
DIGITAL EQUITY IN SPORT: 3D VIRTUAL SPORTS PLATFORM TO OVERCOME SEDENTARY LIFE

Erman Yükseltürk [eyukselturk@gmail.com], Kirikkale University, Hasan Erbay [hxe68@yahoo.com], University of Turkish Aeronautical Association, Mehmet Kutlu [mkutlu2012@gmail.com], Istanbul Gelişim University, Turkey

Abstract

The paper is devoted to a newly developed online 3D virtual sports platform that gives an equal opportunity to all members of the community for doing step-aerobic exercise with the help of a so-called virtual specialist trainer thru remote access. The platform serves people to stay healthy and well-being. Herein, the possible effects of a 6-week step-aerobic exercise program on young adult men and women, that have some pre-measured physical fitness values and quality of life, in tertiary education using the platform is analysed. The sampling pool composed of 25 young sedentary students. The physical fitness parameters consisted of height, body weight, body composition (body mass index, body fat percentage), flexibility, anaerobic power, aerobic power (MaxVO₂), and grip strength. The short form of the World Health Organization quality of life scale was used to measure participants' quality of life. Wilcoxon signed-rank test was used to compare the exercise group before and after the program. The data were analysed through SPSS program. The results of the study indicated that there are no statistically significant differences among the participants' average score of physical fitness' parameters. However, only two items of the quality of life questionnaire increased with statistical significance after the exercise program as compared to before.

Abstract in Turkish

Bu makalede, uzaktan erişim yoluyla sanal uzman eğitmen yardımıyla step-aerobik egzersizi yapmak için toplumun tüm üyelerine eşit fırsat veren yeni geliştirilmiş bir çevrimiçi 3B sanal spor platformu incelenmiştir. Platform, insanların iyi ve sağlıklı olmalarına yardımcı olmak için tasarlanmıştır. Çalışmada, üniversitede eğitim alan genç yetişkin erkek ve kadınların platformu kullanarak uyguladığı 6 haftalık step-aerobik egzersiz programının önceden ölçülmüş fiziksel uygunluk değerlerine ve yaşam kalitesine olan olası etkileri incelenmiştir. Örneklem, 25 genç sedanter öğrenciden oluşmaktadır. Fiziksel uygunluk parametreleri boy, vücut ağırlığı, vücut kompozisyonu (vücut kitle indeksi, vücut yağ yüzdesi), esneklik, anaerobik güç, aerobik güç (MaxVO₂) ve kavrama kuvvetinden oluşmaktadır. Dünya Sağlık Örgütü'nün yaşam kalitesi ölçeğinin kısa biçimi katılımcıların yaşam kalitesini ölçmek için kullanılmıştır. Egzersiz programından önce ve sonra ilgili değişkenleri karşılaştırmak için Wilcoxon Sıralı İşaret Testi kullanılmıştır. Veriler, SPSS programı ile analiz edilmiştir. Çalışmanın sonuçları, katılımcıların ortalama fiziksel uygunluk değerleri arasında istatistiksel olarak anlamlı bir fark olmadığını göstermiştir. Bununla birlikte, yaşam kalitesi anketinin sadece iki maddesi egzersiz programından sonra öncekine kıyasla istatistiksel olarak artmıştır.

Keywords: Digital Equity, Virtual Sport, Sedentary Life, Kinect

Introduction

People work to maintain their lives. However, the human organism is less active in developing civilization. In addition, today's technology is drastically reducing people's daily amount of movement. For example, cars minimize our need to walk, and heavy-duty machines complete our day-to-day work for us. Moreover, devices such as televisions and computers, cause us to remain immobile for a long time. One of the methods to avoid these adverse conditions brought about by sedentary lifestyle is to do regular exercises. Research suggests that when people, even the most sedentary people, walk in a short distances and do light exercises in their life,

they can gain significant benefits in terms of health (Buckworth & Nigg, 2004; Çolakoglu, 2003; Çolakoğlu & Karacan, 2006; Nelson & Gordon-Larsen, 2006).

