Opportunities, Issues and Best Practices in Online Education and Examination of University Students

PHYSICAL ACTIVITY INTERVENTIONS: EFFICIENCY OF DIGITAL APPLICATIONS

Pınar Tanrıverdi, Salih Pınar
Marmara University (Turkey)

Abstract. Aim: The aim of this study is to investigate the effects of digital interventions in increasing the level of physical activity.

Methods: Studies on the effects of digital interventions on the level of physical activity in the literature were examined in detail and then a "Comprehensive Digital Intervention Model" was designed. In order to examine the effects of the model, which was created in order to be more effective, a project was created with the code name "More Active, More Health" to obtain a healthy lifestyle habits. Volunteers were reached to participate in the project through various digital channels. Interventions were delivered to the participants through the mobile application platform called Pacer for the implementation of the experiment. Experimental group 190 and control group 192 people were compared to six-week step numbers and put into statistical tests.

Results: It was observed that the interventions based on the comprehensive digital intervention model contributed to the physical activity level of the experimental group. It was also observed that the participant's follow-up on self and using the social features to the level of physical activity. There were differences in the average number of steps in terms of topics such as education level, gender and income level of the experimental group. It was observed that the measures taken with the corona epidemic caused the number of daily steps to decrease dramatically.

Conclusion: It has been determined that digital interventions using this study model designed are efficient to increase the number of daily steps.

Keywords: self-determination; social media; gamification

Introduction

Although the development of technology is instrumental in advancing in many areas, it also causes some negative situations on human life to arise. One of these disadvantages is that it triggers a sedentary lifestyle. To prevent this, there are studies on physical activity interventions (Muray & Hekler, 2016). Various digital interventions have become widespread recently, especially through mobile applications. The most common form of use is that users have an idea

of how physically active they are via mobile phones and are beginning to take appropriate measures. Today, these interventions on digital platforms are a center of attraction for researchers. This situation, in a way, allows the negativity of technology to be eliminated by using technology. There are many publications in the literature about the benefits of these applications. However, its features that can be improved are also mentioned.

It supports the assumptions that digital interventions will work in this area in many publications. Computer software, web-based applications or smart phone applications used for digital intervention can be easily improved to make better (Kirwan and Others, 2012; Glynn and Other, 2014). It is a very important advantage in response design. These and similar technologies are very promising with some features. These features are; scalable, needing less budget, accessing multiple features with less cost and modification opportunity for real-time improvement (Afshin and Others, 2016).

There are many differences their effects between digital interventions and non-digital, such as i.e. face-to-face consultation (Barak, Hen and Boniel-Nissim, 2008; Steele, Mummery and Dwyer, 2009; Müller and Others, 2016). But digital ones have serious differences compared to others. For example, mobile health (mHealth) interventions can offer many exclusive innovations as solutions. Similarly, the common result of many studies; In order for the intervention to result in the most effective way, it must be designed to be suitable for the content.

The effects of electronic health interventions have controversial results. One reason for this may be related to the fact that the average age of the participants was higher than 50 in some studies and that this age group was more likely to use a computer than a smartphone. In some studies, it has been argued that it is the most effective method to perform healthy interventions via e-mail and telephone (Conn, Hafdahl & Mehr, 2011).

In a study conducted on 127 physical activity applications in the Apple application market, it was seen that very little scientific health content was used (Cowan and Others, 2013).

Afshin et al. (2016) evaluated all digital intervention studies including internet, sensor, mobile and a combination of these. However, they suggest that only 4 of them have mobile-based health interventions and there are no significant differences in their results. They suggest that the results of these studies should be rigorously reviewed to reflect the truth. They emphasized that for future studies, the experiment and analysis should be combined with the same methodological design.

In studies, it is recommended to use accelerometers in devices or GPS in smart phones to be more reliable and objective in order to access data with higher accuracy (Bort-Roig, 2014).

In this study, 18 – 65 years without drawbacks in the exercise of a citizen of the Republic of Turkey has joined contacts. Participants own a smartphone and can

use it actively. They have joined the platform called Pacer used for experimenting with their own devices. 129 women with averages of 31.28 ± 10.47 years, 165.48 ± 6.9 height, 67.4 ± 14.5 weight in the experimental group (n = 190); 61 men with averages of 31.64 ± 12.10 years, 176.9 ± 7.4 height, 76.4 ± 11.75 weight participated. 137 women with a mean age of 29.24 ± 8.55 in the control group (n = 192); 55 men participated with an average age of 36.29 ± 9.11.

