Assessing eLearning for Taking up Social Challenges

A Fitness Online Course for Senior Citizens

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***Abstract*—In this paper, we investigate whether a novel kind of online course on fitness designed to take into account specificities of elderly people and integrating wearable trackers can motivate senior citizens to exercise more in a sound way and help improve their physical condition. The design principles of the online course including content, gamification elements and wearable fitness trackers are described, as well as a first evaluation with 20 participants. The results of the analysis of the users' interactions are promising.**

Keywords- healthy ageing; senior citizens; online course; wearable activity tracker; gamification.

I. INTRODUCTION

In many western countries, the population is ageing. This fact poses several challenges to the society. One of these challenges is to keep senior citizens in good health as long as possible. It is known that social interaction and sufficient physical activity have a positive influence on health. For example, the longitudinal creativity and ageing study by Cohen et al. [1] revealed positive effect of community-based interventions on improved ratings of physical health, reduced medication use, improved social interactions and less loneliness, and even fewer health problems compared to the control group. Further research [2][3] shows that even 30 minutes of daily moderate-intensity physical activity may significantly reduce the risk of chronic diseases. Recent research also suggests that digital technologies can be used with benefits with elderly people when they are properly designed, as shown by Ijsselsteijn et al. [4]. The work by Assad et al. [5] reports that well-designed games have a positive influence on Parkinson's disease patients. Furthermore, the proportion of senior citizens who use digital technologies has been growing worldwide. Duplàa et al. [6] report that from 1208 persons aged 55 or more declaring playing games in Canada about half of them answered that they also play digital games. The study by Ledger and McCaffrey [7] shows that the percentage of persons tracking fitness data through a smartphone has grown rapidly during the last two years.

The aim of the fMOOC (fitness Massive Open Online Course) project is to assess the use of e-learning and mobile devices to take up the social challenge of healthy ageing. More specifically, its aim is to develop an online course on fitness that integrates wearable activity trackers for senior citizens in such a way that these two aspects, social interaction and enhanced physical activity, are addressed. This kind of approach is novel; an online-course targeting senior citizens and integrating wearable activity trackers has not been realized so far. The targeted learners are older citizens who have some familiarity with information technology and are in relatively good health, though they might have some minor impairment, but who could improve their physical condition by doing more exercises and moving more daily. As exposed in Buchem et al. [8], the conceptual design of the fMOOC course includes digital content on weekly physical exercises and the integration of wearable activity trackers connected to the course to help seniors engage in physical activities. The conceptual design includes also forums for sharing and commenting, and for community-based exercises to enhance social engagement and a sense of belonging together of senior participants. Community-based exercises should allow for various learning and physical training scenarios, such as a group-walk for participants living in the same neighbourhood. After the walk, participants should be able to synchronize their wearable devices, so as to store the number of steps recorded by the system. Therefore, the course has to be accessible from mobile devices, such as smartphones. Furthermore, inspired by the work of Ijsselsteijn et al. [4] gamification elements are also part of the conceptual design to support and foster user engagement, as argued by Buchem et al. [9]. Gamification is the use of elements normally found in games like rewards or badges in another context like here in a learning context. In the spirit of agile development and following principles exposed Martinez-Maldonado et al. [10] to support learners better, specific user requirements were designed with potential senior users aged 65+ and tested iteratively. The online course has been tested with 20 senior participants.

This contribution presents the online course and its implementation in section II. The context of the evaluation is given in section III, which is followed by the analysis of the users' digital interactions in section IV. Section V concludes with discussion and future works.

II. THE ONLINE COURSE

Essentially, the online course provides to participants physical training for four weeks, communication forums,

