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The effect of Taekwondo training applied with differential learning approach on the technical skills

El Efecto del entrenamiento de Taekwondo aplicado con el enfoque de aprendizaje diferencial en las habilidades técnicas

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Abstract.
Alongside the fact that the classical learning method has been used for many years in the area of sports such as tae-kwon-do, there have been searches and attempts for unconventional approaches to teaching. One of these is the differential learning approach, it is important the repetitions vary in the differential learning approach and that the attention is given to the basis of the technique rather than the perfect execution of the move. Examining the literature, no study has been found which investigates the outcomes of the taekwondo training program applied with a differential learning approach despite the fact that other branches have supported the positive contribution of the differential learning approach in the literature. The aim of this research is to examine the effect of differential learning on the technical skill development of male and female taekwondo players with red-black belts in the 12-14 age group. A total of 16 taekwondo players, who have a red-black belt in the 12-14 age group star category and have a license of at least three years, participated in the research. In this quantitative research, the pre-test and post-test study group models (within quasi-experimental design) was used. Wilcoxon Test was used to examine the pre-test and post-test between the test values of taekwondo players. When the findings were examined, the differential learning approach has a positive effect on the technical skill development of the female and male taekwondo athletes.
Keywords: Differential learning; taekwondo; training; technical skills; non-linear learning approach

Resumen
Junto al hecho de que el método de aprendizaje clásico se ha utilizado durante muchos años en el ámbito de deportes como el taekwondo, ha habido búsquedas e intentos de enfoques de enseñanza no convencionales. Uno de ellos es el enfoque de aprendizaje diferencial. En el enfoque de aprendizaje diferencial es importante que las repeticiones varíen y que se preste atención a la base de la técnica más que a la ejecución perfecta del movimiento. Examinando la literatura, no se ha encontrado ningún estudio que investigue los resultados del programa de entrenamiento de taekwondo aplicado con un enfoque de aprendizaje diferencial, a pesar de que la contribución positiva del enfoque de aprendizaje diferencial en la literatura ha sido apoyada por otras ramas. El propósito del estudio fue investigar el efecto del entrenamiento de taekwondo aplicado con un enfoque de aprendizaje diferencial sobre las habilidades técnicas de los taekwondistas de categoría estrella de 12-14 años. Participaron en la investigación un total de 16 taekwondistas con cinturón rojo-negro de la categoría estrella de 12-14 años y con una licencia de al menos 3 años. En esta investigación cuantitativa, se utilizó un método de investigación semi experimental sobre el terreno con un grupo de estudio que incluía los modelos pre-test y post-test. La Prueba de Wilcoxon se utilizó para examinar las diferencias entre la prueba previa y posterior los valores de prueba los jugadores de taekwondo. Cuando se examinaron los hallazgos, se ha determinado que el enfoque de aprendizaje diferencial tiene un efecto positivo en el desarrollo de las habilidades técnicas de los atletas de taekwondo.
Palabras clave: de aprendizaje diferencial, taekwondo; entrenamiento; habilidades técnicas; enfoque de aprendizaje no lineal

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Introduction

The origin of taekwondo, a martial art, goes back 120 centuries ago, to Korea. Taekwondo is a defense sport that is performed with the use of hands and feet and the moral aspect is at the forefront. "Tae-" means foot, "-kwon" means hand, and "-do" refers to the way of thinking and behaving that prioritizes the necessity of following morality (Şahin et al.,2012). The outstanding aspect of Taekwondo is that it involves defensive techniques with hands and feet against the opponent. The use of hands and feet in taekwondo are respectively 30% and 70%. Love, respect, humility, and patience are among the other aspects of taekwondo (Larousse,1982). Taekwondo divides into two branches "kyorugi" (two athletes fighting each other with kicks, punches, and defense actions within certain rules and accompanied by a referee) and "Poomsae" (athletes displaying certain techniques by using hitting techniques and blocking imaginarily as if they have an opponent). A taekwondo match consists of three or two-minute rounds with one-minute breaks between rounds (World Taekwondo, 2022; Atasoy et al. 2018).

There are different techniques and tactical factors on the table during a taekwondo match. To earn points with the use of these different techniques and tactical factors, the kicks and the punches must be aimed at and hit the designated points (Bridge et al.,2014). It has been stated that there are limited teaching methods in taekwondo (Kusrin et al., 2022). Alongside the fact that the classical learning method has been used for many years in the area of sport, there have been searches and attempts for unconventional approaches to teaching. One of these is Differential Learning Approach. Differential Learning is a motor learning technique recommended in 1999 (Schöllhorn,1999). Motor learning is a practice that causes relatively permanent learning outcomes in competency-based skills or a series of processes which is related to experience (Schmidt &Lee, 2013).

