INTERNATIONAL JOURNAL OF PERFORMANCE ANALYSIS IN SPORT
2019, VOL. 19, NO. 1, 110–120
https://doi.org/10.1080/24748668.2019.1570457

Routledge
Taylor & Francis Group

he e ect of electronic body protector and gami cation on the performance of taekwondo athletes

Duygu Sevinç and Mergül Çolak

Department of Physical Education and Sports, Erzincan Binali Y ld r m University, Erzincan, Turkey

BSTR CT

The aim of the study is to analyze changes in the performance of taekwondo athletes after training with an electronic body protector and the e ects of gami cation on this change. The study included 15 licensed taekwondo athletes between the ages of 10 and 13 training in a private taekwondo hall. The three techniques most frequently used in matches were selected according to the level of difficulty and the athletes followed a three-month training program. In addition ve athletes were interviewed to determine the e ects of using the electronic body protector system and the gami cation components on their performance. The results showed signi cant di erence between the mean scores of all three taekwondo techniques over time. The data obtained through interviews indicated that training with an electronic body protector improved the participants condition and technical skills and also helped them learn the correct use of the techniques. The electronic body protector was observed to indirectly a ect performance. The participants emphasized fair scoring for everyone as the electronic body protector was perceived as an objective system. Announcement of the scores of each measurement on the scoreboard was reported to increase competition improvement and motivation.

RTICLE HISTORY
Received 27 June 2018
Accepted 13 January 2019

KEYWORDS
Electronic Body Protector; gami cation; performance; taekwondo

1 Introduction

Participation in taekwondo competitions has increased in recent years after it was accepted as an Olympic sport. However, the bias in scoring, which is assessed according to the referee s opinions (Ko et al., 2014; Partridge et al. 2005), has led to the search for new competition systems. The World Taekwondo Federation has decided that the performance of athletes during competitions should be assessed using an electronic system to more accurately assess their performance and to eliminate doubts (Chi, 2005).

This electronic system consists of an electronic body protector and an in-step protector. The sensors in the electronic body protector and on the in-step protector automatically transfer the scores to the scoreboard when su cient pressure is generated through the use of the correct technique (Del Vecchio, Franchini, Del Vecchio, Pieter, 2011; Partridge et al., 2005). This system, in which the strength of kicks, punches

CONTACT Mergül Çolak mcolak@erzincan.edu.tr Department of Physical Education and Sports, Erzincan University, Erzincan, Turkey

and strikes are adjusted according to the category and weight of the athletes, provides a more objective assessment and gives fairer results than subjective scoring by a referee (Chi, 2008; Song et al., 2010b; Song, Woo, Min, Lee, 2010a; Tasika, 2013).

Electronic systems help to analyse the performance, strength and technical capacity of the athletes as well as helping them improve their skills and monitor this improvement (Leveaux, 2010; Tornello et al., 2014). In addition, these systems help to develop strategies, motivate athletes and provide objective feedback (Ball et al. 2011; Kim, Stebbins, Chai, Song, 2011; Tornello et al., 2014).

Setting concrete and achievable goals, motivating athletes, and providing objective feedback play an important role in teaching and improving technical skills in taekwondo, particularly during trainings of children (Elliot Harackiewicz, 1994). Gami cation can be an effective method to put these actions into practise.

Gami cation can be de ned as the use of game philosophy, components and design techniques out of the context of game theory to increase motivation and encourage athletes to solve problems (Deterding, Dixon, Khaled, Nacke, 2011; Werbach Hunter, 2012; Zichermann Cunningham, 2011). Although teaching via games or gami cation basically has the same structural factors, teaching factors are integrated into games in "teaching via games", whereas game components are integrated into existing teaching factors in "gami cation" (Çağlar Kocadere, 2015; Fi Erümit Karaku , 2015). In other words, games are used as a tool to ensure learning within game-based teaching (Bozkurt, 2014), whereas game components such as stars, badges, levels and a leaderboard are integrated into the teaching environment in gami cation instead of centralising a game. Therefore, gami cation yields effects similar to those of games per se (Huotari Hamari, 2012).

