Get your back straight! Learn Pilates with the Pilates Correction Game

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Abstract: Currently, a vast number of the population faces several barriers like the lack of motivation and guidance that impede them from practicing physical activities. Thus, we developed the Pilates Correction Game (PCG), a gamified application designed to support learners with the practice of Pilates. The PCG is composed of two applications: a smartphone application that tracks the learner's back posture and a PC game that steers a rocket and calculates a score based on the smartphone's information. In this paper, we present a user experience evaluation on the PCG. Our results show that PCG was positively perceived by participants and in most cases helped them to improve their posture while doing the Pilates exercise. Furthermore, it is also motivating them to continue with the training.

Keywords: Sensor-based Learning support, MMLA, Physical activity at home.

1 Introduction

"Mens sana in corpore sano" is a widely used phrase to express the theory that physical exercise is an important or essential part of mental and psychological well-being. Regular physical activity can make people feel, function and sleep better and helps with the prevention of several chronic diseases [Pi18]. In terms of education and academic achievement, studies have shown that higher grades over long periods of time are highly related to the Healthy People Guidelines 2010 for vigorous physical activity [SSL08].

Regardless of all the benefits of physical activity, in 2013 less than half of the primary school children in south-west Germany met the current recommendations of 60 minutes of moderate to vigorous daily physical activity [Ke13]. For university students in Germany, some of the most commonly identified barriers for engagement in physical activities are the lack of time, the lack of motivation, the lack of guidance and feedback, and no access to suitable environments to practice [HLD20]. In this context physical activities are referred to as coordinated procedures of body movements that need to be learned. Instruction, practice, and feedback are needed to improve these skills [MK06]. Nevertheless, having a human coach is not always feasible or even possible.

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The integration of sensors with computational systems has created smart devices able to automatically record and analyze events happening in the environment where these devices are situated. These smart devices can in turn be used to support learners with the development of their psychomotor skills [Sc15]. Artificial tutors have been studied in different domains such as public speaking [SRD19], dancing [RSD19], Cardiopulmonary resuscitation [Di20], etc. One commonality of these applications is the use of specialized sensors like depth cameras that are not highly available for the general public.

To address the aforementioned barriers, we developed the Pilates Correction Game (PCG), a gamified application that uses highly available hardware (smartphone and PC) and is intended to be used at home. PCG has been designed to support learners to practice and develop their psychomotor skills for a basic Pilates exercise. In this paper, we present a user experience evaluation on the PCG guided by the following RQs:

RQ1 Can we use highly available devices such as smartphones to develop an application that supports learners with the development of basic Pilates skills?

RQ2 Can we use gamification to motivate learners at home into engaging in physical activity such as Pilates?

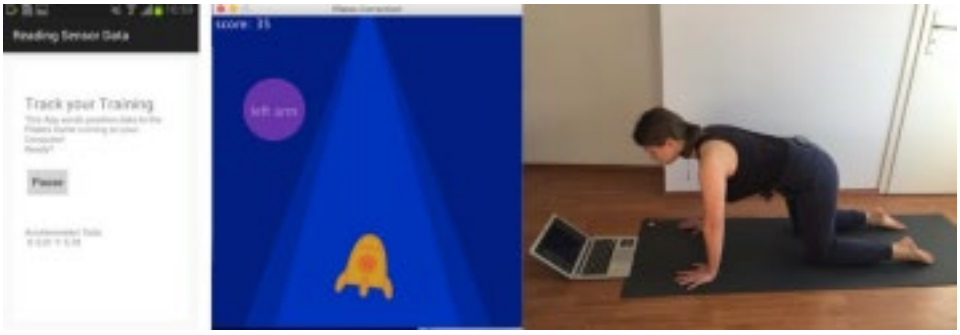

Fig. 1: Left: PCM smartphone application. Center: PCM application running on a Laptop. Right: PCM Setup

