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The Impact of Differential Learning Model on Motor Skills and Handball-Specific Coordination Performance in 11-13-Year-Old Beginners in Handball*

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Abstract

Aim: Improvement of skills in handball means an increase in performance. There are two main learning methods in sport: traditional (classical) and differential learning. The aim of our study was to determine the effect of plyometric training with differential learning method on agility and handball-specific coordination skills in 11-13-year-old handball athletes who are new to the sport.
Methods: In this study, 44 male secondary school students aged 11-13 years from Istanbul and Adana provinces, who were new to sports, volunteered to take part in this study. Two groups of 22 students each were randomly selected as classical training group and differential learning group. All groups were given handball training for adaptation training for 4 weeks. The training sessions were conducted four days a week for 1.5 hours for 12 weeks. Pre-tests were applied before the training period started, and post-tests were applied at the end of 12 weeks. In the study, T-test, zigzag running, obstacle tests as motor skill agility tests; For handball coordination skills, handball slalom dribbling, wall quick pass, hand wall toss pass tests were applied.
Results: Differential learning group (T-test, zig-zag running, obstacle, handball slalom dribbling, wall quick pass, hand wall toss pass tests) were statistically significant compared to the results of the classical training group ($p<0.05$). The fact that there were significant improvements in the control group can be characterized as the natural effect of the sport depending on the age period.
Conclusions: Compared to the classical training group, the group of differential learning showed more improvement.

Keywords

Differential Learning, Motor Skills, Agility, Handball Specific Coordination.

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Farklılıkla Öğrenme Modelinin 11-13 Yaş Arası Hentbola Yeni Başlayanlarda Motor Beceriler ve Hentbola Özgü Koordinasyon Performansı Üzerindeki Etkisi

Özet

Amaç: Hentbolda becerinin gelişimi performansın artması demektir. Sporda geleneksel (klasik) ve farklılıkla öğrenme olarak iki öğrenme yöntemi bulunmaktadır. Çalışmamızın amacı 11-13 yaş aralığındaki spora yeni başlayan hentbol sporcularında farklılıkla öğrenme yöntemiyle yapılan pliometrik antrenmanların, çeviklik ve hentbola özgü koordinasyon becerilerine etkisini belirlemektir.
Materyal ve Metot: Bu çalışmaya İstanbul ve Adana illerinden 11-13 yaş aralığında, spora yeni başlayan 44 erkek ortaokul öğrencisi gönüllü olarak katılmıştır. Her biri 22 öğrenciden oluşan iki grup, klasik eğitim grubu ve farklılıkla öğrenme grubu olarak rastgele seçilmiştir. Tüm gruplara 4 hafta boyunca adaptasyon eğitimi olarak hentbol eğitimi uygulanmıştır. Antrenmanlar 12 hafta boyunca haftada dört gün 1.5 saat olarak gerçekleştirilmiştir. Antrenmanlar başlamadan önce ön testler, 12 hafta sonunda ise son testler uygulanmıştır. Çalışmada motor beceri çeviklik testleri olarak T-test, zikzak koşu, engel testleri; hentbol koordinasyon becerileri için ise hentbol slalom top sürme, duvara hızlı pas, el topu fırlatma pas testleri uygulanmıştır.
Bulgular: Farklılıkla öğrenme grubu (T-testi, zig-zag koşu, engel, hentbol slalom top sürme, duvara hızlı pas, eltopu pas atma testleri) klasik eğitim grubu sonuçlarına göre istatistiksel olarak anlamlı fark vardır ($p<0.05$). Kontrol grubunda da anlamlı gelişmelerin olması yaş dönemine bağlı spor yapmanın etkisi olarak nitelendirilebilir.
Sonuçlar: Klasik antrenman grubu ile karşılaştırıldığında, farklılıkla öğrenme grubu daha fazla gelişim göstermiştir.

Anahtar kelimeler

Farklılıkla Öğrenme, Motor Beceri, Çeviklik, Hentbola Özgü Koordinasyon.