Although gami cation is a new concept, it has already been used in many elds, such as business, marketing, health, sports, education and social media platforms. For example, applications such as Foursquare, eBay and Samsung Nation are social platforms designed based on gami cation. An example from the elds of health and sports is Nike Plus, a social tness application developed in cooperation with Apple that aims to increase the desire of its users to participate in sports in acompetitive environment. With this application, users determine their running time and distance using a wristband and try to surpass their own scores while competing with other users. They are entered in the leadership board by ful ling tasks such as running a certain distance in a competition. In addition, they can instantaneously share information about their daily sports in their social network pro les, each "like" is reflected as a cheering sound on the music they listen to while running, and they receive feedback about being supported by their friends while doing sports.

In addition to the effects of gami cation in the social media eld, studies that have been published on education up to today indicate that it leads to positive results in teaching, although these studies are in limited number (Samur, 2015). These studies show that gami cation has several positive effects: creating an entertaining learning environment (De-Marcos, Domínguez, Saenz-de-Navarrete, Pagés, 2014; Kocadere Çağlar, 2015), increasing motivation (Kocadere Çağlar, 2015; Sillaots, 2014; Su Cheng, 2015), increasing competition between individuals (De-Marcos et al., 2014), arousing a sense of flow (Kocadere Çağlar, 2015; Sillaots, 2014), ensuring commitment to the environment, and increasing academic success (Hanus Fox, 2015; Ibáñez, Di-Serio, Delgado-Kloos, 2014; Su Cheng, 2015).

However, these studies have been conducted mostly in the context of computer sciences and information and communications technologies; scarcely any of them have been conducted in the realms of health and sports (Dicheva, Dichev, Agre, Angelova, 2015; Karata , 2015). In parallel with this, the literatüre on taekwondo was found to include a limited number of studies analysing the effects of electronic systems on performance (Partridge et al. 2005; Song et al., 2010b, 2010a).

For this reason, this study aimed to analyse performance changes in taekwondo athletes after training with electronic body protectors, and the effects of gami cation on this change. This study is expected to contribute to the literature, which includes a small number of studies, by integrating the use of electronic body protectors and gami cation in sports education, which are both newly introduced concepts.

2 Methods

This study aimed to analyse changes in the performance of taekwondo athletes after training with electronic body protectors (Figure 1), and the effect of gami cation on this change. For this purpose, this study was designed using a mixed research method in which both qualitative and quantitative research methods were used.

2 1 Study sample

The study sample consisted of 15 licensed taekwondo athletes between the ages of 10 and 13 years who train in a private taekwondo hall. The athletes are in the red-black (1. GIP) belt category and above belt category and have been practising for the past 2 years. The participant athletes in the same age category have never practised with electronic body protector.

2 2 Study design

Various approaches have been used in the design of gami cation, as in the studies of Nicholson (2015) and Simões, Redondo, and Vilas (2013). The design model of gami cation of Werbach and Hunter (2012) was used in the present study. This model is based on both the organisational objectives and the characteristics of the individuals and consists of six steps, as follows: 1. De ne business objectives, 2. Delineate target behaviours, 3. Describe your players, 4. Devise activity loops, 5.

Figure 1 Electronic body prodector and instep protector with sensors.

Figure 2 Study design.

Don t forget the fun and 6. Deploy the appropriate tools. Figure 2 shows the research design prepared based on these steps.

2 3 Training programme and data collection

The parents of the athletes were informed about the study, and their permission was obtained to collect technical data from their children before starting the study. The three techniques most frequently used in matches were determined based on their level of di culty, to improve the technical skills of the athletes and to monitor changes in their performance. The score values determined by the World Taekwondo Federation were used to score the techniques: Palding-chagi = 1 point; jump front turning Palding-chagi = 1 point; and 360 turning Palding-chagi = 3 points.

One of the researchers, Taekwondo trainer, administered 2-h training programme 3 days a week for 3 months. The athletes practised the Palding-chagi, jump front turning Palding-chagi and 360 turning Palding-chagi techniques with electronic body protector adjusted on an average pressure of 20 bar during the training programme designed according to weight and category turning. In order to connect with the real life, each technique in the framework of the match rules was three rounds each 1.5 min and a rest break for 30 s between each round was given. In a training unit, all athletes repeated a single stroke technique for six times. 1.5 min × 3 rounds followed by one repetition, and following each repetition, a 10-min active rest was permitted.