In differential learning, it is crucial for the instructor to provide change and variety in the moves they assess. This aims to prepare the person to adapt to new, unexpected, and sudden situations as quickly as possible. Therefore, instead of repeating the same or similar moves one after the other as in other training methods, it is important that the repetitions vary in the differential learning approach and that the attention is given to the basis of the

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technique rather than the perfect execution of the move. Error evaluations in other training methods are considered as naturally occurring differences in the differential learning approach. (Schöllhorn, 2015; Schöllhorn et al., 2009).

When we examine the studies made carried out by using differential learning approach in the area of physical education and sports, we come across on Çakıt et al (2022) about the impact of differential learning model on motor skills, Savelsbergh et al. (2010) on the speed skating, John &Schöllhorn (2018) about the effect of skipping rope on the acute effects of brain activity, Alpullu and Bozkurt (2018) in regard to its effect on technical development of child basketball players, Topsakal, Bozkurt&Akin (2019) concerning its effect on attention and speed development of primary school students, Mateus, Santos, Vaz, Gomes, Letter (2015) about the outcome of physical literacy and differential learning program on motor, technical and tactical basketball skills, Özüak&Çağlayan (2019) differential learning as an important factor in the training of technical soccer skills, Bozkurt (2018) regarding the effects of differential learning and traditional/classical learning training on the technical development of soccer players, Santos et al. (2017) on differential learning as a primary training approach to improve creative and tactical behavior in soccer, Gaspar et al. (2019) regarding the acute effects of differential learning on soccer kick performance and counter move jump, Hartigh et al. (2021) concerning effect of differential learning on motor performance, Oftadeh et al. (2021) about effects of differential learning on learning futsal. The researches reveal that the differential learning approach has a positive effect on the technical skill development of individuals.

Once we investigate the research on taekwondo, we encounter Aydemir, Yüksek&Ölmez (2021) about its effect on motor features of 12-14 years old taekwondo players, Kan&Karacan (2017) on the anaerobic training program for male taekwondo players aged 14-16, Yılmaz, Var&Marangoz (2022) on the effects of balance exercises and stretching exercises of taekwondo players on dollyo chagi technique, Kusrin et al. (2022) about the effectiveness of hand-body observation and manipulation and taekwondo Poomsae training methods in primary school, Tsania et al. (2022) regarding increasing the speed and power of dollyo chagi kicks in taekwondo players. During a taekwondo match, the technical and

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tactical process may not proceed as planned by the athlete or coach due to the influence of the opponent. In this case, if the athlete cannot adapt to the differences that occur during the competition, they may face defeat. Therefore, it is crucial that the athletes adapt to the effect of the opponent or different environmental conditions. In this respect, it is viewed that the differential learning approach can contribute to taekwondo education as in other branches.

Examining the literature, no study has been found which investigates the outcomes of the taekwondo training program applied with a different learning approach despite the fact that other branches have supported the positive contribution of the differential learning approach in the literature. In this sense, this research is considered to have a unique value and to be contributory to the literature.

Purpose of the Study. The study's purpose was to examine the effect of differential learning on the technical skill development of male and female taekwondo players with red-black belts in the 12-14 age group.

Materials and methods

Participants. A total of 16 taekwondo players, eight females and eight males, who have a red-black belt in the 12-14 age group star category and have a license of at least three years, participated in the research. Ten of the athletes participating in the research have the right dominant hitting leg and 6 of them have the left dominant hitting leg. Sample size calculations were performed for repeated measures analysis of variance using the G*Power software 3.1.9.7 (Universität Düsseldorf, Germany). Hypothesizing an effect size for a required power of 95% at $P < 0.05$, a sample size of at least eight in each group was required (Faul et al., 2007; Seabra et al., 2016)

Research Design. In this quantitative research, the pre-test and post-test study group models (within quasi-experimental design) was used.

This research, which was conducted during the match season, intends to investigate the effect of the taekwondo basic skills training program (independent variable) applied with a differential learning approach on the technical skills (dependent variable) of taekwondo

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players. The tests were assessed in a single session (i.e., 6:00 pm and 8:00 pm hours) in the same conditions for the pre-test and post-test.