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INTRODUCTION

Today, skill and technical training is unique to the athlete. For this reason, the movement repetitions they perform are never exactly alike and are different. Differential learning: Basically, it is the learning

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that takes place with fluctuations in the process of skill acquisition, without movement repetitions and without feedback to the movements performed (Schollhorn, Michelbrink, Welminsiki, & Davids, 2009). In relation to differential learning, the importance of variability and integration of other (physiological and non-physiological) approaches such as synergistic or dynamic systems approaches, stochastic resonance, neurobiology and arterial neural network simulations in motor development and learning has been emphasized (Button et.al., 2003; Schollhorn et. al., 2009 a, b).

Due to the nature of the game, handball involves the necessary movement skills such as balance, coordination, agility, changes of direction, offensive and defensive actions. Differential learning practices aim to learn new skills with different repetitions using different shapes and components. With this method, it is important for performance and permanent learning to be able to apply these self-planned, self-organized skills in an optimum way. Schollhorn, Hegen & Davids (2012) explained the differential learning approach as "non-repetitive" and "constantly changing movement tasks" that add stochastic perturbations from fluctuations in a complex system.

In classical learning, there is a more systematic progression of the learning environment. The motor learning approach suggests that students develop a skill only through repetition. According to the principles of teaching, exercises are selected consistently from simple to complex and from easy to difficult. Traditional learning approaches are typically based on a linear understanding of causality, where the same cause leads to the same effect (Erdil, 2016; Bozkurt, 2018).

For this reason, especially those who are new to sports learn the right skill when they perform exercises with variety, repeated constantly, and with different fluctuations of movement. It is important to practice motor skills and coordination in a regular program starting from a young age. In relation to motor skills, kinesthetic ability to distinguish, which is characterized as the basic condition of movement sensitivity and motor learning, reaches its first peak between the ages of 10 and 13 (Muratlı, et. al. 2011)

Motor skills improve during adolescence. An adolescent athlete with earlier improvement of motor skills performs more efficiently than an athlete of the same chronological age. It is known that functional movement patterns can be developed and corrective exercises improve functional movement patterns (Mokha et al., 2016; Usluer et. al., 2021). Several experiments have shown higher skill acquisition of the differential learning approach compared to traditional linear approaches, and most interestingly, it performs even better in the retention phase of learning (Wagner & Muller, 2008; Schollhorn, 1999).

In the review study "plyometric training programs in children", Johnson et. al. (2011) examined six skills in 275 children aged 8-14 years, all of whom were soccer players. Seven of these skills were jumping-related skills (squat jumps, long jumps, vertical jumps, depth jumps, countermovement jumps, and multi-limitation). Then running speed (distances between 10 m. and half a mile), balance, agility, power and striking distance. They determined improvements in agility, balance and kicking distance evaluated in the study. Meylan and Malatesta (2009) reported the association of plyometric training with significantly improved agility (effect size, d=22.15) among young soccer players, while Rubley et al. (2011) found that plyometric training significantly improved striking distance (d=2.62) in adolescent soccer players.

In the view of these studies, the literature was reviewed and it was seen that there is a limited number of studies in the field of differential learning, especially there is a lack of research on the development of motor skills. The handball game was the subject of the research as a sport branch that includes speed, agility, body control and coordination skills, as well as dribbling, passing, continuous change of direction, and basic skills that are often experienced in the game for this reason, the aim of our study was to determine the effect of plyometric training with differential learning method on agility and handball-specific coordination skills on 11-13 year old handball athletes who are new to the sport.

METHOD

A total of 44 male secondary school students between the ages of 11-13 years, who were new to sports and volunteered to participate in this study. Before the studies, the athletes and their parents were informed and consent forms were obtained.

Approval for this study was obtained from the Faculty of Medicine Ethics Committee. Approval date and Approval number: 14.12.2020 / E-70737436-050-01.04-2000329635). In addition, the study protocol was implemented according to the Declaration of Helsinki.