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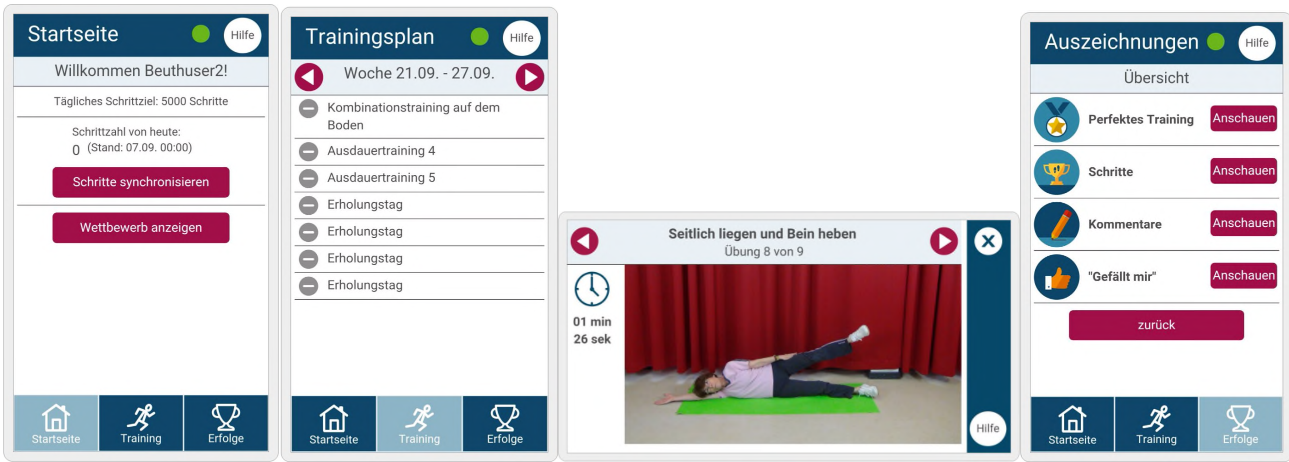

Figure 1. The user interface – left: after log in; middle-left: weekly training plan; middle-right: training-exercise; right: badges.

as well as an overview of their achievements. Participants are expected to wear an activity tracker that counts the steps they walk, presently the tracker Vivofit from Garmin [11].

The instructional design of fMOOC combines elements of Online learning with elements of gamification and principles of seamless learning. The fMOOC architecture integrates wearables, mobile and learning technologies to capture and share fitness data and learning/training content with other senior learners. The fMOOC can be accessed via the "fMOOC App" using a laptop, a tablet or a mobile phone phone phone. The fMOOC software includes a gamification service to incorporate rewards and playful elements in the course, including badges and battles, as argued by Buchem et al. [8][9]. The user interface has been designed to take into account specificities of older people, which includes among others simple vocabulary, short texts, big buttons and fonts, as exposed by Kurniawan and Zaphiris[12]. We first explain the course as a learner sees it, and then describe how the system has been implemented

A. Learner View

Fig. 1 left shows the screen that a learner sees right after logging in. At the top right of the screen, the help button (Hilfe) gives a hotline number where to call in case of problems. Below, the number of steps a learner is expected to walk daily is reminded, 5000 steps (5000 Schritte) and the number of steps already walked in the current day (Schrittzahl von heute:) is shown. The button synchronize your steps (Schritte synchronisieren) reminds participants to synchronize their tracker, so that the fMOOC system pulls their data from the Garmin host. For synchronization, a mobile application of the provider of the wearable activity tracker has to be installed on the smartphone and needs to run in the background. A user has to hold his/her tracker near enough to his/her smartphone and press the "synchronize" button. The transmission is automatic, but can last a few seconds. When the transmission is successful, the number of steps walked in the current day is almost immediately updated in the fMOOC system and displayed on the start view. The button show battle (Wettbewerb anzeigen) is to show the current status of the battle; this gamification element will be explained below. The three buttons at the bottom are always visible except when a user is in the process of completing a training day. The home button (Startseite) allows the user to come back to this view anytime. The button Training gives access to the training plans, while the button Achievements (Erfolge) allows the user to check her/his achievements.

The physical training has been developed according to medical recommendations as exposed in [13]. In particular, training begins with a warming up exercise and finishes with a cool down exercise. Further, endurance, strength and flexibility exercises are mixed properly. Each week is made up of three training days and four rest days (Erholungstag), as participants should not over-exercise; the interface shows a "–" in front of each day which is not completed. Fig. 1 middle-left shows an overview of the training plan at the beginning of a week. A learner can complete the training days in the order he/she wants. The intensity of the exercises vary as to fit 3 levels of fitness. Each exercise is explained with a sequence of 2-3 photos or a video of 1-2 minutes, and 1-2 lines of instructions. The user interface follows known principles of web navigation, see for instance [14], to guide users through the different exercises till the training is finished, then to make users rate the training and finally comment it. Participants can complete the training at their own pace. After completing the last exercise, they touch the finish button. At that point, the system records that this training has been performed with a timestamp. The next screen invites participants to rate how s/he feels and how s/he liked the training. The next screen invites participants to write a feedback on the training, to read / answer messages of others and to give "likes" to feedbacks of others.