In the training implementation process; Yopchagi, Dollyo chagi, Dui-chagi, and Palding chagi techniques, which are the basis of taekwondo, were practiced using a differential learning approach. The 16 taekwondo players who participated in the research were trained with the differential learning approach for two hours and two days a week for four weeks, a total of 16 training hours. The training program enriched with a differential learning approach was added to taekwondo training in the warm-up section as 15-20 minute drills. In the central part, four basic taekwondo techniques and different exercises with random order were applied in one training session.

In the training programme, rather than movement repetitions, the aim was to accept the learning of the variability of movements as a principle, not to make adjustments or providing no corrective feedback during the skill-acquisition process, and to carry out the trainings by adding random perturbations to the movement arrangement (Schöllhorn, 2000; Schöllhorn et al., 2009). The core idea of the differential training was to increase the fluctuations of techniques and in order to provide the athletes with the possibility to seek and explore functional movement patterns (Schöllhorn, Hegen & Davids, 2012).

The evaluation and measurement of taekwondo technical skills. A total of 4 techniques of yopchagi, dollyo chagi, dui-chagi, and palding chagi techniques were performed in this order right foot, left foot, and both feet, respectively. The techniques were applied as 10 seconds of hit and 1 minute of rest. Techniques were evaluated as coach observations by two trainers who have 3-level coaching certificates. During the implementation of the 10-second techniques, each successful hit was recorded as one score.

In yopchagi, dui-chagi, and palding chagi techniques, the kick pad is held 90-110 cm above the ground. Kick pad holding distance is adjusted according to the self-guard, which is the body protector, and it is 30-35 cm on average. However, in techniques such as kick pad and dollyo chagi, it is kept 140-150 cm above the ground. The kick pad, which is held at head level, is about 15-20 cm.

The descriptions of the techniques applied are given below (Kala, 2018).

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***Palding chagi**:* The hit zone is the torso level. Kick is made with the top of the foot. By pushing the hip forward and pulling the knee, the foot extends forward the shortest distance. The opponent's upper body is hit.

Dollyo chagi: The head area is hit with the top of the foot. By pushing the hip forward and pulling the knee, the foot is kicked forward the shortest distance. The opponent's head area is hit.

Yop chagi: With the foot standing in front of the guard, the knee is pulled and the upper body is kicked with the bottom of the foot.

***Dui chagi**:* The hit zone is medium. It is hit with the heel of the foot. Turning from the back, the opponent's body area is hit with the heel and sole of the foot backward.

Borg Scale: The evaluation of the techniques applied by the athletes in the match was made by two trainers with a 3rd level coaching certificate, giving points between 1 (lowest rate) and 10 (highest rate).

Ethics Approval. All subjects gave their informed consent for inclusion before they participated in the study. The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Ethics Committee of the School of Medicine, Marmara University (approval number: 02.2021-114)

Statistical Analysis. SPSS 22 statistical package program was used for the statistical analysis of quantitative data. With descriptive statistics, arithmetic mean ($\bar{x}$), standard deviation (Ss), maximum (Max.), and minimum (Min.) values are given. The fit to a normal distribution was also examined using the Shapiro-Wilk Test. Levene's test was used to ensure the homogeneity of variances. Although some scores showed the normal distribution between the test values of taekwondo players due to the sample being small (n=8) the "Wilcoxon test" was used only to examine the pre-test and post-test differences for all analyses. A p-value below 0.05 obtained as a result of the tests was considered statistically expressive for all tests.

Results

Descriptive statistics of the present study including technical characteristics are shown in Table1.

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Table nº 1. Descriptive statistics of technical characteristics by gender