Each training was initiated with 15-min warm-up and 10-min stretching and n-ished with 10-min cooldown. Every month, the athletes continued their training systematically with no change. In addition, during the practise of the techniques, the

athletes were asked to hit with right then left foot successively during the rounds. Trainings were conducted with the uniforms used in the competition.

At the end of three rounds, the total points taken from the technical application were told to the athletes. A measurement was taken from the athletes performing technical work with the electronic body protector system at the end of each month. The results of the measurement are listed on the scoring table in terms of the scores they have received from each technique and the sum of the three techniques.

After the training programme, ve volunteer participants selected randomly were interviewed, and their answers were recorded to analyse the effects of the electronic body protector system and gami cation components on their performance.

2 4 Data collection tools

To analyse changes in the performance of the athletes, the researchers recorded in a table the scores they obtained from the log records of the electronic body protectors for each technique at the end of each round. Two open-ended questions were prepared to evaluate the effects of the electronic body protector system and gami cation components on the athletes performance.

2 5 Data analysis

The scores obtained from the three measurements were analysed using one-way ANOVA for repeated measures. The qualitative data obtained from the interviews were analysed using the content analysis method. To ensure consistency, during thematic coding it is important to pay attention to whether the data pertaining to the chosen themes constituted a meaningful whole (Patton, 2014; Y ld r m Simsek, 2013). Thus, data were separatelyb coded by two researchers and organised according to the common grounds in this study to ensure consistency. The consistency formula (a statical calculation) was used to ensureb reliability, and the result was found to be 0.80.

3 Results

The results of three measurements obtained for the Palding-chagi, jump front turning Palding-chagi, and 360 turning Palding-chagi techniques at the end of each month were analysed using one-way ANOVA for repeated measures. The homogeneity of the variances was tested using Mauchly s test of sphericity before the comparison. The measurement variances for all three techniques were found to be homogeneous ($p > 0.05$).

A signi cant difference was found between the mean scores for each technique ($F_{\text{Palding-chagi}} = 50.323$, $p < 0.05$; $F_{\text{jump front turning Palding-chagi}} = 14.241$, $p < .05$; $F_{\text{360 turning Palding-chagi}} = 19.322$, $p < 0.05$) according to the ANOVA test. The *post hoc* test results were used to analyse the mean measurement scores that signi cantly differed from each other in terms of change over time.