Determination of Sample Size

All the athletes in the study were given handball training for 4 weeks, 4 days a week, prepared in a game form to ensure the homogeneity of the groups. Then 44 male students were randomly divided into 2 groups. Two groups of 22 students each were determined as classical handball training group.

In the experimental study phase, the trainings were conducted four days a week for 1.5 hours for 12 weeks. Pre-tests were applied before the training started and post-tests were applied at the end of 12 weeks. In the study, T-test, zigzag running, obstacle tests were applied as motor skills agility tests; handball slalom dribbling, fast pass on the wall, hand wall toss pass tests were applied for handball coordination skills.

Study design

The classical handball training group applied a training program for 16 weeks (64 units of training) aimed at the development of technical, tactical and skills related to handball basic training. The differential learning handball training group applied a training program that continued 4 days a week (48 units of training) for 12 weeks as a plyometric training group with the learning with difference method, after 4 weeks (16 units of training) of handball training in the studies prepared in the game form to ensure the homogeneity of the groups.

In addition to classical handball training group, the differential learning handball training group applied motor skills and coordination tests (T-test, zig-zag running, obstacle test, handball slalom dribbling test, wall passing test, hand wall toss passing test) used as variables in the differential learning Model studies within the training program. With the materials used in the test materials, tires, ropes, additional weights, balls, exercises with different branch balls, creating movement fluctuations, creating a variety of exercises that are not similar to each other and goal-oriented. The athletes were asked to try the movements freely and to adapt and find the right movement performance in each different movement according to themselves, in which they would show the best performance. For this purpose, exercises were performed without giving positive or negative feedback to the athletes. When plyometric training was started; 1st-3rd week; all jumping movements were practiced using field lines or stripes without using height and no obstacle height was used. 4th-7th week; 15-20 cm obstacles were used in plyometric training and jumps. In the 8th-12th week, 25-30 cm obstacles were used in plyometric training and jumps. Until the end of the studies, 3-4 movements complementing each other from a total of 15 basic movements were determined, and in each training, the number of repetitions of these movements was continued by increasing and constantly changing the obstacle height and predetermined ratios.

Table 1. Training programme

Group &Athletes	**Classical handball training group 22 athletes**	**Differential handball training group 22 athletes**
Handball adaptation training program	4 week	4 week
Number of weekly workouts	3-4	3-4
DL (Week)	___	5-16. week
Plyometric training	___	5-16. week
Plyometric training	___	15 min./20''sec. 20''sec
Duration/rest time (sec)	4.week / 16. week	4. week / 16. week
Pre-tests/post-tests (training)	16-48	16-48
Planned unit training	**64**	**64**

Differential learning training

Differential learning workouts were created using functional motor skills and coordination tests. After 4 weeks of adaptation training, differential learning handball training group practiced classical handball training for 2 consecutive days and differential learning handball training for 2 consecutive days for 12 weeks by combining three of the six motor skill and coordination tests. In 12 weeks, they practiced differential learning handball training immediately after warming up in weeks 1-3-5-7-9-11 and in the last part of the training in weeks 2-4-6-8-10-12. While handball players were doing plyometric training, applications were made by selecting the degree of difficulty according to the loading intensity of the general training (generally 3 movements) among the movements determined as 15 in total according to the skills they use the most.

Plyometric training

The plyometric exercises used during the study are given below:

A. For lower extremity development; leg hops, tuck jump, vertical jumps, lateral/diagonal and broad jumps, vertical and obstacle jumps, standing long jump, box jumps, drop jumps
B. For upper extremity development; explosive push-ups, jumping spiders, clapping push-ups, medicine ball presses, rotational throws, chest passes, overhead throws

Performance tests of the study

In order to measure the motor skills of the athletes, multi-directional speed, agility and body control tests were used.

T-test: It was performed on a flat non-slip surface with four cones and a stopwatch. Athletes were made: to sprint (the order of going to the cones was A-B-C-D-B-A) (Pauole et. al.2000).