Technical characteristics	Gender	Tests	*N*	*Min.*	*Max.*	*Mean*	*St. Dev.*
Yapcagi (right side)	Boys	Pre-test	8	13,00	19,00	17,25	2,05
		Post-test	8	17,00	21,00	18,63	1,77
	Girls	Pre-test	8	14,00	21,00	17,50	2,20
		Post-test	8	16,00	22,00	18,50	2,07
Yapcagi (left side)	Boys	Pre-test	8	14,00	20,00	16,25	1,98
		Post-test	8	16,00	22,00	19,00	2,07
	Girls	Pre-test	8	15,00	20,00	17,13	2,10
		Post-test	8	16,00	21,00	18,50	1,85
Yapcagi (both right and left sides)	Boys	Pre-test	8	13,00	17,00	15,00	1,51
		Post-test	8	15,00	20,00	17,25	1,67
	Girls	Pre-test	8	14,00	19,00	17,25	1,67
		Post-test	8	15,00	20,00	17,25	1,83
Ducagi (right side)	Boys	Pre-test	8	11,00	18,00	15,25	2,49
		Post-test	8	12,00	19,00	16,63	2,20
	Girls	Pre-test	8	12,00	20,00	14,00	2,56
		Post-test	8	12,00	22,00	14,88	3,04
Ducagi (left side)	Boys	Pre-test	8	12,00	17,00	14,25	1,98
		Post-test	8	13,00	19,00	15,88	1,96
	Girls	Pre-test	8	12,00	20,00	14,13	2,59
		Post-test	8	13,00	22,00	15,38	2,88
Ducagi (both right and left sides)	Boys	Pre-test	8	13,00	19,00	15,63	1,85
		Post-test	8	12,00	21,00	16,63	2,92
	Girls	Pre-test	8	13,00	16,00	14,38	1,30
		Post-test	8	13,00	23,00	16,38	2,97
Dollyo Chagi (right side)	Boys	Pre-test	8	13,00	20,00	15,88	1,96
		Post-test	8	15,00	21,00	16,75	1,83
	Girls	Pre-test	8	12,00	21,00	15,00	2,78
		Post-test	8	14,00	22,00	16,75	2,76
Dollyo Chagi (left side)	Boys	Pre-test	8	14,00	18,00	15,13	1,36
		Post-test	8	15,00	20,00	17,13	1,46
	Girls	Pre-test	8	15,00	20,00	16,13	1,73
		Post-test	8	16,00	21,00	17,63	1,77
Dollyo Chagi (both right and left sides)	Boys	Pre-test	8	16,00	20,00	17,25	1,58
		Post-test	8	16,00	21,00	18,38	1,60
	Girls	Pre-test	8	13,00	22,00	16,75	2,60
		Post-test	8	16,00	24,00	19,25	3,11
Palding (right side)	Boys	Pre-test	8	15,00	23,00	18,00	2,73
		Post-test	8	16,00	26,00	21,38	3,02
	Girls	Pre-test	8	14,00	20,00	17,13	2,03
		Post-test	8	15,00	20,00	18,25	1,91
Palding (left side)	Boys	Pre-test	8	16,00	20,00	17,50	1,31
		Post-test	8	17,00	24,00	19,50	2,39
	Girls	Pre-test	8	16,00	19,00	17,38	1,06
		Post-test	8	15,00	23,00	18,50	2,45
Palding (both right and left	Boys	Pre-test	8	19,00	28,00	22,25	2,92
		Post-test	8	18,00	28,00	24,00	3,25

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sides)	Girls	Pre-test	8	17,00	22,00	18,88	1,55
		Post-test	8	17,00	23,00	20,13	2,30
Coach observation in Yapcagi	Boys	Pre-test	8	4,00	7,00	5,88	1,13
		Post-test	8	5,00	8,00	6,25	1,04
	Girls	Pre-test	8	4,00	8,00	5,88	1,46
		Post-test	8	5,00	9,00	6,88	1,36
Coach observation in Ducagi	Boys	Pre-test	8	4,00	7,00	5,25	1,04
		Post-test	8	5,00	8,00	6,13	0,99
	Girls	Pre-test	8	4,00	7,00	4,88	1,13
		Post-test	8	4,00	8,00	5,50	1,20
Coach observation in Dollyo Chagi	Boys	Pre-test	8	4,00	5,00	4,75	0,46
		Post-test	8	4,00	6,00	5,00	0,93
	Girls	Pre-test	8	4,00	6,00	4,75	0,71
		Post-test	8	5,00	7,00	6,13	0,64
Coach observation in Palding	Boys	Pre-test	8	6,00	9,00	7,38	0,92
		Post-test	8	6,00	9,00	7,38	1,06
	Girls	Pre-test	8	4,00	7,00	5,63	0,92
		Post-test	8	7,00	8,00	7,38	0,52

Comparisons for participants' technical characteristics are shown between Table 2. and Table 3.