In the first stage of the research process, interventions that prevent inactivity or increase physical activity level, which is one of the most common problems of our age, are examined, and in the next stages, an evaluation of how an appropriate model can be applied using a mobile application is included. Our study includes the "Comprehensive Digital Intervention Model" design by making use of the references of past studies and marketing strategies in the world of mobile applications. The result of the experiment with the developed intervention sets depends on this model, it was concluded that it had a promising effect on the level of physical activity and there are no significant differences from simple intervention sets.

Aim and objectives of the study

We claim that the digital intervention which is developed by using the Comprehensive Digital Intervention model will be an effective tool to increase the physical activity level. The following items are listed as our hypotheses for this study. One of the aims of the study is to investigate the accuracy of these hypotheses. Another aim is to examine the effect of pandemic on physical activity level.

– Digital interventions developed on the basis of behavioral change, according to digital interventions performed without adhering to any theory; increases people's physical activity level.

– In the digital intervention designed to increase physical activity, when constructive feedback is received using social media, there will be more significant difference in the level of physical activity than depending on when social media is not used as a tool.

– Adding gamification and social mechanics to digital intervention design to increase physical activity will be more effective than digital intervention without these mechanics.

– In the digital intervention design to increase physical activity, as a hybrid: gamification; Adding social mechanics and / or using digital interventions based on constructive feedback using social media and / or behavior change, increases the level of physical activity of people.

Methods

Our working method consists of 3 main sections. The first part covers detailed literature review, evaluation, having sufficient insight about the subject and

designing a proper model which is called "Comprehensive Digital Intervention". The second stage, it covers whether the model was constructed correctly and the design of the appropriate experiment to evaluate its benefits. In the final stage, the data we obtained with the experiment were analyzed statistically.

Designing Comprehensive Digital Intervention Model

At this stage, the publications we have accessed were primarily evaluated in detail. There are many sources in the literature about the problems caused by the lack of physical activity. However, there are many studies showings that it can be improved with digital and other interventions. Table 1 represents of Comprehensive Digital Intervention Model as a framework to assist for creation intervention sets.

Table 1. Comprehensive Digital Intervention Model

Comprehensive Digital Intervention Model			
Pillars	Self Determination Theory	Gamification Basics	Social Media Effects on Behavior
Principles	Autonomy, Competence, Belonging	Mechanical, Dynamic, Emotions	Content, People, Communication
Features	News feed, profile page, forum, follower	Points, leaderboard, Awards, Status, Points, Level	Content Card, Share, Comment, Like, Messaging

Some of the studies that address the pillars of comprehensive digital intervention model and examine the effects of interventions are listed below.

– **Effect of Social Media on Physical Activity**

Another remarkable finding is that the results of the increase in physical activity by the participants share social media positively. Supportive comments that increase motivation from social media strengthen the impact of the intervention (Payne and Others, 2015). So far, many interventions have not been intertwined with social media (Müller and Others, 2016). This idea actually gives us an idea to try a new way for future work.

In a different study we encountered while examining the impact of social media, the concluded that social networks increase physical activity. It says that the sports together are maintained for a longer period of time (Hunter and Others, 2015). We can also mention that social media can contribute to doing sports in a sustainable way, as it indirectly allows participation in real-life social networks.

In a study on an application following the level of physical activity, it shared remarkable results. New connections established through the social media feature on the application have been shown to increase in-app activities by

30%, traffic by 17% and the level of physical activity in the real world by 7% (about 400 steps more) (Althoff and Others, 2017). Azumio Argus application was used to measure the changes here. The analyzed data were collected in five (2011 – 2016) years through the mobile application, which is a global participant. Users created approximately 631 million sharing of sports activities during this time. The number of steps followed through the application is installed on the phone is approximately 824 billion. As a result of this data, more the number of connections on the application means more steps. In another finding, those who submit follow-up requests are mostly active, but those who accept follow-up requests have a visible difference in physical activity level for a while (Althoff and Others, 2017). The amount of increase in the level of physical activity continues to increase with each new connection. It was seen that women are more open to change and show greater resistance to change in both genders as they get older. Another interesting value is that when a man sends his connection request to his fellow man, there is a 37% increase in activity level, and there are fewer changes in behavior for those who send it to women (Althoff and Others, 2017).