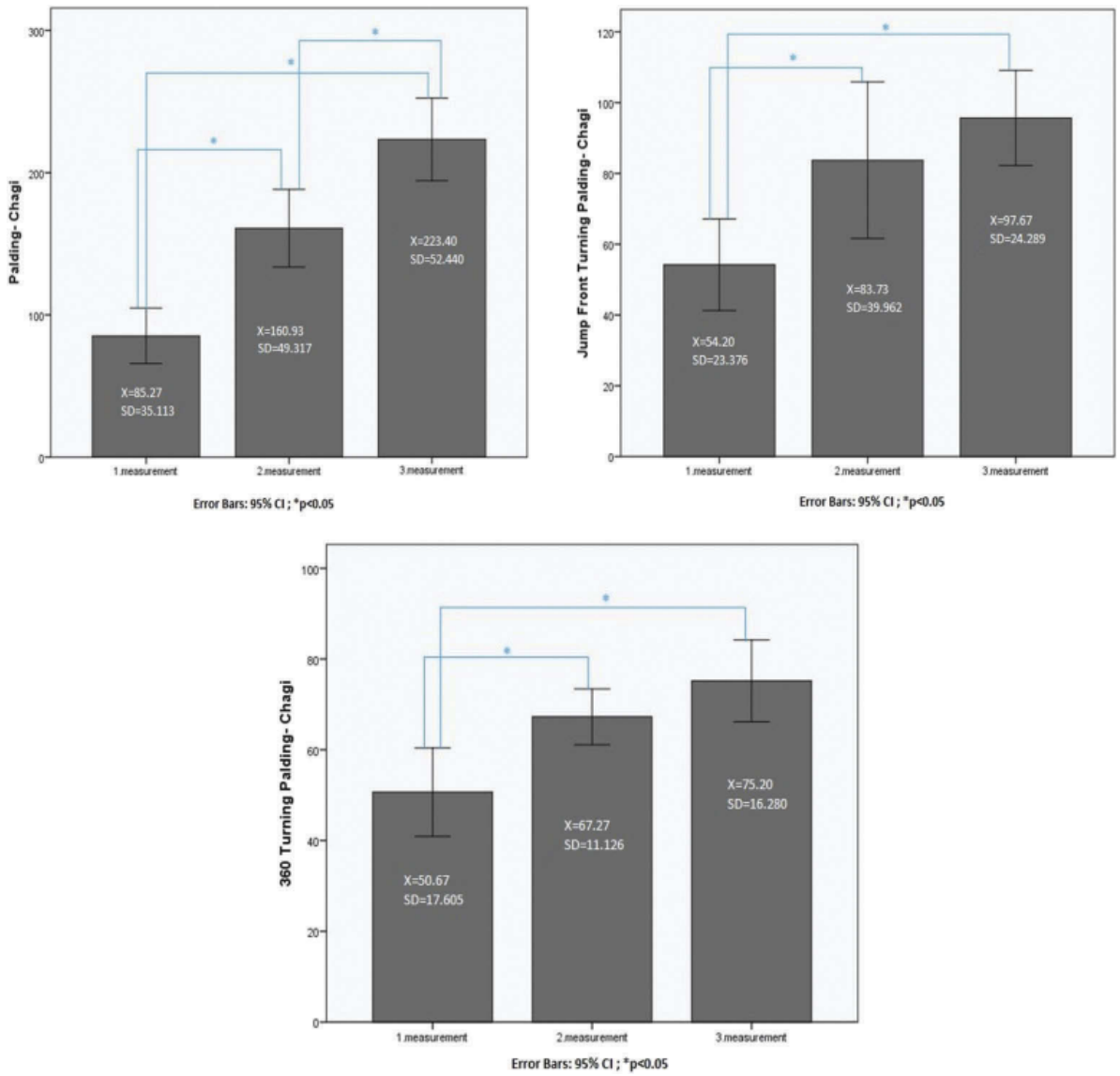

Figure 3 Comparison of the mean scores for Palding-chagi, jump front turning Palding-chagi and 360 turning Palding-chagi techniques.

Figure 3 shows that the differences between measurements 1 and 2, 1 and 3, and 2 and 3 were signi cant for the Palding-chagi technique. The differences between measurements 1 and 2 and measurements 1 and 3 were signi cant, whereas the differences between measurements 2 and 3 were not signi cant for the jump front turning Palding-chagi and 360 turning Palding-chagi techniques.

In addition to these ndings, data obtained from open-ended interview questions were analysed using the content analysis method. The ndings were then tabulated under thematic codes, and the ndings for each question were supported by the opinions of the participants in order to describe the effects of the electronic body protector system and gami cation on the athletes performance.

The thematic codes were analysed based on the opinions of ve participants who trained with an electronic body protector for the rst time. Codes were classi ed under two categories: the contribution made by training with an electronic body protector and the effect of using a scoreboard on performance (Table 1).

Table 1 Opinions of participants on electronic body protector and scoreboard use.

Theme	Code	Participants = 5)
Contribution of the electronic body protector	Improvement of condition	5
	Improvement of technical skills	4
	Correct use of the techniques	3
	Footwork improved	1
	Objective and fair system	4
E ect of scoreboard on performance	Increased competition	5
	Stimulated to improve themselves	4
	Motivated to the group	3

As seen in Table 1, all participants (n = 5) stated that training with an electronic body protector improved their condition. In addition, four of them stated that it improved their technical skills, three of them stated that they learned the correct use of the techniques, and one of them stated that his footwork improved.

First of all, our condition has improved. Our techniques have become better, and our technical skills in kicking have improved." [P2]
It has improved my condition, my footwork and technical skills in kicking." [P5]

The majority of participants (n = 4) emphasised that scoring was fair for everyone, as the electronic body protector is an objective system.