2 Pilates Correction Game

Pilates is a physical training method designed to exercise all parts of the body. The PCG[3] is designed to support awareness for lower back stability while performing the Pilates exercise “Kneeling Arm and Leg Reach”. It is a classic beginner's exercise that promotes core strength and stability. It can be modified to suit more advanced learners. PCG is composed of a mobile application running on an Android smartphone and a computer

[3] The code of the PCG can be found at: https://github.com/4yjo/PilatesCorrection

game running on a second device, e.g. a laptop. The smartphone app (see Fig. 1 Left) retrieves data from the smartphone's accelerometer. To get information on the lower back posture, the smartphone is mounted on the learner's lower back with tape. The smartphone app provides haptic feedback when the learner has a hollow or round back. The data is also sent to the computer game running on the laptop using a TCP/IP network connection. The computer game reads the data sent by the smartphone and uses it for the control of a virtual rocket (see Fig. 1 Center). The rocket, therefore, tilts based on the position of the back and also changes its color. The straighter the position of the back the less the rocket tilts and the score increases. If the tilt is too much the rocket crashes and this is a game over. This is especially mandatory to avoid actual injuries that could occur when doing an exercise wrong. The game, therefore, includes a basic gamification approach based on the high score.

3 Method

For our evaluation, we tested the setup with six participants (5 females, 1 male) that have a basic knowledge of Pilates. We considered this amount reasonable since the recommended number of participants for the user test is five [NL93]. The age of the participants ranged from 26 to 30. They are all acquaintances and were recruited on personal request. All of them stated to already know the "Kneeling Arm and Leg Reach", however, they all were novices in Pilates.

Each testing session was individual. After entering the testing room, the examiner explained to the participants the purpose of the study, the exercise to be conducted, and basic details about the PCG. The participant was asked to perform the "Kneeling Arm and Leg Reach" exercise. After performing the exercise correctly once, the participant was asked to install the smartphone on their back.

Once the smartphone was in place, the exercise procedure started. The participant clicked the start button and played the game for 40 seconds. The laptop running the game was about 40 cm in front of the participant (see Fig. 1 Right). The participants had a chance to rest for 20 seconds and then restart the exercise procedure. Each participant repeated the exercise three times. Afterward, each participant filled in an evaluation survey.

During the evaluation, the PCG smartphone application was running on a Samsung Galaxy S3 Mini operating on Android Jelly Bean version 4.1.2. The PCG was running on a MacBook Air running Mac OS 10.15.7 with a 13-inch display.

To measure the participants' performance among the three sessions their game score was recorded. To evaluate the PCG, participants filled in an adapted version of the user experience questionnaire proposed by the grand challenge of Multimodal Learning Analytics 2015 [Wo15]. We used this adapted questionnaire because we considered it suitable to get information about the user experience of participants, strengths, and weaknesses of the PCG.

4 Results

The six participants played three games each, accumulating to a total amount of 18 games played for user experience testing. Results of the scores are displayed in Tab. 1. The average score of participants among all sessions was 30.5 out of a maximum score of 40. As seen in Tab. 1. with the exception of two cases, the majority of participants' scores increased from one session to the next.

	P1	P2	P3	P4	P5	P6
Session 1	39	35	2	38	20	Game Over
Session 2	39	27	21	38	29	37
Session 3	Game Over	23	30	40	30	40

Tab. 1: Game scores achieved by the participants in the three game sessions.