The Effect of Gamification on Physical Activity

According to the systematic evaluation for studies on mobile applications in which gamification is used to acquire healthy habits, 64 of 1680 health applications used gamification. Of these, 94%, 60 of them have feedback and monitoring, 81%, 52% of them have reward and education, and 52 of them have objectives and planning. It was concluded that the outcomes regarding the behavior change in healthy living habits remained below its potential (Edwards and Others, 2016).

One of the interesting findings is some phone applications that have gamification mechanics are much more effective than those which do not use gamification (Payne and Others, 2015).

We thought that knowing the principles on which gamification was based would make sense to use in our new model. In our research on this, we found a study that gathered principles like mechanics, dynamics, and emotions (Robson and Others, 2015). It helped to create the new model's gamification module.

The Effect of Behavior Change Theory on Physical Activity

Behavioral change techniques and specific behavioral therapy have been observed to have a significant effect on positive health attitudes (Zhao, Freeman & Li, 2016). In fact, it is argued that interventions based on behavioral change are more effective than those made without adhering to any theory. There are many studies in this field without using any theory or even mentioning it. This is another issue to be considered for future research.

In order to be efficient in the targeted motivation when designing a digital intervention, considering the needs of human psychology, it is extremely important to comply with the basic principles of "Self Determination Theory" (Weman-Josefsson & Fröberg, 2015).

Performing the experiment

In our experiment, have prepared digital interventions based on the comprehensive digital intervention model. These interventions were applied only to the experimental group, and the control groups will be exposed only to simple digital interventions that are already in the Pacer application, which is a mobile step counter and social health platform and we use it as the experimental environment.

Before starting the study, ethics committee approval was received from Marmara University Health Sciences Institute on April 2, 2018 with a protocol number 117 with a PhD thesis.

The experiment started with the announcement of the project. The announcement was made through the website more active and healthier (www.dahaaktifdahasaglikli.com) and through various social media channels. Following the announcement, the ones who were participate in the project by filling in the application form and joined in the official project group on the Pacer application and the steps were started to be logged. This study is being carried out by volunteers who are citizens of Turkey, the difference between the weekly average of the number of steps between the experimental group and the control group were examined.

Data Collection

The number of steps, physical activity level, demographic data such as age, gender, etc. were obtained from participants through digital forms or devices in the study.

The volunteers who participated in the research get involved in the 2-step project detailed on the website. The first step is to fill the forms and accepts terms&conditions. After the first step downloaded the Pacer mobile application, which was the most important step. Afterward, they participated in the official Pacer group prepared for those in the experimental group from the project participants. During the experiment, we sent the digital interventions prepared according to the comprehensive digital intervention framework to the participants or shared them on this group wall via the Pacer application.

Participants in this group which means the experimental group, whose daily and weekly steps were logged via Pacer. The weekly step numbers of the control group were also logged via Pacer. The control group is collected from different groups which are established in Turkey and excluded The More Active, The More Healthy group.

Results

Have been listed some relations with the experimental group's average steps count below. Next, have been shown the result of the comparison between the experimental and the control group.

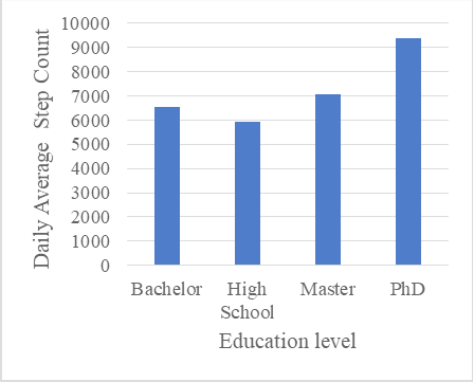

Figure 1. Distribution of step numbers depending on the education level of the experimental group volunteers