When the effects of exercise on the human organism are examined, positive effects are seen for each age group. The most well-known positive effect is to increase the daily living conditions of individuals. In other words, exercising allows the person to feel more energetic, overcome laziness, and become less tired physically from work. In short, it has been observed that there is a stronger resilience of the person to daily work after regular exercise. Another positive effect of regular exercise occurs on people's health. It affects the heart and circulatory system. Namely, regular exercise reduce the risk of hypertension and heart attack. Furthermore, it helps to improve muscle strength and aids the circulatory system in working more effectively (Çolakoğlu & Karacan, 2006; Medicine, 2013; Penedo & Dahn, 2005; Warburton, Nicol, & Bredin, 2006; Zorba, 1999).

Although regular exercises have multiple benefits, problems such as living conditions, time allocations, lack of facilities and difficulty in reaching specialist trainers make it difficult to do regular exercise and lead people to the more sedentary lifestyle (Deliens et al., 2015; Greaney et al., 2009). Despite all of this, recently developed, advanced technologies supply tools for doing, independent of time and place, regular exercises with the help of a virtual specialist trainer. In this research, by using the Kinect motion detection technology and the internet, an online 3D virtual sports platform is introduced that provides an equal opportunity to do sports in the regular base for all members of the community, especially, those who can't do sports due to various reasons, in addition, provides tools to evaluate their activities in online content. The platform ensures healthy lives and promotes well-being for all at all ages, that is, it serves people to stay "healthy and well-being", among the sustainable development goals of the United Nations (United Nations, 2015). Moreover, the platform falls into "Expanding Access and Equity" meta category outlined in Horizon Report 2018 Higher Education (Becker et al., 2018).

Digital Equity

Digital equity means to create equal access and opportunity to digital tools, resources, and services to improve digital knowledge, awareness, and skills of individuals, diverse groups without discriminating race, ethnicity, socio-economic class, language, and gender. Its aim is to reduce the digital divide among the learners (Yuen et al., 2016). It is known that the networked society does not imply digital equity. In fact, access to digital resources one of the factors achieving digital equity (McLaughlin, 2003). Other factors are responsive and high quality content, assuring skilled educators in using information and communication technology (ICT), and providing tools to both students and educators to create their own content (McLaughlin, 2003). Moreover, Resta and Laferrière (2008) describe five dimensions to achieve true digital equity. The dimensions are (a) accessing to hardware, software and connectivity to the Internet, (b) accessing to meaningful, high quality, culturally relevant content in local languages, (c) accessing to creating, sharing, and exchanging digital content, (d) accessing to educators who know how to use digital tools and resources, (e) accessing to high quality research on the digital technologies to enhance learning.

Digital equity is one of the main challenging issues for education policymakers despite of variety of ICT devices. It is agreed that it is more than just accessing digital technology. We need several solutions consisting educational perspective. For example, pedagogy 2.0 is a framework, it sets strategies for twenty-first century pedagogy in line with the aim of digital equity. It provides learners to engage flexible, relevant learning tasks in the learner's self-direction. It also provides to select which media to access, which resources to exploit, which tools to use and how, when and where to use them (McLoughlin & Lee, 2008).

In addition, as stated in Horizon report for Higher education (United Nations, 2015) main challenges is to scale advancing digital equity to more flexible platforms that improve the future workspace. Educators think that analytic technologies are increasingly adopted by higher

education institutions. Moreover, using the student data gathered through a proliferation of sources, it is expected that adaptive learning technologies and artificial intelligence methods will be adapted to teaching and learning environments. Thus, universities have been taking strides in building platforms for faculty, students and staff to collaborate and become more productive no matter where they are and what time is. In other words, universities have updated their information technologies' infrastructures to provide more flexibility environments in how, when and where people learn. As a result, this study analysed a newly developed online 3D virtual sports platform that gives an equal opportunity to all members of the community for doing step-aerobic exercises.

Kinect technology

Kinect is the most up-to-date image sensing sensor offered to the world markets under the name "Project Natal" by Microsoft in 2010. Compatible with Xbox 360 and Windows operating system, this sensor provides three-dimensional motion capture, face recognition, and voice detection at specified intervals with a depth sensor camera, RGB camera sensor, and quad microphone set. In the Kinect software development kit, the skeleton is made up of 20 joints numbered according to the places in the human body, and images of body movements are processed by following the positions and distances of these joints. Kinect technology allows control and interaction, especially on body movements' software or gaming, without the need for an extra command controller. Because of this feature, it has applications in diverse fields such as games, medicine, and health (Lien et al., 2012; Sales et al., 2011; Tenekeci, Gümüşçü, & Ağırman, 2014).