Obstacle test: Six 12 m long obstacles (60 cm high and 80 cm wide) were placed 2 m apart. The runner was asked to run over the first obstacle, under the second obstacle, and after the six obstacles to the starting line by the shortest route (Alricsson et. al. 2001).

Zig-zag running test: The length of the field was 3,04-4,86 m with colored bands and cones at each corner. Athletes were asked to run zig-zag (Ortiz et.al. 2005).

Handball coordination tests

Hand wall toss pass test: The purpose of the hand wall toss pass test is to measure hand and eye coordination. A tennis ball was taped 2 meters away from a flat wall. The stopwatch was started when the athlete first threw the ball against the wall. The ball was caught with the opposite hand each time it was thrown. After 30 seconds, the number of repetitions was noted (Cho et. al. 2020).

Wall quick pass test: The aim of the handball-specific wall quick pass test is to determine the ball throwing speed and the number of passes. A shooting line was drawn 2 m. away from a flat wall and a spare ball basket was placed behind the shooting line. The athlete tried to reach the maximum number of passes within 30 seconds (Mülazımoğlu, 2007).

Handball slalom dribbling test: The aim of the handball-specific slalom dribbling test is to determine dribbling skills. 5 funnels are placed at a distance of 15 meters, spaced three meters apart. The athlete dribbles with his/her right or left hand or in a mixed manner by drawing an 'S' between the slalom bars. He returns from the last slalom bar and slaloms back to the starting point (Lidor et. all, 2005) and the stopwatch is stopped.

Data analysis

In the evaluation of the data, shapiro-wilk test was used as normality test for the difference between the groups and levene test was used for homogeneity of variances. Independent t-test and Mann whitney-U tests were used to look at the difference between the groups; paired sample t-test was used for the normally distributed group and Wilcoxon test was used for the non-normally distributed group in in-group pre-test and post-test comparisons. SPSS statistics 22.0 program was used for the analysis.

RESULTS

The differences between the groups before and after training are as follows. To determine their body composition, body weights were measured in kg and height in meter(m). Body mass index (BMI) was calculated in kg/m^2. The height of the classical handball training group was 1.53 ± 0.07 m, body weight was 45.64 ± 8.57 kg, and body mass index (BMI) was 19.27 ± 2.58 kg/m^2, while the height of the differential learning handball training group was 1.52 ± 0.08 m, body weight was 46.09 ± 9.38 kg, and body mass index (BMI) was 19.67 ± 2.34 kg/m^2.

Table 2. Normality test results of the differential learning group and classical learning group

Variables	Group	Mean	SD	Min	Max	Shapiro-Wilk	p
Age (y)	CL group	11.77	0.53	11	13	0.70	**0.000****
	DL group	11.68	0.65	11	13	0.77	**0.000****
Body weight (kg)	CL group	45.64	8.57	32	60	0.94	0.235
	DL group	46.09	9.38	34	61	0.89	**0.016***
Body height (m)	CL group	1.53	0.07	1.39	1.63	0.92	0.073
	DL group	1.52	0.08	1.40	1.70	0.95	0.279
Body mass (kg/m^2)	CL group	19.27	2.58	15.65	25.30	0.95	0.325
	DL group	19.67	2.34	16.67	24.44	0.93	0.100

*CL Group= Classic Learning Group; DL Group= Differential Learning Group; ** p<0.01 * p<0.05*

In the evaluation of the normality test results for the physical characteristics variables of the athletes, the Shapiro-wilk test was used as the normality test for the difference between the groups. According to the results of the test, it can be said that the measurements of at least one of the groups for the age and weight variables in table 2, do not fit the normal distribution, while the height and BMI variables fit the normal distribution in both the differential learning group and the classical learning group (p>0.05).