In the manual system, the referees were giving scores according to their own opinions even if my technique was totally correct. However, the electronic body protector has sensors on it, and it is a fairer system because it gives the scores itself." [P4]

Table 1 also shows that the participants stated that announcing the scores of each measurement on the scoreboard increased competition (ve participants), stimulated them to improve themselves (four participants), and motivated the group (three participants).

It has helped me to improve myself because we have done it for the rst time. I have reached a certain score and tried to pass that score. We have discussed who got a better score after each training. Everyone has tried to increase their scores. And we were working more to do this." [P2]

It was a nice competition. Some have tried to pass each other, tried to kick more. Some have done it, but some have not." [P3]

Our friends who trained were telling us [about the system] while waiting for our turn. They were trying to help us by telling us where to kick to get higher scores: the harder you kick, the higher you score, etc. And I think that was a good thing because it motivated us and made us help each other." [P1]

4 Discussion

In general, the ndings show that the differences between the mean scores for the three techniques were signi cant. This implies that training with an electronic system improves athletes technical skills and enhances their performance. Partridge et al. (2005) analysed a scoring and training system using wireless sensors for the martial arts and also indicated that this system improved training techniques. In another study, Song et al. (2010a) stated that the electronic system used by taekwondo trainers improved athletes training techniques and positively affected their performance.

Furthermore participants stated that training with an electronic body protector improved their condition, improved their technical skills, helped them learn the correct use of the techniques, and improved their footwork. Song et al. (2010b) evaluated the effectiveness of such an electronic system and the users satisfaction with it. In their study, 10 individuals they interviewed were generally satis ed with the system. The participants also stated that scoring was fair to everyone, since the electronic body protector is an objective system, and that receiving a recompense for their work affected their performance. These ndings indicate that it is important for the athletes to obtain performance scores instantly and objectively from electronic systems, which adjust the strength of kicks, punches and strikes according to the category and weight of the athletes (Chi, 2008; Tasika, 2013). The literature has reported that knowing their scores has a range of bene ts: it affects athletes motivation (Chiviacowsky, Wulf, Wally, Borges, 2009; Garris, Ahlers, Driskell, 2002; Salmoni, Schmidt, Walter, 1984), facilitates learning motor skills (Garris et al., 2002; Sousa Mendes Bandeira Godinho, 1994; Lee Carnahan, 1990), reduces mistakes (Winstein, Pohl, Lewthwaite, 1994) and provides feedback (Chiviacowsky et al., 2009).

In addition, participants stated that announcing the scores for each measurement on the scoreboard increased competition, stimulated them to improve themselves and motivated the group. Sutton and Doyle (2014) also reported that gami cation changed behaviours, improved skills and increased engagement in sports. Similarly, the literature includes studies reporting that gami cation increases the motivation of learners (Domínguez et al., 2013; Sillaots, 2014; Su Cheng, 2015), ensures

commitment to the environment (Su Cheng, 2015) and supports teaching (De-Marcos et al., 2014; Ibáñez et al., 2014; Kocadere Çağlar, 2015; Su Cheng, 2015) even if not in sports.

5 Conclusion

In totality, electronic systems reveal actual performance development since they generate accurate and reliable results. Therefore, electronic systems should be used to monitor the improvement of athletes technical skills. In addition, although rank scoring and a scoreboard were used in the present study as gami cation factors to support the improvement of technical skills, the electronic body protector can also be regarded as a gami cation factor. Practises where open targets are set (Werbach et al. 2012), levels are formed in parallel with the learners skills (Simões et al., 2013), and competition and cooperation are used together (Li, Dong, Untch, Chasteen, 2013; Sillaots, 2014) are considered to be more effective in enhancing athletes performance.

What are the new ndings

- Exercise with the electronic system improves the athletes technical skills and their performance.
- It can be said that the gami cation components also in the sports eld have increased the motivation and improved their technical skills of the athletes.
- Since electronic systems produce accurate and reliable results, they help to eliminate bias and thus exposed real performance.

Disclosure statement

No potential conflict of interest was reported by the authors.

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