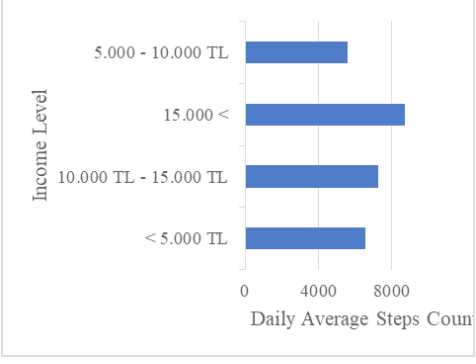

Figure 2. Distribution of step numbers depending on the income level of the experimental group volunteers

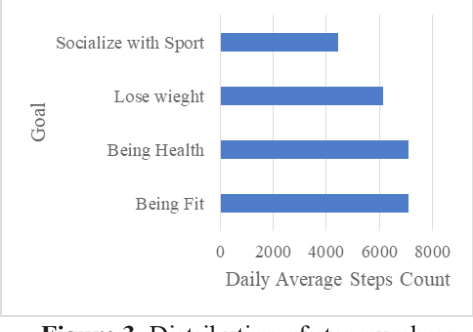

Figure 3. Distribution of step numbers depending on their own project goals of the experimental group volunteers

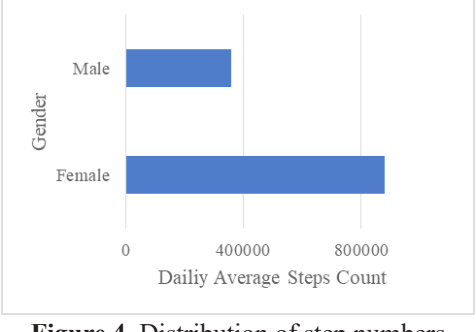

Figure 4. Distribution of step numbers depending on their gender of the experimental group volunteers

Statistical Analysis of the Difference Between Experimental and Control Groups

After the t test performed for comparing the number of steps obtained for 6 weeks of the experiment and control group participants, there was no significant difference ($p < 0.05$) in terms of statistical analysis in the average number of steps per week per person of the experiment and control group ($t_{(0,05 : 353)}=1304$). However, it was seen that the average number of steps of the participants of the experimental group was higher for each week. Table 2 has summary of the t-test result.

Table 2. T-test result table of experiment and control group comparison

Group	N	Avarage	Ss	t	df	p
Experimantal	176	15351.81	28655.26	1.304	353	0.193
Control	179	12154.69	15834.12			

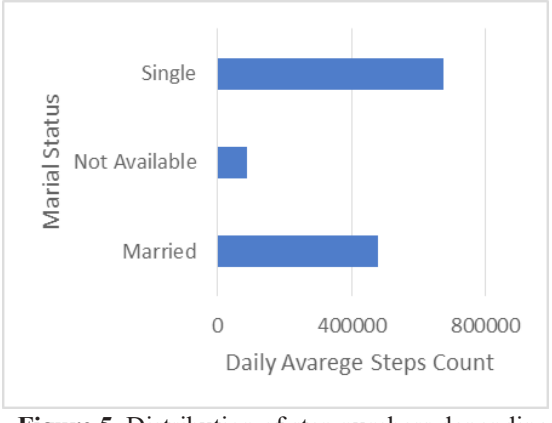

Figure 5. Distribution of step numbers depending on their marital status of the experimental group volunteers

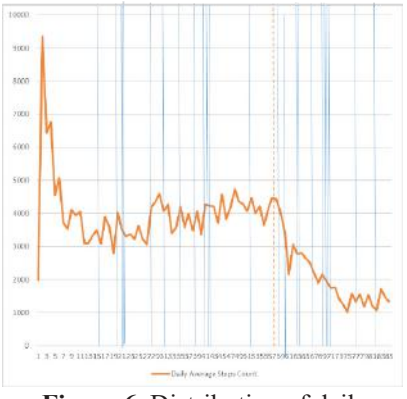

Figure 6. Distribution of daily experimental group volunteers average step numbers depending on the effects of the interventions

Discussion

Half of the twelve weeks were used to familiarize the experimental group participants with the Pacer platform and reach a sufficient number. It has been used for the last 6 weeks to perform the experiment and to observe the differences between the control group. Keeping the experiment period longer in future studies will allow more data and participants. However, the limitations and assumptions of the applied experiment should be taken into consideration when evaluating the results. These constraints and assumptions;

– In this study, only between 18 and 65 years old who are citizens of Turkey and able to do exercise could have been participant.

