. Moreover, when they perform free workout sessions, they train more than when they set a goal.

In conclusion, the major differences between the considered periods are obtained between the subscription periods and the "no subscription" periods. We can see that the percentage of workout sessions completed by following a trainer plan significantly rises during the subscription period and falls outside of it. Results show that the user-created workout sessions and the free workout sessions are nearly ignored during the subscription periods and, considering all the workout sessions since the first subscription, we can notice a strong prevalence of the trainer-created workout sessions.

This will allow us to provide an answer to the first research question.

RQ1. Is there any quantitative evidence that the trainer-created guided workout sessions are the ones preferred by the users? If so, how much do they prefer the direct human support or to what extent does the application's virtual trainer satisfy their needs?

Answer. The results of these experiments clearly lead to a positive answer to the first research question. The users undeniably complete more workout sessions when they are planned by a human coach. So, the support of a human trainer is clearly more motivating and engaging with respect to the virtual trainer that reveals itself alone insufficient to fulfill athletes needs.

4.4.2 Engagement Towards the Trainer

In the second set of experiments, we evaluate the influence on users provided by an active subscription to the personal trainer service. We will measure the engagement of a user towards the trainer, by exploiting the metric presented in Section 4.3.2.

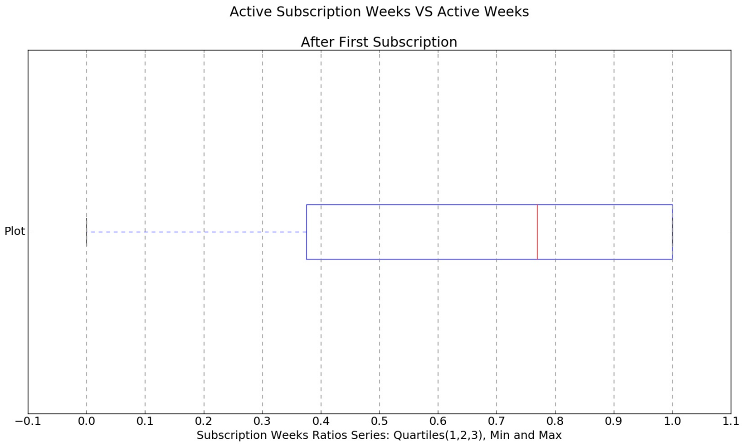

Fig. 10: Active weeks of subscription on active weeks ratios

The box plot presented in Fig. 10, shows the values computed for each user. The results show that 25% of the users only worked out during their subscription period. For 50% of the users, the training weeks during an active subscription period represented from 78% to 100% of their active weeks.

Before answering to the second research question, it is important to point up that there are also users (not included in the sample of users under evaluation) that never subscribed to the personal training service. It is interesting to compare how they perform by considering their "active weeks" with respect to users who subscribed to the personal trainer service. In particular, during the timespan under consideration, we identified 86 users (45 males and 41 females with an average age of 37.4) that completed at least one workout session (from a user-created workout plan or a free workout session).

Thanks to the analysis of the follow up emails of our customer care service[9] we are able to report the main reasons that led them not to subscribe to the personal training service. In particular (see also Fig. 11):

a) They supposed that the remote interaction with a personal trainer service is ineffective;
b) They deemed the personal trainer service too expensive;
c) They did not want to be judged by a human coach;
d) Other reasons.

Moreover, 88% of these users worked out by performing only free workout sessions and, on average, they had a number of active weeks lower than 39% compared to users that subscribed to the personal trainer service. This data strengthens previous statistics related to the original sample, confirming how the human coach is fundamental to keep users motivated to exercise.

[9] The customer care sends an email to new users 3 weeks after their first login if they do not subscribe to the personal training service, to convince them to give it a try.

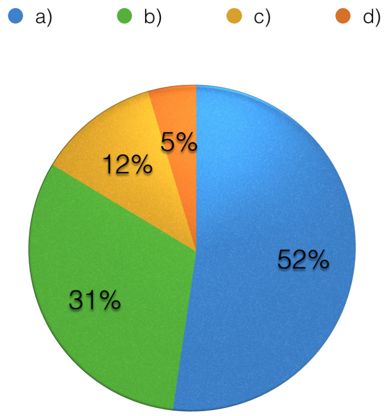

Fig. 11: Main reasons for not subscribing to the personal trainer service

We can now provide an answer to the second research question.

RQ2. Do the users tend to train more often when supervised by a real personal trainer?

Answer: Yes, the users train more when they are supported by a trainer. This is clear by looking at the plot in Fig. 10, which shows the proportion of the subscription period on the total workout period. The subscription period is clearly predominant for most of the users.

4.4.3 Adherence to the Planned Workout Sessions

In the last set of experiments, we analyzed the amount of workout sessions completed by the users with respect to those that they planned to perform. This has been done for the different types of available workout sessions (i.e., related to user-created or trainer-created workout plans), considering the three time periods considered in the first set of experiments (Section 4.4.1). The results obtained in each time interval are presented in the box plots shown in Figs. 12, 13, and 14.