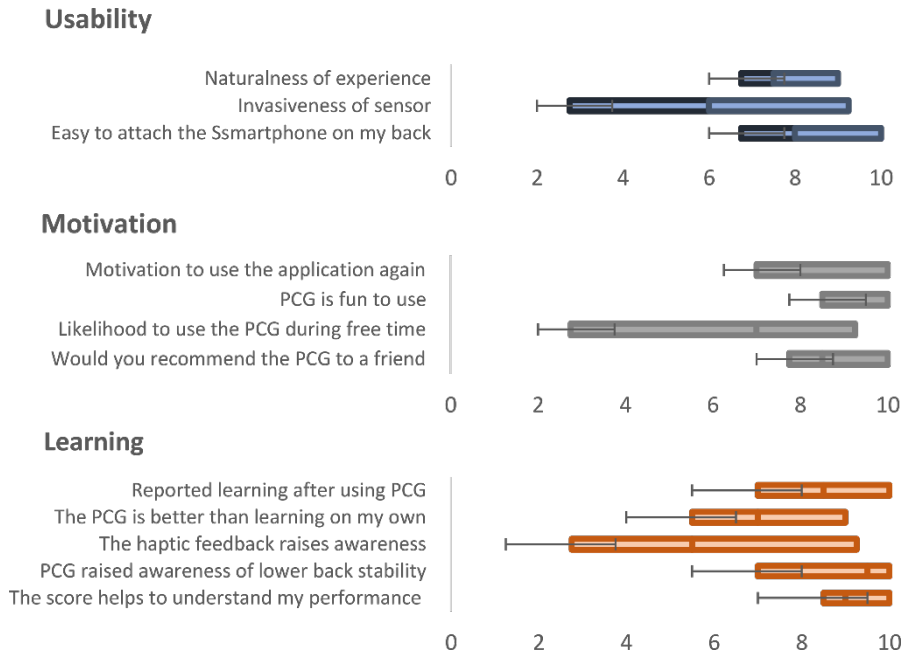

Fig. 2: Reported scores using the adapted UEQ [Wo15].

Results from the closed-ended questions of the user experience questionnaire are displayed in Fig. 2. Participants reported a uniform positive opinion for the majority of the items

with the exception of the usefulness of the haptic feedback, invasiveness of sensors, and likelihood of using PCG in their free time.

When examining the open-ended questions, all participants reported having learned to pay attention to their lower back. The most-reported positive aspects of the PCG relate to the feedback that allows learners to train correctly (6 mentions) and how fun and motivating it is. The most-reported negative aspects of the PCG concern the difficulty to mount the phone in the lower back and not feeling the haptic feedback. Both aspects were reported 3 times. Suggestions to improve the PCG included the addition of levels, multiplayer, selection of vehicles, and feedback reports.

5 Discussion

The user experience evaluation of the PCG allowed us to identify important information on how such a tool is perceived by learners and how to improve it. Concerning our RQ1, results from our study based on the sessions' scores show that learners become better at keeping their lower back in the right posture while doing the "Kneeling Arm and Leg Reach" exercise. The scores corroborate with the participants' reports claiming to have learned to pay attention to their lower back. Hence, showing that the PCG can support learners with the development of basic Pilates skills.

Results from our evaluation show that participants reported being motivated to use the PCG to train Pilates. They generally evaluated the PCG as a fun-to-use application that they would like to recommend to friends. Most of them would use it in their free time. We conclude that our gamified application can motivate learners at home into engaging in physical activity, i.e. Pilates, and hence providing a satisfactory answer to our RQ2.

The main limitations of our study have to do with the number of participants and the short time of using the PCG. A larger and more diverse sample of participants that use the PCG for a longer period of time would provide us with more generalizable results. Moreover, it is important to acknowledge a possible bias of participants mostly based on the selection process. However, we consider that our results present a comprehensive first impression of the PCG. Moreover, our study provided us users' perspectives for future work. In terms of usability, we should explore mechanisms to easily mount the smartphone on the lower back, such as a modified armband used for running. We also want to explore solutions to make the haptic feedback reliable. In terms of long-term usage motivation, our study shows that we should add more levels of difficulty and exercises. Multiplayer options and different choices of vehicles could provide additional gamification aspects.

Overall this study showed how applications such as the PCG that run on commercial devices, can help to motivate people to learn and engage in physical activities and support a healthy mind in a healthy body. As one of the participants commented: "The app is really motivating and makes moving more efficient and safer in a playful way."

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