– This study was limited as participants using smart phones with IOS or Android operating system.

– In order for the measurement results to reach the research team, the Pacer mobile application must be opened on the mobile device by the participant at least once every day and step count could have been logged only if the user carries own mobile phone.

– The samples are considered to be ready to develop habit. Because the ones who came by clicking on our social media ad prepared specifically for the project call to meet those who are ready for change formed the sample group.

– Have accepted that Pacer application, which is our data collection tool, works correctly in the same conditions and with the same sensitivity in each participant.

– Participants were considered to be adequately motivated for six weeks.

– It was accepted that all participants were exposed to digital interventions under equal conditions.

– It has been accepted that the texts used in digital interventions will be clearly understood by each participant, without causing different meanings and interpretations.

Suggestions

– One of the difficulties encountered during the study was the high number of participants, leading to restrictions in personal interventions. It is thought that more effective and personal digital intervention contents can be produced and delivered by using machine learning technologies through a crowded team or a longer-term study.

– The corona epidemic in the part of the realization phase of the experiment and the lockdown measures taken affected the number of steps. When we examined the literature, a study examining how the physical activity level was affected in an epidemic was not found.

– In another prominent finding, the physical activity level starts to draw an increasing graph in the experimental group after the weekends and after the intervention. When we examine similar studies in the literature, simultaneous reactions after the intervention were not mentioned. In this respect, it is one of the first studies that talked about the changes immediately after the digital intervention.

– Similar to a different study conducted in the literature (Muntaner et al., 2015), in this study, it can be stated that most of the participants are women, similar studies, that women are more interested in the healthy life project, or that women are consuming more contents about changing lifestyle in digital channels.

– In the middle of the experimental timetable, it has a direct impact on the research results in the announcement of the World Health Organization's Pandemic and precautionary measures in our country. The decline in the level of physical activity can be clearly seen. Therefore, when everything returns to normal, it would be appropriate to repeat a similar study with a more crowded team and to activate the machine learning infrastructures from the first day.

In summary, considering the situations already in the literature and mentioned above, it seems that it is possible to increase the level of physical activity with digital interventions. In addition to this, the model we designed for how to do digital interventions more effectively and the findings I obtained as a result of our experimental study we designed to test this model; Although more effective digital interventions increase the level of physical activity, it seems to support our hypothesis, but the fact that there was no statistically significant difference compared to the control group refuted the accuracy of our hypothesis or left a question mark in the way we conducted the experiment. We believe that research and measurements based on the citations of the studies in the literature and the model we created at the end of our own analysis will be a pioneer for the advances in this field.

REFERENCES

Afshin, A., Babalola, D., Mclean, M., Yu, Z., Ma, W., Chen, C. Y. & Mozaffarian, D. (2016). Information technology and lifestyle: a

systematic evaluation of internet and mobile interventions for improving diet, physical activity, obesity, tobacco, and alcohol use. *Journal of the American Heart Association*, 5(9), e003058.

Althoff, T., Sosič, R., Hicks, J. L., King, A. C., Delp, S. L., & Leskovec, J. (2017). Large-scale physical activity data reveal worldwide activity inequality. *Nature*, 547(7663), 336–339. doi:10.1038/nature23018

Barak, A., Hen, L., Boniel-Nissim, M. & Shapira, N. (2008). A comprehensive review and a meta-analysis of the effectiveness of Internet-based psychotherapeutic interventions. *Journal of Technology in Human Services, 26*(2 – 4), 109 – 160.

Bort-Roig, J., Gilson, N. D., Puig-Ribera, A., Contreras, R. S. & Trost, S. G. (2014). Measuring and Influencing Physical Activity with Smartphone Technology: A Systematic Review. *Sports Medicine,* 44(5), 671 – 686.

Conn, V. S., Hafdahl, A. R. & Mehr, D. R. (2011). Interventions to increase physical activity among healthy adults: meta-analysis of outcomes. *American journal of public health*, 101(4), 751 – 758.