When considering the whole period from their first subscription, the first box plot in Fig. 12 shows that half of the users completed 50% or more of their planned workout sessions. The second box plot shows that at least 56% of the users complete their workout sessions when using real-trainer workout plans, and decrease (to 12%) when it comes to completing the workout sessions planned by themselves (third box plot).

Since the total workout sessions conditions is just a combination of the other two conditions, an independent-samples t-test was conducted to compare the adherence to the planned workout sessions in trainer-created workout sessions and user-created workout sessions conditions, during the whole period since the first subscription. There was a significant difference in the scores for trainer-created workout sessions ($M = 0.54$, $SD = 6.07$) and user-created

Fig. 12: Adherence to the workout sessions calculated by considering all the ones created after the first subscription

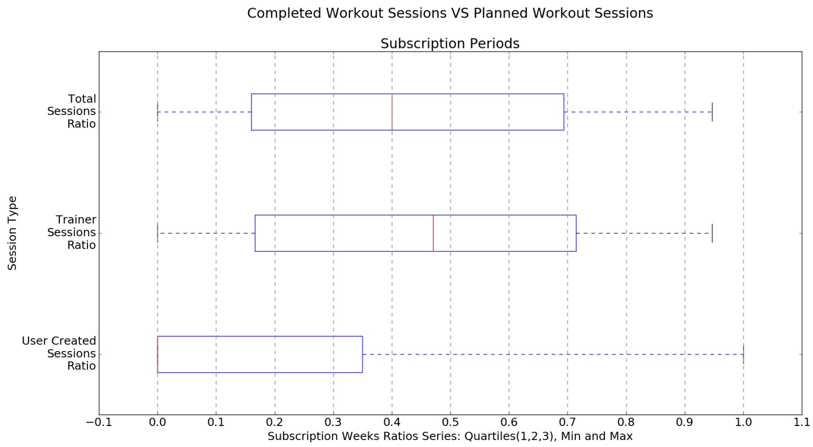

Fig. 13: Adherence to the workout sessions calculated by considering all the ones created during a subscription period

workout sessions ($M = 0.15$, $SD = 5.59$) conditions; $t(63) = 7.92$, $p < .0001$. These results suggest that performing trainer-created workout sessions really does have an effect on the adherence to the planned workout sessions. Specifically, our results suggest that, considering the whole period in which the users trained, they tend to complete a number of workout sessions closer to those they planned to perform, when these workout sessions were planned by a trainer.

Fig. 13 shows that, during the subscription period, half of the users completed 47% or more of the workout sessions they were given by the trainer

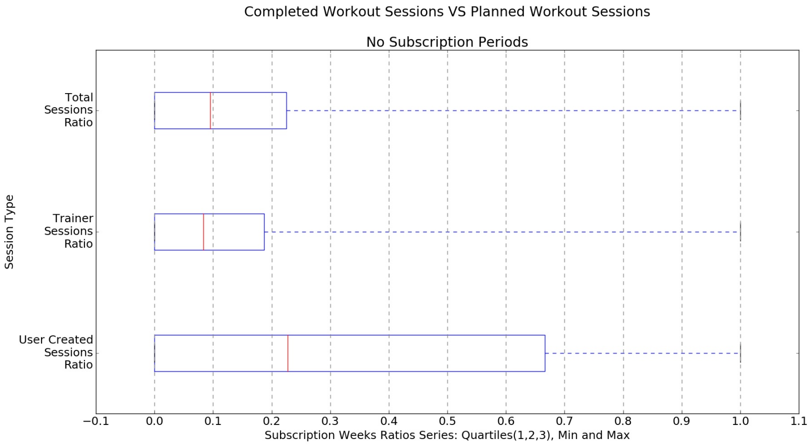

Fig. 14: Adherence to the workout sessions, calculated by considering all the ones created during a no-subscription period

(a decrease with respect to the results shown for the whole period is normal, since we are considering a narrower period), while half of the users did not complete any session that were planned by themselves.

An independent-samples t-test was conducted to compare the adherence to the planned workout sessions in trainer-created workout sessions and user-created workout sessions conditions during the subscription periods. There was a significant difference in the scores for trainer-created workout sessions ($M = 0.46$, $SD = 5.07$) and user-created workout sessions ($M = 0.04$, $SD = 1.67$) conditions; $t(63) = 11.66$, $p < .0001$. These results suggest that performing trainer-created workout sessions really does have an effect on the adherence to the planned workout sessions. Specifically, our results suggest that, considering the subscription periods, the users tend to complete a number of workout sessions closer to those they planned to perform, when these workout sessions were planned by a trainer.

The results of the last time period considered, i.e., that in which the users where not subscribed to the personal training service, are shown in Fig. 14. The second box plot shows that 75% of the users completed at most 19% of their planned workout sessions related to trainer-created plans. As the third box plot shows, half the users completed 23% or more of self-made workout sessions.