To support engagement and motivation, the instructional design integrates gamification elements in the form of badges and battles. Participants can earn four kinds of badges, and in each category they can earn four badges:

A *"training" badge* can be earned at the end of each week if participants have accomplished a perfect training, doing every single training day of the week and leaving a rest day between two consecutive training days. Contrasting with the "step" badge below, there is no partial reward. A *"step" badge*, to encourage movement every

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day, can be earned at the end of each week as well. A step badge comes in three colors: bronze, silver and gold. A bronze badge is earned if the learner has walked at least 5000 steps 5 days of the week, a silver badge for at least 5000 steps 6 days and the gold badge for at least 5000 steps each single day of the week. The four *"comment" badges* can be earned any time as soon as a learner has written enough messages in some discussion thread (each training day has its own thread). The first badge goes with 2 messages written, the second with 4, the third with 6 and the last badge with 8 messages written. Similarly, four *"like" badges* can be earned anytime as soon as a participant has received enough likes from others on his/her messages. The first badge goes with 3 likes, the second with 6, the third with 9 and the last with 12.

Battles have been designed as a group competition, presently between female and male users, based on the number of steps walked by the whole group. As soon as some user has synchronized her/his tracker, the status of the battle is updated too. Participants can check their achievements anytime. The design follows the principle "overview first, details on demand" of Schneiderman [15]. With the show steps button (Schritte anzeigen) a user can see how many steps s/he has walked during the current day, or during the current week or since the beginning of the course by touching the corresponding button for these details. With the show battle button (Wettbewerb anzeigen) users can check which group currently leads. Fig. 1 right shows 4 badges: perfect training (Perfektes Training), steps (Schritte), posts (Kommentare) and like (Gefällt mir). By pressing the corresponding look (Anschauen) button, the four badges of that category are shown. The background colour indicates for each badge whether the user has already earned it or not, or whether the badge is in progress. By pressing an individual badge, learners can get details: how much they still need to do to earn that badge.

B. Implementation

The fMOOC course has been implemented as a Web application in responsive design using the platform Moodle as backend to store the content (training days) and to provide the forums, see Fig. 2 for the overall architecture.

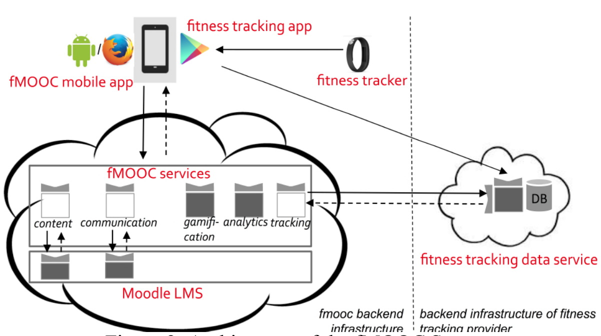

Figure 2. Architecture of the fMOOC System.

As already mentioned, the design of the user interface has adopted an agile methodology, testing most of the elements with senior users before implementation. In order to allow for a potentially "massive" opening of the fMOOC system beyond the scope of the user group envisaged in the pilot study, the user interface was developed as a mobile web application based on recent HTML5 standards [16]. It can be run on any browser installed on a reasonably modern smartphone regardless of whether it uses Android, iOS or Windows as an operating system. As for the backend components of the system, the application is currently deployed on a single server, but the overall architecture was designed according to the stateless paradigm of a RESTful architecture [17], which provides a solid basis for scalability.

As for the tracking service provider, the current version of the fMOOC system has only been integrated with the service of Garmin so far, which had been selected at the beginning of the project given the usability requirements of the user group. An agreement with Garmin allowed access to its backend service infrastructure through a specific connector. As structure and access to data collected by fitness trackers has not been subject to industry standardisation so far, commercial activity trackers and services are relatively "closed" system infrastructures, and providers differ with respect to how access may be realised by third party systems like fMOOC. For this reason, the fMOOC system has been designed as independent of any particular tracking provider, where different providers can be integrated by implementing a backend-side connector to the particular tracking service. Hence, also with regard to the tracking service, openness of the fMOOC system has principally been foreseen.