Due to movement-based technology, there has been an increase in the number of studies on Kinect in the field of physical education and sports for several years. Particularly, in traditional sports training, face-to-face training with one or more people confronts some problems due to high costs as well as time and space restrictions. For this reason, it is suggested that technologies such as Kinect can be used as solutions, given that they are motion capture tools providing high-precision accurate data (Che & Lu, 2014). It also serves digital equity. In these directions, positive results are seen in academic studies. For example, Xbox Kinect technology has been used to restore the equilibrium ability of previously injured young, male athletes, and the method developed using this technology has been described as a valuable, feasible and enjoyable (Vernadakis et al., 2014). In another study, a 3D motion capture and feedback system were used by means of Kinect technology when giving discus training. Positive results were obtained, especially, at the beginning of training (Yamaoka et al., 2013).

In short, the worldwide lack of physical activity is increasingly threatening the health of communities. For this reason, it is very important to develop innovative methods that provide equal opportunities for them to increase their sporting possibilities and help them gain the habit of doing sports. It is known that using the advantages of current and advanced technologies to solve the existing deficiencies and to produce new methods in this area may be a good solution. With the opportunities provided by current and advanced technologies, such as Internet and Kinect, providing simultaneous sporting facilities guided by the virtual trainer in which neither the trainer nor the group has to be in the same room will contribute to the field as an alternative solution. In this study, it is planned to investigate the effects of step-aerobic exercises performed in a new developed 3D virtual sports environment with Kinect. In other words, we explore whether the program could improve the physical fitness and life quality of sedentary university students or not.

Method

In this study, the experimental research design was conducted to analyse the effects of a 6-week step-aerobic exercise program on young adult men and women of some physical fitness values and quality of life through the 3D virtual sports platform.

Setting

The 3D Virtual Sports Platform was designed and developed by researchers with the help of the 3D Studio Max and Unity 3D programs. It is a kind of desktop application and it can be connected to the database on the server over the Internet. It is designed as a two-user system: trainer and participant. In other words, the trainer and participant see different screenshots by providing “username” and “password” to the application.