Table 3. Results of the changes in motor skill measurements between pre-test and post-test in the classical learning handball training group

		Pre-test	Post-test	Paired t-test		Wilcoxon	
Variable	**n**	**Mean ± SD**	**Mean ± SD**	**t**	**p**	**Z**	**p**
Zig-zag running	22	8.76 ± 1.62	8.50 ± 1.36	2.64	**0.015***		
Obstacle Test	22	13.82 ± 2.68	13.82 ± 2.68			-2.78	**0.006****
T-test	22	11.40 ± 0.80	11.40 ± 0.80	2.60	**0.017***		

** *p<0.01* * *p<0.05*

In table 3, the zig-zag running test variable of the athletes in the classical handball training group was 8.76 ± 1.62 sec. in the pre-test and 8.50 ± 1.36 sec. in the post-test; obstacle test was 13.82 ± 2.68 sec. in the pre-test and 12.74 ± 2.14 sec. in the post-test; t-test was 11.40 ± 0.80 sec. in the pre-test and 11.09 ± 1.06 sec. in the post-test. There is a statistically significant difference (p<0.05) in zig zag running (p<0.05). obstacle test (p<0.05) and t-test (p<0.05) pre-test and post-test skill changes (p<0.05).

Table 4. Results of changes in motor skill measurements between pre-test and post-test in differential learning handball training group

		Pre-test	Post-test	Paired t-test		Wilcoxon	
Variable	**n**	**Mean ± SD**	**Mean ± SD**	**t**	**p**	**Z**	**p**
Zig-zag running	22	9.48 ± 0.63	8.70 ± 0.56	9.95	**0.000***		
Obstacle Test	22	14.45 ± 1.84	12.48 ± 1.84			14.79	**0.000****
T-test	22	12.44 ± 0.81	10.85 ± 1.18	10.01	**0.000****		

** *p<0.01* * *p<0.05*

In table 4, the zig-zag running test variable of the athletes in the differential learning handball training group was 9.48 ± 0.63 sec. in the pre-test and 8.70 ± 0.56 sec. in the post-test; obstacle test was 14.45 ± 1.84 sec. in the pre-test and 12.48 ± 1.84 sec. in the post-test; t-test was 12.44 ± 0.81 sec. in the pre-test and 10.85 ± 1.18 sec. in the post-test. There is a statistically significant difference (p<0.05), in the pre-test and post-test skill changes in zig-zag running (p<0.05), obstacle test (p<0.05) and T-test (p<0.05).

Table 5. Results of the change between the pre-test and post-test of handball coordination measurements of the athletes in the classical learning handball training group

Variable		Pre-test	Post-test	Paired t-test		Wilcoxon	
	n	**Mean ± SD**	**Mean ± SD**	**t**	**p**	**Z**	**p**
Handball slalom dribbling	22	10.86 ± 1.53	10.71 ± 1.60			-2.00	**0,046***
Wall quick pass	22	22,95 ± 3,61	24,64 ± 3,50	3,67	**0,001****		
Hand wall toss pass	22	15.82 ± 3.62	17.41 ± 2.74			-2.70	**0.007****

** *p<0.01* * *p<0.05*

In table 5, the handball slalom dribbling test variable of the athletes in the classical handball training group was 10.86 ± 1.53 sec. in the pre-test and 10.71 ± 1.60 sec. in the post-test; wall quick pass test was 22.95 ± 3.61 in the pre-test and 24.64 ± 3.50 in the post-test; hand wall toss pass test was 15.82 ± 3.62 in the pre-test and 17.41 ± 2.74 in the post-test. There is a statistically significant difference (p<0.05) in handball slalom dribbling (p<0.05), handball wall pass test (p<0.01) and hand wall toss pass test (p<0.05) pre-test and post-test skill changes (p<0.05).