III. Context of the Evaluation

The evaluation has been conducted in a blended learning approach consisting of two face-to-face meetings separated by the four weeks online course. Twenty volunteers not possessing any wearable activity tracker have been recruited, 10 men and 10 women aged 62 to 75.

During the first face-to-face meeting, participants were introduced to the whole course. They received a properly installed smartphone and an activity tracker each. Learners were introduced to smartphones, had a chance to try the course, the activity tracker and the synchronization procedure. Their fitness level was determined so that they would receive the proper level of exercises, and their physical condition recorded. This included, among others, measuring balance ability, strength, the distance they can walk in 6 minutes and the percentage of body fat. During the second face-to-face meeting, the physical condition of the users has been recorded again. Further, participants filled anonymously a questionnaire regarding their overall experience with the course.

IV. Analysis of the Digital User Interactions

The usage of the interface has been analyzed using the piwik web analytics tool [18]. First, we analyse logging in the App and synchronisation, then the physical activities through training and steps badges and the rating of the trainings, then the social activity through the comment and like badges and finally how often users have consulted their achievements.

A. Logging in the Web App and Synchronisation

A learner eager to complete all physical activities of the course should log in at least once every day to synchronize the activity tracker, and possibly more on a training day. Table I shows how often users have logged in the App and how often they have touched the synchronize button during the 4 weeks. The large standard deviations indicate that users differ greatly; a closer look at the data gives two outliers: one with 90 log in and one with 702 synchronisation actions. An inspection of the weekly data shows that two users out of the 20 gave up after two weeks, which means nobody gave up right at the beginning of the course. The high number of synchronize interactions compared with log in might indicate some problem when synchronizing the activity tracker. This is confirmed when inspecting the sequential actions of individual visitors' log files: quite often the synchronize button is pressed twice in a row, or alternate with the help button.

TABLE I. LOGGING IN THE WEBAPP AND SYNCHRONISATION

	average	**std**
Log in	44	21
Synchronization	129	152.12

The help button has been pressed 100 times during the 4 weeks, 40 times during the first 3 days and 62 times during the first week. The hotline has been called 32 times by 16 users, including the numerous calls by one user for whom some setting needed to be redone. These interactions indicate some usability issues with the synchronisation of the activity tracker, which made users feel insecure in the first week of the course.

B. Physical Activity

The badges earned in the category "training" and "steps" assess whether participants have accomplished the training properly and included enough movement in their daily life.

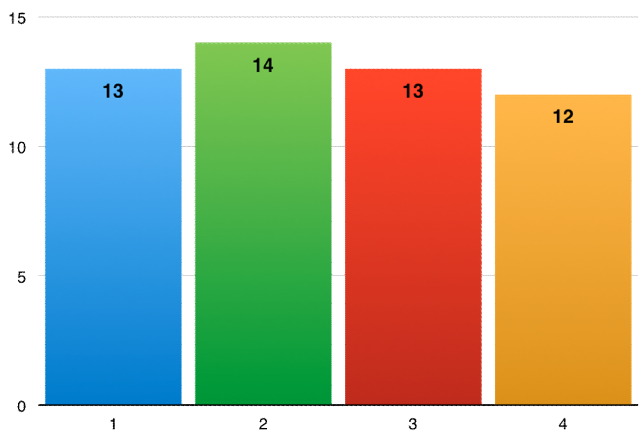

Figure 3. Number of learners who earned a "training" badge; the x-axis shows the weeks.

The histogram Fig. 3 shows that the majority of the users have earned a "training" badge each week. Taking into account that 2 users abandoned after 2 weeks, 68.4% of the "training" badges have been earned. Most of the users rated the training after completing it, thus following the design adopted for the interface. In total, 201 ratings were given for each of the two questions: "how do you feel after training" and "how did you like the training?". Ratings were mostly positive: 69.15% of the wellbeing-ratings was "great" and 64.7% of the liking-ratings was 3 or 4, see Fig. 4.