Table nº 2. Wilcoxon Test analysis of pre-test and post-test tae-kwon-do technical measurements of the boys

Technical characteristics	***Tests***	***N***	***Mean***	***Std. Dev.***	***Z***	***p***
Yapcagi (right side)	Pre-test	8	17,25	2,05	-2,232	,026*
	Post-test	8	18,63	1,77		
Yapcagi (left side)	Pre-test	8	16,25	1,98	-2,530	,011*
	Post-test	8	19,00	2,07		
Yapcagi (both right and left sides)	Pre-test	8	15,00	1,51	-2,132	,033*
	Post-test	8	17,25	1,67		
Ducagi (right side)	Pre-test	8	15,25	2,49	-1,560	,119
	Post-test	8	16,63	2,20		
Ducagi (left side)	Pre-test	8	14,25	1,98	-1,982	,047*
	Post-test	8	15,88	1,96		
Ducagi (both right and left sides)	Pre-test	8	15,63	1,85	-1,552	,121
	Post-test	8	16,63	2,92		
Dollyo Chagi (right side)	Pre-test	8	15,88	1,96	-.2,333	,020*
	Post-test	8	16,75	1,83		
Dollyo Chagi (left side)	Pre-test	8	15,13	1,36	-2,401	,016*
	Post-test	8	17,13	1,46		
Dollyo Chagi (both right and left sides)	Pre-test	8	17,25	1,58	-1,638	,101
	Post-test	8	18,38	1,60		
Palding (right side)	Pre-test	8	18,00	2,73	-2,536	,011*
	Post-test	8	21,38	3,02		
Palding (left side)	Pre-test	8	17,50	1,31	-1,843	,065
	Post-test	8	19,50	2,39		

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Palding (both right and left side)	Pre-test	8	22,25	2,92	-,1892	,058
	Post-test	8	24,00	3,25		
Coach observation in Yapcagi	Pre-test	8	5,88	1,13	-1,342	,180
	Post-test	8	6,25	1,04		
Coach observation in Ducagi	Pre-test	8	5,25	1,04	-2,070	,038*
	Post-test	8	6,13	0,99		
Coach observation in Dollyo chagi	Pre-test	8	4,75	0,46	-707	,480
	Post-test	8	5,00	0,93		
Coach observation in Palding	Pre-test	8	7,38	0,92	,000	1,000
	Post-test	8	7,38	1,06		

* p<0.05

There were statistically significant differences *(p<0.05)* among the results related to the technical characteristics of the boys (Yapcagi (right side), Yapcagi (left side), Yapcagi (both right and left sides), Ducagi (left side), Dollyo (right side), Dollyo (left side) Palding (right side) and Coach observation in Ducagi).

There were no statistically significant differences *(p>0.05*) in technical characteristics of the boys Ducagi (right side), Ducagi (both right and left sides), (Dollyo-both right and left sides), Palding (left side), Palding (both right and left side), Coach observation in Yapcagi, Coach observation in Dollyo and Coach observation in Palding).

Table nº 3. Wilcoxon Test analysis of pre-test and post-test tae-kwon-do technical measurements of the girls

Technical characteristics	***Tests***	***N***	***Mean***	***Std. Dev.***	***Z***	***p***
Yapcagi (right side)	Pre-test	8	17,50	2,20	-2,271	,023*
	Post-test	8	18,50	2,07		
Yapcagi (left side)	Pre-test	8	17,13	2,10	-2,050	,040*
	Post-test	8	18,50	1,85		
Yapcagi (both right and left sides)	Pre-test	8	17,25	1,67	,000	1,000
	Post-test	8	17,25	1,83		
Ducagi (right side)	Pre-test	8	14,00	2,56	-1,823	,068
	Post-test	8	14,88	3,04		
Ducagi (left side)	Pre-test	8	14,13	2,59	-2,058	,040*
	Post-test	8	15,38	2,88		
Ducagi (both right and left sides)	Pre-test	8	14,38	1,30	-2,214	,027*
	Post-test	8	16,38	2,97		
Dollyo Chagi (right side)	Pre-test	8	15,00	2,78	-2,414	,016*
	Post-test	8	16,75	2,76		
Dollyo Chagi (left side)	Pre-test	8	16,13	1,73	-2,640	,008*
	Post-test	8	17,63	1,77		
Dollyo Chagi	Pre-test	8	16,75	2,60	-2,207	,027*