Table 6. Results of the changes between the pre-test and post-test of handball coordination measurements of the athletes in the differential learning handball training group

Variable		Pre-test	Post-test	Paired t-test		Wilcoxon	
	n	**Mean ± SD**	**Mean ± SD**	**t**	**p**	**Z**	**p**
Handball slalom dribbling	22	13.79 ± 2.37	12.04 ± 2.00			-4.11	**0.000****
Wall quick pass	22	16.95 ± 3.71	26.41 ± 3.80	19.42	**0.000****		
Hand wall toss pass	22	13.77 ± 3.72	20.68 ± 3.24	15.02	**0.000****	-2.70	**0.007****

** *p<0.01* * *p<0.05*

In Table 6, the handball slalom dribbling test variable of the athletes in the differential learning handball training group was 13.79 ± 2.37 sec. in the pre-test and 12.04 ± 2.00 sec. in the post-test; wall quick pass test was 16.95 ± 3.71 sec. in the pre-test and 24.41 ± 3.80 sec. in the post-test; hand wall toss pass test was 13.77 ± 3.72 sec. in the pre-test and 20.68 ± 3.24 s in the post-test. There is a statistically significant difference ($p<0.05$) in the pre-test and post-test skill changes in handball slalom dribbling ($p<0.05$). wall quick pass test ($p<0.05$) and hand wall toss pass test ($p<0.05$).

DISCUSSION

In this study, agility, coordination and passing skills, which are the basic variables of handball, were trained using differential learning techniques and motor skill performance tests were used.

Regarding the importance of plyometric exercises, Hammami et al. (2019) reported increases in sprint, change of direction and jump performance after 8 weeks of plyometric training with change of direction exercises in male handball players under 15 years of age. Similar to the results of our study, an increase in agility and motor skill performance improvements was determined in the differential learning handball group.

Regarding differential learning, Savelsbergh et al. (2010) compared the differential learning group with the classical learning group in speed skating. Although there was no significant difference between the groups, they reported that the performance of the differential learning group showed more improvement.

In another study, Tallir et al. (2012) compared 3:3 and 5:5 basketball games and found that small side games that provide a differential learning environment have more positive effects on variables in the actual game, and in another study, Schollhorn et al. (2012) provided clear evidence of the superiority of the differential learning approach, taking into account the results of their tests on soccer technique in their research. Similarly, Coutinho et al. (2018) reported that enriched training programs based on differential learning and physical literacy seem to have the potential to improve the in game performance of attacking players in football and the results obtained from this study confirmed their hypothesis that there are improvements in physical, technical, creative and tactical performances, especially in the U15 age group, and can be used to improve performance in the training of attacking players in football. In another study, Santos et al. (2018) reported that coaches can use differential learning variations sustained in small side games to enhance players' creative and tactical behaviors and improve their ability to adapt to the environment. The results of our study also showed that differential learning handball group started to perform small-sided games better with the gains in agility and coordination skills obtained in the trainings.

In one more another study, Santos et al. (2017) in the results of their study "Effects of the Skills4Genius sport-based training program on creative behavior" showed that a training program sustained in creative thinking, differential practice, physical literacy and non-linear pedagogy has great potential to promote overall creativity in team sports. Another study in this direction Wagner and Müller, (2008) reported the effects of different and differential training on the quality parameters of handball throwing in handball, and in another team sport study, Mateus, et. al. (2015) in their conclusions on basketball differential learning, they reported that the experimental group of "BasketCAL" students were continuously exposed to different and varied stimuli, allowing the athletes to develop attentional mechanisms to use the necessary information to overcome these constraints of the game. Similarly, Haudum et al. (2011) confirmed that the different stimuli imposed by different training allow individuals to develop the skills they need to succeed in dynamic game situations. In the research on differential learning, Torrents and Balagué (2006) reported that differential training benefits the performance indicators and behavioral aspects of the game and is supported by research highlighting the ability of players to find the best solutions to constant environmental changes, adapting their behavior to practice. Similarly, in the results of our study, skills such as agility, change of direction, body control, agility, coordination, slalom dribbling, and quick passing, which are important skills that must be done in handball, were observed in the results of our study. It was seen that the performances of the athletes in the differential learning handball group performed better than all the athletes in the classical handball group in terms of handball coordination skills and motor skills.