Cowan, R.E., Nash, M.S. & Anderson, K.D. (2013). Exercise participation barrier prevalence and association with exercise participation status in individuals with spinal cord injury. *Spinal Cord*. 51(1):27 – 32. doi:10.1038/sc.2012.53

Edwards, E.A., Lumsden, J., Rivas, C., et al. (2016). Gamification for health promotion: systematic review of behaviour change techniques in smartphone apps. *BMJ Open,* 6:e012447. doi: 10.1136/bmjopen-2016-012447

Hunter, F., McAneney, H., Davis, M., Mark, T., Thomas, V. & Kee, F. (2015). "Hidden" Social Networks in Behaviour Change Interventions. *American Journal of Public Health*, Vol 105, No. 3

Murray, E., Hekler, E.B., Andersson, G., Collins, L.M., Doherty, A., Hollis, C., Rivera, D.E., Robert, W. & Wyatt, J.C. (2016). Evaluating Digital Health Interventions: Key Questions and Approaches, *American Journal of Preventive Medicine*, 51 (5), pp. 843 – 851.

Muntaner-Mas, A., Vidal-Conti, J. & Palou Sampol, P. (2015). Increasing physical activity through mobile device interventions: A systematic review. *Health informatics journal*. 22. 10.1177/1460458214567004.

Müller, A., Alley, S., Schoeppe, S. & Vandelanotte, C. (2016). The effectiveness of e-& mHealth interventions to promote physical activity and healthy diets in developing countries: A systematic review. *International Journal of Behavioral Nutrition and Physical Activity*. 13. 10.1186/s12966-016-0434-2.

Glynn, L. G., Hayes, P. S., Casey, M., Glynn, F., Alvarez-Iglesias, A., Newell, J. et al. (2014). Effectiveness of a Smartphone Application

to Promote Physical Activity in Primary Care: the SMART MOVE Randomised Controlled Trial. *British Journal of General Practice*, 64(624), 384 – 391.

Kirwan, M., Duncan, M. J., Vandelanotte, C. & Mummery, W. K. (2012). Using Smartphone Technology to Monitor Physical Activity in the 10,000 Steps Program: A Matched Case–Control Trial. *Journal of Medical Internet Research*, 14(2), e55 – 10.

Payne, H. E., Lister, C., West, J. H. & Bernhardt, J. M. (2015). Behavioral Functionality of Mobile Apps in Health Interventions: A Systematic Review of the Literature. *JMIR mHealth and uHealth*, 3(1), e20 – 9.

Payne, H. E., Moxley, V. B. & MacDonald, E. (2015). Health Behavior Theory in Physical Activity Game Apps: A Content Analysis. *JMIR Serious Games*, 3(2), e4 – 13.

Robson, K., Plangger K., Kietzman, J., McCarthy, I. & Pitt, L. (2015). Is it all about game? Understanding the principles of gamification. Kelley School of Business, Indiana University. Published by Elsevier Inc. *Business Horizons*, Vol. 58, Issue 4, July – August 2015, Pages 411 – 420.

Steele, R. M., Mummery, W. K. & Dwyer, T. (2009). A Comparison of Face-to-Face or Internet-Delivered Physical Activity Intervention on Targeted Determinants. *Health Education & Behavior,* 36(6), 1051 – 1064.

Weman-Josefsson, K., Fröberg, K., Karlsson, S. & Lindwall, M. (2015). Mechanisms in Self-Determined Exercise Motivation: Effects of a Theory Informed Pilot Intervention. *Current Psychology*, 36(1), 90-100. doi:10.1007/s12144-015-9388-9

Zhao, J., Freeman, B. & Li, M. (2016). Can Mobile Phone Apps Influence People's Health Behavior Change? An Evidence Review. *Journal of Medical Internet Research*, 18(11), e287 – 12.

✉ **Pınar Tanrıverdi**
ORCID ID: 0000000160574047
Faculty of Sports Sciences
Marmara University
Istanbul, Turkey
E-mail: pinartanriverdi@gmail.com

Salih Pınar
ORCID ID: 0000000183997835
Faculty of Sports Sciences
Marmara University
Istanbul, Turkey