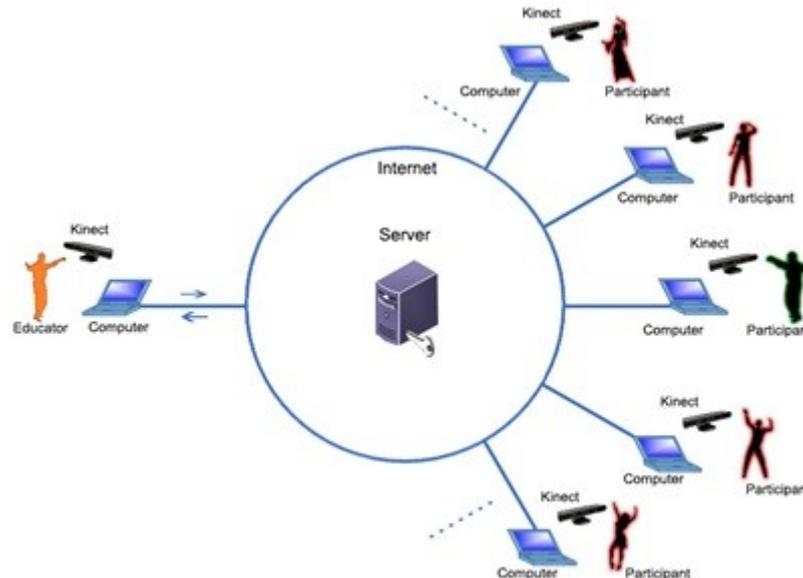


Figure 1. Physical perspective of the 3D Virtual Sports Platform

Using computers connected to Kinect cameras, trainers are able to record programs they want to prepare (such as aerobics programs) by recording the desired sports movements (for example, lifting the right arm 8 times) and combining a large number of recorded movements. For this study, several aerobic-step exercise movements were recorded and a special sport activity program was created from the movements requested by the experts. Those who enter as a participant can select programs created by the experts and perform sports activities. On the screen, participants and the trainer can see the avatar of their bodies and move the avatar with their Kinect cameras. The participants' movements are compared simultaneously with the movements made by the trainer and non-matching body regions are determined at a certain rate, giving a red warning in the screen. The process of comparing the participants' movements with the movements of the trainer was performed using the Dynamic Time Warping (DTW) Algorithm. The DTW, proposed by Sakoe and Chiba (1978), is originated from speech recognition and used to measure the similarity between two-time sequences, that is, it measures the similarity between two sequences that may differ in time and speed. The algorithm is efficiently used in diverse fields such as genetics (Criel & Tsiporkova, 2006), gestures recognition (Corradini, 2001), handwriting (Tappert, Suen, & Wakahara, 1990). The DTW algorithm, detailed in the book by Müller (2007), inputs two time sequences P and Q of size m and n , respectively. Since Kinect camera returns X , Y and Z coordinates for each body joints, each elements of P and Q is a triplet. Then, it computes the matching cost matrix $D(P, Q)$ of size $m \times n$. Then, the optimal warping path $W = \{w_1, w_2, \dots, w_k\}$ obtained. The length of the path W is used as the metric of disparity between P and Q . The results of this comparison are displayed on the screen. Also, after the selected sports program is completed, the average percentages of movement are displayed as an average and recorded as the participant's performance in the database.



Figure 2. Examples of interfaces of 3D Virtual Sports Platform

In addition, the athlete models (avatars) are designed for use on the platform. These 3D models were designed using the Adobe Fuse program. The skeletal structure of the models is specifically drawn and clad in. The greatest feature of these avatars are the connection with Kinect camera, so we can get the X, Y and Z coordinates of the model's 24 points. Also, a web platform is designed by ASP.NET and SQL SERVER to provide some services to trainers and participants. As a trainer, access to the web platform can provide access to the performance of all participants using the platform and participants' information. However, individual performances can be seen when a participant logs on. Thus, users of the 3D virtual sports platform can use the website to access the reports of sports activities they do.

Sampling

The sample of this study consists of 25 sedentary young university students (8 male, 17 female). Their age distribution ranged from 19 to 23 years. Table 1 shows that the average of their heights and their weights were 165.4 centimetres and 58.6 kilos, respectively. While selecting the sample, the following criteria were taken into account:

- volunteering;
- not having previously played sports regularly;
- living a sedentary life;
- no negative results from general health screening;
- no bad habits like smoking and/or alcohol;
- no use of any medication on a regular basis.

Table 1: Properties of participants

	M	SD
Age	20.88	2.07
Height	165.36	9.67
Weight	58.56	16.89

We note that prior to participating in this study, participants signed a written informed consent form in accordance with the ethical principles of the declaration of Helsinki.

A step-aerobics exercise program for the study

In this study, 50 different movements including step-aerobic movements were recorded on the platform. These movements were decided and recorded by three instructors from the Physical Education and Sports Department at a large research university in the central region of Turkey. With the help of these instructors, a step-aerobics exercise program was created by selecting 19 movements from 50 different movements where the platform could be used most efficiently. Information about this program is as follows:

- consists of 19 movements (8 movements per movement);
- applied in 3 sets, each set will last 15 minutes for a total of 45 minutes;
- completed two times per week;
- lasts 6 weeks in total.

Data Collection and Analyses

In this study, in addition to some tests to measure some physical fitness parameters, World Health Organization Quality of Life-short form was used to collect the data. The physical fitness parameters of participants, including height (cm), body weight (kg), body composition (body mass index, body fat percentage), flexibility (cm), anaerobic power (kg. m /sec), aerobic power (MaxVO₂), and grip force (kg) were investigated. These values were measured in the physiology laboratory of the Physical Education and Sports Department of the university.

The short form of the World Health Organization (WHOQOL-BREF) quality of life scale was used to measure participants' quality of life. The psychometric properties of WHOQOL-BREF, the 26-item abbreviated version of WHOQOL-100 have been found satisfactory, and it is a valid and reliable alternative for the assessment of domain profiles using the WHOQOL-100. It is universally regarded as important in assessing the quality of life by 15 field centres of various countries. The validity and reliability study in Turkey was carried out by Eser et al. (1999).