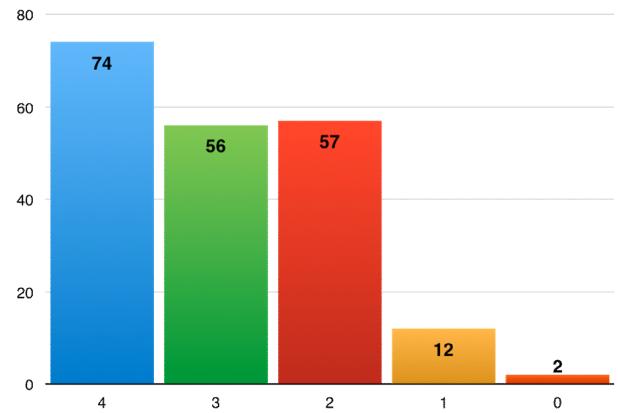

Figure 4. Liking rating given: 4 is the best, 0 the worst.

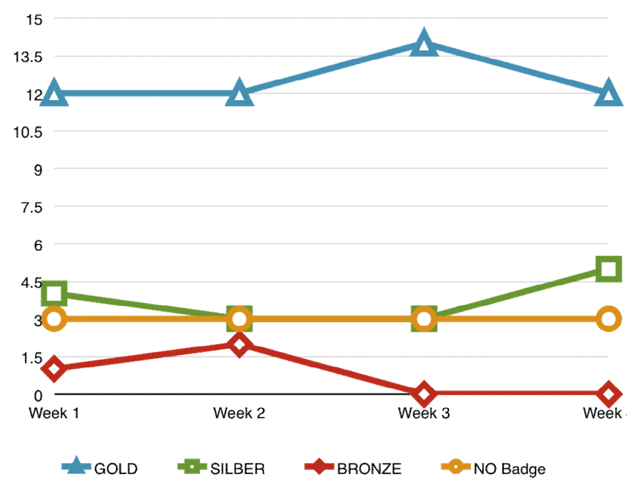

Figure 5. Number of learners who earned "step" badges.

Taking the training days perspective and counting how many stars each training has received, one cannot notice any training that stands out as particularly excellent or bad: the average goes from 2.44 till 3.4 for the liking-rating, and from 1.64 to 1.72 for the wellbeing-rating (scale 2, best, to 0, worst).

The majority of the users have earned a "step" badge each week, which results in 89.5% of the badges earned, when taking into account that two users abandoned after week 2 and aggregating all colors. The flat curve of Fig. 5 shows that each week three participants did not achieve 5000 steps on at least five days. These figures include the two participants who abandoned. Aggregating training and step badges shows that 19 participants earned a training badge or a step badge or both in the first week.

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C. Social Interactions

The course has been designed to encourage social interactions by prompting feedback in the form of comments and likes after the completion of each training.

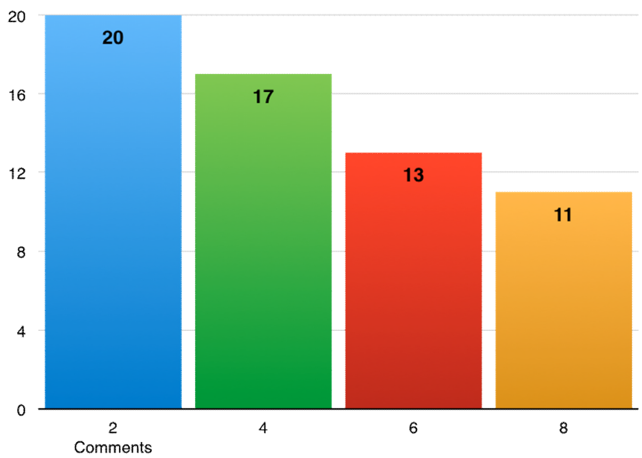

Figure 6. Number of learners who earned “comment” badges.

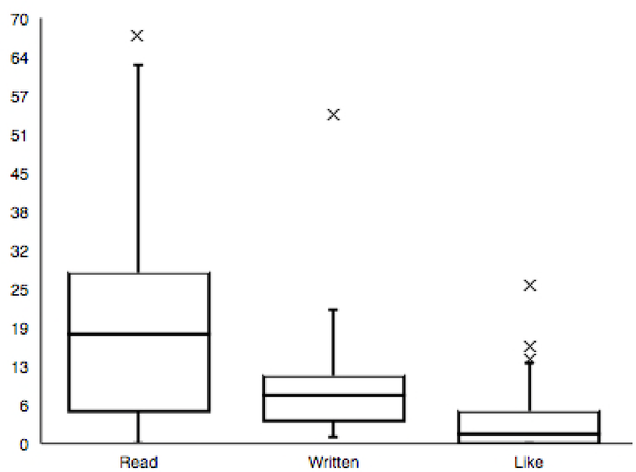

Figure 7. From left: number of read and written messages and number of likes given.