CONCLUSION

As a result, in our study, the motor skills and handball coordination tests of the handball training group with differential learning method showed more improvement than the classical training group. The fact that there were significant improvements in the control group can be characterized as the natural effect of the sport depending on the age period. Compared to the classical handball group, the handball training group with differential learning method showed more performance improvement.

However, as in the studies in the literature in which differential learning method was applied in other sports branches, we recommend that differential learning method should be used and disseminated as an option for handball athletes from team sports. Adding differential learning to the traditional training and increasing the diversity by combining it with different methods and techniques will increase the individual development of the athletes and provide an effective support in raising elite and more successful athletes with high self-confidence and developed skills.

PRACTICAL APPLICATIONS

In our study, the positive effect of the differential learning model on agility and handball-specific coordination skills was revealed. It is recommended that coaches interested in sports branches where agility and coordination are important in team sports should take the results of our study into consideration. In this way, coaches can increase the performance development of athletes and achieve more successful results.

REFERENCES

Alricsson, M., Harms-Ringdahl, K., & Werner, S. (2001). Reliability of sports related functional tests with emphasis on speed and agility in young athletes. *Scandinavian Journal of Medicine & Science in Sports, 11*(4), 229-232.

Bozkurt, S. (2018). The Effects of Differential Learning and Traditional Learning Trainings on Technical Development of Football Players. *Journal of Education and Training Studies, 6*, 25-29.

Button, C., Macleod, M., Sanders, R., & Coleman, S. (2003). Examining movement variability in the basketball free-throw action at different skill levels. *Research Quarterly for Exercise and Sport, 74*(3), 257-269**.**

Cho, E.H., Yun, H.J., & So, W.Y. (2020). The validity of alternative hand wall toss tests in Korean children. *Journal of Men's Health, 16*(1), 10-18.

Coutinho, D., Santos, S., Gonçalves, B., Travassos, B., Wong, D. P., Schollhorn, W., & Sampaio, J. (2018). The effects of an enrichment training program for youth football attackers. *PloS one, 13*(6), e0199008.

Erdil, G. (2016). Farklılıkla öğrenme motor becerilerin öğrenimine farklı bir bakış. *Marmara Üniversitesi Spor Bilimleri Dergisi, 1*(1), 39-48.

Hammami, M., Gaamouri, N., Aloui, G., Shephard, R.J., & Chelly, M.S. (2019). Effects of combined plyometric and short sprint with change-of-direction training on athletic performance of male U15 handball players. *The Journal of Strength & Conditioning Research, 33*(3), 662-675.

Haudum, A., Birklbauer, J., Josef, K., & Muller, E. (2011). Motor learning of gross-motor skills under variable practice conditions. *Baltic Journal of Sport and Health Sciences, 1*(80), 22-28

Johnson, B.A., Salzberg, C.L., & Stevenson, D.A. (2011). A systematic review: plyometric training programs for young children. *The Journal of Strength & Conditioning Research, 25*(9), 2623-2633.

Lidor, R., Falk, B., Arnon, M., & Cohen, Y. (2005). Measurement of talent in team handball: the questionable use of motor and physical tests. *Journal of Strength and Conditioning Research, 19*(2), 318.

Mateus, N., Santos, S., Vaz, L., Gomes, I., & Leite, N. (2015). The effect of a physical literacy and differential learning program in motor, technical and tactical basketball skills. *Revista de Psicología Del Deporte, 24*(1), 73-76.

Meylan, C., & Malatesta, D. (2009). Effects of in-season plyometric training within soccer practice on explosive actions of young players. *The Journal of Strength & Conditioning Research, 23*(9), 2605-2613.

Mokha, M., Sprague, P.A., & Gatens, D.R. (2016). Predicting musculo skeletal injury in national collegiate athletic association division II athletes from asymmetries and individual test versus composite functional movement screen scores. *Journal of Athletic Training 51*(4), 276-82.

Muratlı, S., Kalyoncu, O., & Şahin, G. (2011). Antrenman ve müsabaka (3 b.). İstanbul: Kalyoncu Spor Danışmanlık San. Tic. Ltd. Şti. 8-12.