This study was conducted from October to December 2018. Participants and experts were educated about the systems before the study started. The physical fitness' parameters of the participants were measured at the beginning and end of the study. Similarly, they were asked to complete a quality of life scale at the beginning and end of the study. To analyse these collected quantitative data, SPSS tool and t-test (Wilcoxon signed rank test) were used in pre and post training components. The results are presented in tabular values and frequencies.

Finding

The data obtained from the questionnaire and measurements are presented in this section.

Physical fitness' parameters

Table 2 shows that there are no statistically significant differences among the participants' average score of physical fitness parameters before and after the study based on Wilcoxon signed-rank test results.

Table 2: Physical fitness parameters

	Pre-test		Post-test		WSRTest <i>p</i>
	M	SD	M	SD	
Body weight (kg)	58.56	16.89	56.92	17.27	0.239
Body mass index	21.24	4.90	20.67	4.57	0.420
Body fat percentage	19.01	7.39	19.40	7.11	0.085
Flexibility (cm)	34.82	6.47	36.20	5.67	0.299
Anaerobic power (kg-m/second) (Vertical jump test)	84.59	22.17	89.55	20.78	0.334
Aerobic power (MaxVO ₂) (20 m shuttle running test)	25.11	5.19	24.17	2.60	0.190
Grip force (kg)	34.36	13.09	35.35	12.73	0.083

M: Mean, SD: Standard Deviation, WSRTest: Wilcoxon Signed Ranks Test, *p* < 0.05

Quality of Life

Table 3 shows that there is no difference in participants' perceptions of their quality of life before and after the study except for two items. According to the Wilcoxon signed ranks test, the participants' perceptions about the item (How satisfied are you with your health?) increased

at a statistically significant level from the pre- step-aerobics exercise program (M = 3.32) to post- step-aerobics exercise program (M = 3.57). Similarly, the participants' perceptions about another item (How satisfied are you with your ability to perform your daily living activities?) increased at a statistically significant level from pre-program (M = 3.36) to post-program (M = 3.78).

Table 3: Participants' Perceptions of Quality of Life

	Pre-test		Post-test		WSRTest
	M	SD	M	SD	<i>p</i>
How would you rate your quality of life?	3.64	0.64	3.39	0.89	0.134
How satisfied are you with your health?	3.32	0.85	3.57	0.66	0.011*
To what extent do you feel that physical pain prevents you from doing what you need to do?	2.40	1.19	2.39	1.03	0.667
How much do you need any medical treatment to function in your daily life?	1.68	0.95	1.52	0.67	0.751
How much do you enjoy life?	3.88	0.97	3.78	0.90	0.477
To what extent do you feel your life to be meaningful?	3.44	1.12	3.78	0.90	0.197
How well are you able to concentrate?	3.24	0.60	3.09	0.42	0.206
How safe do you feel in your daily life?	3.56	0.92	3.52	0.85	0.803
How healthy is your physical environment?	3.04	1.24	3.39	0.50	0.231
Do you have enough energy for everyday life?	3.88	0.83	4.09	0.60	0.132
Are you able to accept your bodily appearance?	3.92	1.04	3.68	0.84	0.334
Do you have enough money to meet your needs?	3.28	0.68	3.30	0.64	0.813
How much is the information that you need in your day-to-day life available to you?	3.68	0.56	3.83	0.58	0.206
To what extent do you have the opportunity for leisure activities?	3.32	0.75	3.36	0.66	0.74
How well are you able to get around?	4.04	0.68	4.04	0.83	0.963
How satisfied are you with your sleep?	3.08	0.95	3.26	1.05	0.378
How satisfied are you with your ability to perform your daily living activities?	3.36	0.76	3.78	0.74	0.032*
How satisfied are you with your capacity for work?	3.88	0.78	3.65	0.78	0.236
How satisfied are you with yourself?	3.40	1.16	3.91	0.79	0.142
How satisfied are you with your personal relationships?	3.88	0.67	4.00	0.74	0.477
How satisfied are you with the support you get from your friends?	3.92	0.91	3.87	0.82	0.935
How satisfied are you with the conditions of your living place?	3.80	1.26	4.00	0.67	0.329
How satisfied are you with your access to health services?	3.60	1.16	3.48	1.04	0.499
How satisfied are you with your transport?	3.44	1.04	3.35	0.94	0.71
How often do you have negative feelings such as blue mood, despair, anxiety, depression?	3.20	0.76	2.96	0.77	0.18
What are your difficulties with regard to pressure and control in your relationships with those close to you (spouse, colleague, relative)?	2.76	0.83	2.61	0.72	0.593