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(both right and left sides)	Post-test	8	19,25	3,11		
Palding (right side)	Pre-test	8	17,13	2,03	-1,913	,056
	Post-test	8	18,25	1,91		
Palding (left side)	Pre-test	8	17,38	1,06	-1,552	,121
	Post-test	8	18,50	2,45		
Palding (both right and left side)	Pre-test	8	18,88	1,55	-1,983	,047*
	Post-test	8	20,13	2,30		
Coach observation in Yapcagi	Pre-test	8	5,88	1,46	-2,530	,011*
	Post-test	8	6,88	1,36		
Coach observation in Ducagi	Pre-test	8	4,88	1,13	-1,890	,059
	Post-test	8	5,50	1,20		
Coach observation in Dollyo	Pre-test	8	4,75	0,71	-2,428	,015*
	Post-test	8	6,13	0,64		
Coach observation in Palding	Pre-test	8	5,63	0,92	-2,565	,010*
	Post-test	8	7,38	0,52		

* $p<0.05$

There were statistically significant differences *($p<0.05$)* among the results related to the technical characteristics of the girls Yapcagi (right side), Yapcagi (left side), (Ducagi (left side), Ducagi (both right and left side), Dollyo (right side), Dollyo (left side), Dollyo (both right and left side), Palding (both right and left side), Coach observation in Yapcagi, Coach observation in Dollyo and Coach observation in Palding.

There were no statistically significant differences *($p>0.05$)* in technical characteristics of the girls Yapcagi (both right and left sides), Ducagi (right side), Palding (right side), Palding (left side) and Coach observation in Ducagi.

Discussion

The aim of this research is to examine the effect of differential learning on the technical skill development of male and female taekwondo players with red-black belts in the 12-14 age group.

The major finding of the presented study was that the 4-week taekwondo training program with the differential learning approach (2 hours, 2 times/week) improve the technical skills of male and female taekwondo players. The results were consistent with other studies. Core skills are important with regard to the acquisition of the development of motor functions at an early age. Physical activities performed at an early age do not only contribute to the development of the child but also help the development of their motor skills, and social,

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reactive, and academic skills (Lucas et al., 2016). Ayan & Mülazimoğlu (2009) state that determining performance at an early age paves the way for the athlete to reach the optimal level, and within this context, applying necessary tests to children should start at an early age.

Winning the competition requires not only technical and tactical training but also a high level of physical qualifications. For example, boys in the 12-14 age group use complex techniques in Taekwondo whereas it is seen that techniques applied to the head such as dollyo chagi are used more by girls (Palii, 2021).

In their study on taekwondo sport, Şahin et al. (2012) reported that ten weeks of regular taekwondo training that was applied by children in the 7-8 age group considerably increased the development of their motor skills.

It has been stated that children's motor skills improve by degrees and it is important to develop sport-specific features as well as their general motor development (Haslofça, Haslofça&Kutlay, 2011; Bressel et al., 2007).

It is given that basic movement skills training applications applied with a differential learning approach can be effective in speed development, which is one of the attention and motor features of 9- year-old (3rd grade) primary school students (Topsakal, Bozkurt&Akin, 2019).

According to Özçelik & Alpullu (2019) the study on young basketball players, a significant difference was found in technical skills between traditional learning and differential learning groups. Furthermore, it has been reported that the athletes in the differential learning group proved an increment in dribbling, passing, shooting, and technical skill performances.

It was deduced that differential learning training have positive effects on the motor features of 14-year-old male basketball players (Aydın&Küçük, 2022). Positive effects of differential learning training on hurdlers were observed (Schöllhorn et al., 2010). There is a significant increase in the technical performance of young football players who practice differential learning training (Bozkurt, 2018). The researches reveal that the differential learning approach has a positive effect on the technical skill development of athletes.

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Conclusions

In consonance with our research findings, it has been determined that differential learning approach positively affects the technical skill development of taekwondo athletes. The findings suggest that the differential learning approach could be significantly more effective, especially for the techniques of Yapchagi, Dui-chagi, Dollyo Chagi, and Palding. Practicing with differential learning may also be effective in terms of saving practice time for the development of tae-kwon-do skills.

In this context, it is considered that the differential learning approach has a positive effect on the development of technical skills, and its use in physical activity and movement skills may be beneficial.

The findings of the present study should be interpreted in the context of

limitations. The small number of participants could give the study the character of a pilot study for differential learning in children's taekwondo. Future studies should be investigated in sports analyzing different age and gender groups and wider samples, as well as a longer intervention period to better understand the phenomena of differential learning in tae-kwon-do with children in sports. These findings also may be useful for trainers in the selection process of participants and in preparing taekwondo training programs.

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