An independent-samples t-test was conducted to compare the adherence to the planned workout sessions in trainer-created workout sessions and user-created workout sessions conditions during the non subscription periods. There was no significant difference in the scores for trainer-created workout sessions ($M = 0.12$, $SD = 1.85$) and user-created workout sessions ($M = 0.16$, $SD = 6.40$) conditions; $t(63) = -1.18$, $p = 0.24$. These results suggest that performing trainer-created workout sessions does not have an effect on the adherence to the planned workout sessions. Specifically, our results suggest that, during periods without an active subscription, users do not show a difference in the way they adhere to the planned workout sessions. Indeed, the creator of the workout sessions does not have an influence on the amount of completed workout sessions with respect to those planned.

The results of this last set of experiments lead us to the answer to our third question.

RQ3. Is there a difference between the percentage of completion of user-created and trainer-created guided workout sessions?
Answer. Yes, the plot in Fig. 12 clearly shows the difference between the percentage of completion of user-created and trainer-created guided workout sessions. In particular, it shows how the completion percentage of trainer-created workout sessions exceeds the completion percentage of user-created workout sessions. Fig. 13 and Fig. 14 show how the trend varies when the user has an active subscription (i.e., she is supervised by a trainer) compared to when she does not have such supervision. We can see that the users tend to complete the highest percentage of trainer-created workout sessions when they are supervised by a human trainer, while when they do not have an active subscription they have an adherence to the workout plan that is not related to the coaching type.

4.4.4 Discussion

The results of our experimental analysis showed the persuasive capabilities of our e-Coaching ecosystem from different perspectives. Indeed, users mostly tend to train by means of a user- or a trainer-created workout plan, thus choosing to be supported either by the virtual personal trainer or by both the virtual and the human personal trainer. Both features are exploited by the users to the point that the free workout sessions are seldomly performed.

Moreover, the human personal trainer has an essential role in motivating users since, differently from the virtual support, she has a role *before* the workout (she prepares the plans) and *after* it (she provides feedback to users and adapt the routines to users' progress in trainings). Indeed, once the users exploit the services of the human trainer, they hardly use the other forms of training. Moreover, after they subscribe and choose to be followed by a personal trainer, they stay active and train constantly. This form of engagement finds associations with the so-called "Hawthorne effect" [21], which studies how the motivation of an individual may result increased thanks to the communications with other individuals (the human trainer in our scenario) on factors that affect them. This is especially true in our use case, given the context in which we are operating, in which users ask to be supervised by a human trainer. This is also shown in the non subscription periods, in which users train less.

Another aspect that emerges from these results is that *the human personal trainer is not only perceived as a professional figure who merely prepares workout plans*, but her supervision, both before and after the workout sessions, are key elements that motivate the users. Indeed, during periods of no active subscription, users train with self-created workout plans. This shows that the human personal trainer is a reference figure for the users, especially because of the continuous interactions that occur during the workout period.

In conclusion, the proposed e-Coaching platform and its forms of support represent key elements to motivate the users, which choose to be followed by both the virtual and human trainer and, in response, train more and with a higher frequency.

5 Conclusions and Future Work

In this paper, we presented an e-Coaching platform in which users have the possibility to train under the direct supervision of qualified human personal trainers. The obtained results showed that our support system is able to fill the aforementioned gap on the lack of human support in mobile applications that motivate users to have an active lifestyle. Moreover, they put in evidence that an effective e-Coaching protocol cannot be entirely automated but it must be heavily based on human interactions to favor users motivation and adherence to training routines. We analyzed gathered data about users' behavior in order to answer the proposed research questions and we found out that the users create forms of engagement with the human trainer.

The main strengths of the proposed platform can be summarized as follows: it is a real commercial framework used by real users that allowed us to conduct the experiments on real workout sessions data, it supports direct interaction between athletes and qualified human trainers, and the capability to favor different forms of motivation and engagement.

Regarding the weaknesses of the ecosystem in its current form, there is the lack of trusted sources of information for the trainer (indeed, she can rely only on what the users tell her and on sensor-provided that might not be very accurate, which might lead to an inaccurate analysis of users' performances). Moreover, the user cannot express feedback through structured interaction forms that might be offered to her; therefore, a user and a trainer communicate after a workout session only when either of the two parties decides to do so. The last weakness we highlight is related to the fact that the sensors monitor the users only during the workout sessions, and there is no information about what happens during the rest of the day (heartbeat, amount of sleep, etc.).

This study represents the starting point for our future developments and investigations. In particular, we are currently studying how to improve the virtual personal trainer by mining common behavioral patterns that may emerge from the collected statistics. To this end, we are evaluating to integrate new physiological sensors to enhance the quality and the quantity of gathered data [23]. The aim is twofold: on the one hand, we strive for improving the accuracy of the data. On the other hand, we aim at collecting more data not strictly related to the training performance by integrating in the platform nowadays activity trackers. This will undoubtedly allow human trainers to infer a more accurate profile of the athletes, in order to provide more tailored and accurate workout plans.

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