M: Mean, SD: Standart Deviation, WSRTest: Wilcoxon Signed Ranks Test, $p < 0.05$

Discussion and Conclusion

It is possible to maintain a healthy and happy life by extending regular exercise into a lifestyle. However, the increasing adoption of modern life is causing an immobile lifestyle to spread. Sedentary life causes people to have difficulty even in daily activities and is seen as the beginning of many diseases (Buckworth & Nigg, 2004; Çolakoğlu & Karacan, 2006; Genç et al., 2011). Although the researchers have indicated a positive relationship between physical activity and health, they agree that people do not exercise as much as they should (Deliens

et al., 2015; Greaney et al., 2009). The widespread sedentary lifestyle is increasingly threatening the health of communities. Therefore, it is very important to offer alternative methods to increase the sporting possibilities of people and to help them gain the habit of doing sports.

On the other hand, improvements in ICT introduced new learning policies such as the equal distribution of ICT to all learners, i.e. digital equity should be satisfied since ICT has an important role in the twenty-first century's learnings as well as modern life. Digital equity has different dimensions as such access to meaningful, high quality, culturally relevant content and access to creating, sharing, and exchanging digital content (Resta & Laferrière, 2008). To advance in digital equity, these dimensions must be achieved (Pittman, McLaughlin, & Bracey-Sutton, 2008).

In addition, the United Nations have announced seventeen sustainable development goals to be fulfilled, by all countries in a global partnership, for peace and prosperity for people and the planet, now and into the future (United Nations, 2015). They acknowledge that poverty and other deprivations can be terminated with strategies improving health and education, reducing inequality in all aspects (United Nations, 2015).

In this study, the 3D virtual sports platform was designed as an alternative method for sport exercise with equal access and opportunity to all members of the community. The platform ensures healthy lives and promotes well-being for all at all ages, that is, it serves people to stay "healthy and well-being", among the sustainable development goals of the United Nations (United Nations, 2015). Moreover, the platform falls into "Expanding Access and Equity" meta category outlined in Horizon Report 2018 Higher Education (Becker et al., 2018). We analysed the effects of a 6-week step-aerobic exercise program on this virtual platform to young adult men and women with some physical fitness values and quality of life.

The results of this study indicated that there are no statistically significant differences among the participants in terms of the average physical fitness scores, but, only two items in the quality of life questionnaire increased with a statistically significant difference from before to after the exercise. The reasons why there is no change in participants' physical fitness parameters and perceptions at almost all items concerning quality of life might be related to virtual platform or exercise programs. For example, the six-week program might not be enough time for seeing changes in results. Also, the participants might not have been able to adapt since they were using the system for the first time. On the other hand, the results showed that participants were more satisfied with their health and performing their daily living activities after the exercise program. Actually, these findings were not entirely surprising, because they replicated many of the existing findings from the literature. It is known that when people walk a short distance in their life, they can gain significant benefits in terms of health (Buckworth & Nigg, 2004; Çolakoglu, 2003; Çolakoğlu & Karacan, 2006; Nelson & Gordon-Larsen, 2006).

Some potential limitations of this study should also be considered when discussing the results. The study sample was composed of young adult men and women with some physical fitness values and quality of life. The study was carried out without diet or nutrition control. Also, the study population consists of only 25 young, sedentary university students, which limits the generalizability of the results. Extending the population to various ages, weights and occupations could produce different results.

In brief, researchers agree that doing regular sports is useful for a better quality of life and health, regardless of whether one is competing at the top level or walk in the park. Also, the developments in science and technology, and the advances in medicine have raised the average lifespan (Genç et al., 2011). As a result, the need for doing sports is increasing. Despite the high opportunity for participating in regular sports in developed countries, it is observed that in developing countries this opportunity is not sufficiently widespread, unfortunately, and the rate of sports per capita is not at the expected level (Aydın, 2008; Sunay, 2003). Therefore, the developing and disseminating sports facilities is more important. It could

be concluded that one of the ways to find a solution to this situation is to use several advanced technologies in order to provide sports facilities to everyone.

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