Fig. 6 shows that every user has written in some discussion thread, as 20 badges for writing at least two comments have been earned; the numbers on the horizontal axis: 2, 4, 6 and 8, are the numbers of comments a learner has to write to earn the corresponding badge. All together 76.25% of the “comment” badges have been earned. Fig. 6 shows also that only 11 participants have written 8 comments or more, which suggests that participants differ in their social interactions. This is confirmed by the box plots of Fig. 7 that show the number of times users have touched the read button to read a message, the write button to send a message, and the number of times they have given a like to a message. One finds again well known behaviors also observed Cobo et al. [19] or Merceron [20] in online courses: participants read more than they write, and a few outliers write more than the majority. Users have not given many “likes”. As a consequence, less learners have earned “like” badges resulting in only 21.25% of the “like” badges being earned.

D. Consulting Achievements

The systemic gamification design has been implemented through two main elements: badges and a battle. How often have users looked at the current state of the battle or at their badges? Here too, behaviors vary greatly. With a median of 60, battle is the gamification element which has been the most consulted. These high figures are confirmed when analyzing the views that are accessed right after the start view of the app: the battle view has the highest proportion of moves, followed by the training view, where users can start their training, followed by the achievement view, where users can look at the badges they have earned, see Fig. 1 left. Remarkably, this pattern stays stable in each of the four training weeks.

The medians for consulting the badges lie around 10 with a peak of 17 (Training) and a depression of 6 (Steps). This indicates that 50% of the users have consulted their badges about 2 times a week on average. These figures suggest that participants have been interested in playing the game of the battle. They have appreciated the other badges, but might not have been eager to collect them.

V. DISCUSSION AND CONCLUSION

The analysis of the digital interactions has shown that users could log in, synchronize and use the fMOOC App during the four weeks. The two users who abandoned gave the following explanation: one found the training exercises too laborious, and the other lost interest. Therefore, one can conclude that the online course on a smartphone is easy to use. This has been confirmed by the interview of the second face-to-face meeting: the majority rated the App as easy to use. The synchronization procedure has posed some problems, as the analysis of the interaction data has shown. It has been confirmed by the calls received on the hot line: the worries mainly concerned synchronization. A better feedback in the App in case of an unsuccessful pulling of the data is necessary. However, one should also notice that after the first week users have learned to adjust.

Most of the users have learned to train properly and to include a minimum of 5000 steps in their daily life, as they have earned the corresponding badges. Inspecting the daily number of steps, one notices big differences between learners. This suggests replacing the common goal of 5000 steps by a personalized goal to be adapted each week.

The training proposed in the course is effective. Indeed, the physical condition check during the two face-to-face meetings has shown that all users who completed the course improved their physical condition and the improvement was statistically significant as shown by Steinert et al. [21]. Further, users reported that they felt fitter after the course.

The gamification elements have been introduced to support motivation and engagement of users. Users have consulted their achievements regularly, though they have consulted the battle most. During the second face-to-face meeting, participants confirmed that the battle was exciting, and indicated a moderate interest in the other badges, their main interest being to complete the physical activities.

Summarizing, the analysis of the interaction data enriched with the answers of the users during the second face-to-face meeting and the pre- and posttests concerning physical condition shows that the fitness online course provides an enjoyable user experience, that participants have learned how to exercise more in a sound manner and that the health-related goal is met, as participants who completed the course have an improved physical condition.

A future work is to run this course massively and openly. This slightly changes the targeted population, as participants will be expected to have their own activity tracker but not necessarily a smartphone, as the course can run on a personal computer. A digital introduction and physical condition check will be needed, to replace the two face-to-face meetings of the evaluation. An enhancement that is highly desirable is to develop connectors for other tracking providers, in order not to be limited to wearable activity trackers from Garmin. Though there is no technical difficulty to implement this enhancement, since the present system architecture has been designed to allow for it, the realization might be tedious because there is no standard. Further, with an increased number of learners, the conditions to earn comments and like badges need to be revised.

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