Mülazımoğlu, O. (2007) Hentbol yetenek test bataryası geçerlik ve güvenilirlik çalışması. *Sport Sciences, 4*(4), 300-312.

Ortiz, A., Olson, S.L., Roddey, T.S., & Morales, J. (2005). Reliability of selected physical performance tests in young adult women. *The Journal of Strength & Conditioning Research, 19*(1), 39-44.

Pauole, K., Madole, K., Garhammer, J., Lacourse, M., & Rozenek, R. (2000). Reliability and validity of the T-test as a measure of agility, leg power, and leg speed in college-aged men and women. *The Journal of Strength & Conditioning Research, 14*(4), 443-450.

Rubley, M.D., Haase, A.C., Holcomb, W.R., Girouard, T.J., & Tandy, R.D. (2011). The effect of plyometric training on power and kicking distance in female adolescent soccer players. *The Journal of Strength & Conditioning Research, 25*(1), 129-134.

Santos, S., Jiménez, S., Sampaio, J., & Leite, N. (2017). Effects of the Skills4Genius sports-based training program in creative behavior. *PloS one,* 12(2), e0172520. https://doi.org/10.1371/journal.pone.0172520

Santos, S., Coutinho, D., Gonçalves, B., Schollhorn, W., Sampaio, J., & Leite, N. (2018). Differential learning as a key training approach to improve creative and tactical behavior in soccer. *Research Quarterly for Exercise and Sport, 89*(1), 11-24.

Savelsbergh, G.J., Kamper, W.J., Rabius, J., De Koning, J.J., & Schollhorn, W. (2010). A new method to learn to start in speed skating: A differencial learning approach. *International Journal of Sport Psychology, 41*(4), 415.

Schollhorn, W.I., Hegen, P., & Davids, K. (2012). The Nonlinear Nature of Learning – A Differential Learning Approach. *The Open Sport Science Journal, 5,* 100-112. https://doi.org/10.2174/1875399X01205010100

Schollhorn, W.I, Michelbrink, M., Welminsiki, D., & Davids, K. (2009a). Increasing stochastic perturbations enhances acquisition and learning of complex sport movements. *Perspectives on Cognition and Action in Sport*. Nova Science Publishers, Hauppauge, NY, United States 59-73

Schollhorn, W.I., Mayer-Kress, G., Newell, K.M., & Michelbrink, M. (2009b). Time scales of adaptive behavior and motor learning in the presence of stochastic perturbations. *Human Movement Science, 28*(3), 319-333. https://doi.org/10.1016/j.humov.2008.10.005,

Schollhorn, W.I. (1999). Individualität-ein vernachlässigter Parameter. *Leistungssport 2/99 magazine*,7-11.

Tallir, I., Philippaerts, R., Valcke, M., Musch, E., & Lenoir, M. (2012). Learning opportunities in 3 on 3 versus 5 on 5 basketball game play: An application of nonlinear pedagogy. *International Journal of Sport Psychology, 43*(5), 420-437.

Torrents, C., & Balagué, N. (2006). Dynamic systems theory and sports training. *Baltic Journal of Sport and Health Sciences,* 1(60). 72-83.

Usluer, S.N., Aktug, Z.B., İbis, S., & Aka, H. (2021). The effect of corrective exercises on functional movement screen test and motor skills. *Journal of Human Sciences, 18*(3), 390-399.

Wagner, H., & Muller, E. (2008). The effects of differential and variable training on the quality parameters of a handball throw. *Sports Biomechanics, 7*(1), 54-71.

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Cakıt, I., Camlıgüney, A.F. & Erdil, N.G. (2022). The Impact of Differential Learning Model on Motor Skills and Handball-Specific Coordination Performance in 11-13-Year-Old Beginners in Handball. *International Journal of Sport Exercise and Training Sciences - IJSETS*, 8(4), 152-160. DOI: 10.18826/useeabd.1152610