Effects of variability of practice using the concept of differential approach and traditional learning on learning round-off in gymnastics based on the analysis of movement construction

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Abstract:

The objective of this study is to assess the effect of differential learning approach in comparison with the traditional learning in learning round off in gymnastics as a one of close motor skill. thirty two accademic students (boys M = 20.5, SD = 3.2 years) parallelized to two groups according to pre-test results: differential learning group wheareas the other group was tranditional learning group. in both groups 90. Min. Training units (2 dayes/week) were performed for 8 weeks. The **'Differential learning'** group was based on the indications for differential learning according to Schöllhorn (1999), tabel (1) shows a list of possible variations of the round off. In this experiment differential learning group completed stochastic movement variations and Increasing the number of movement fluctuations, The **'tranditional learning'** group completes a methodical series of round off with blocks of repetitive movements that build on one to another, in addition the students in this group was perfromed the skill with corrective feedbacks. The contents of traditional technique training are based on the classic methodical exercise series for learning the round off. Results was determined that, differential learnig method is more effective than traditional learning method in learing round off in gymnastics.

Introduction:

The aim of movement instruction at schools and clubs in early childhood is to help children learn better while promoting physical, social, and emotional development. Research suggests that when developing gross motor skills such as walking, running, and jumping, they are also developing their cognitive abilities. It is connected to our visual processing, spatial perception, and cognitive abilities. When a child or young player wants to learn a new skill then the classic idea of movement learning is normally as follows: they repeat the movement to be learned several times in a row. In the beginning, the movement is usually achieved very unsafe and has many technical errors. Teachers and trainers have a certain idea of what the target movement should look like and tries to transfer this to the learner as comprehensibly as possible using visual or descriptive information. Everything that corrupts from this optimal movement (technical model) during the execution is wrong and must be avoided if possible during the repetition of the trainer (constant target / actual value comparison). The deviation from the technology model is increasingly reduced until the target

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movement is reached with as little variation as possible. That means in this research traditional learning. This approach is used in physical education or training in clubs. The trainers or teachers try to repeat the movement and correct the errors until movement or technique is achieved.

Another strategy to learn movements is the system dynamic approach. it regards the phenomenon of movement as a complex (i.e. consisting of many individual components) and dynamic (i.e. changing over time) system. The interaction of the individual components (neurons, muscles, limbs, etc.) determines the externally visible movement; however, this interaction is not determined by a central motor program or similar but it is self-organized. Then learning movement is a process that aims to discover the regularities of the specific task-person-environment constellation. This can only happen through active and authentic movement experiences. Variations in the execution of movements are not to be interpreted as errors, but as an inherent and ultimately necessary phenomenon in the search process. Newell et al. (1989) describe various search strategies in this context. it makes sense to intensify the natural variations when learning to move to support the search process in this way and possibly even to maintain it over a longer period, namely until found the individually optimal movement solution. Schöllhorn (1999, 2003) developed the method of differential learning, in which - in contrast to traditional learning - experiences of difference or discrepancy are consciously conveyed, which, metaphorically speaking, should set and keep the "learner system" vibrating. With the classic learning methods that the learner "settles down" prematurely on a suboptimal movement, the strong variation of the movement execution but in differential learning should lead to suboptimal movement solutions being abandoned repeatedly until the movement optimum is finally reached. It must be taken that the optimum movement can shift because of the change in the task-person-environment constellation during the exercise process.

As a new teaching and learning approach that tries to combine both critical points is the approach of differential teaching and learning (Schöllhorn, 1999), which essentially assumes that an additional increase in the fluctuations that occur in all phases of the learning process increases performance has an effect.

Within the scope of these factors, meeting the multifaceted demands regarding the skill characteristics of the round off in the floor exercise in gymnastics. Within this context, it became very important to employ scientific and innovative methods in achieving the desired level of performance. One of these methods is differential learning (Schöllhorn, 2000). In this method, the diversity in a method is considered rather than the repetition multiple times. The Differential Learning Method is based on adapting to the random instruments, ground, and body motions to the skill

to confuse the mind, avoid the repetition during the acquisition, and then avoid corrective feedback (Schöllhorn et al., 2012). The results obtained by integrating random tools, grounds, and movements into the skill in the learning process are at least as successful as the results obtained in traditional teaching methods. Moreover, it was observed that the skill learning gains are at a higher level in the differential learning approach (Müller et al., 2009).

After initial studies on differential technique training in sprinting, which led to the same performance progress when training twice a week (differential) as training five times a week (classic), numerous studies have now been carried out in different sports, different performance and age groups with the same results. Two studies on soccer (Trockel & Schöllhorn, 2003) and the shot put (Beckmann & Schöllhorn, 2003) are listed here as examples.

Especially, previous studies on differential learning have shown results and oriented open and closed skills (Poulton, 1957). However, the performance of the forehand in tennis or the long jump lags behind the movement result achieved (Gawin & Jaitner, 2003). Previous also oriented closed movements such as the handspring and round off in gymnastics; these are evaluated according to their deviation from an ideal movement and accepted by experts. The differences in the movement at the training units are often interpreted as (errors) and attempt to correct these errors through feedback and technique corrections. In differential learning (Schöllhorn, 1999) when the round-off skill to be learned must constantly variations in geometry and in terms of speed, acceleration, and rhythm in addition to some errors. The basis for the differential learning model is the observation that movements in learning and high level do not seem to be repeatable (Bauer & Schöllhorn, 1997). Recent studies show that non-repeatability even for different performance classes gymnasts, although they train as precise a movement reproduction as possible (Hiley et al., 2013). Against this background, the present study compares the effects of differential learning with traditional learning or 'learning through repetitions' on the acquisition and learning performance of novices using the example of round off.

Aim of the study

The objective in This study is to evaluate the effect of differential learning approach on learning the Round off in floor exercise gymnastics in comparison to the traditional teaching methods.

Research hypotheses

- The first hypothesis is that the differential learning method and traditional learning would have positive effect on the learning round off.
- Second hypothesis is that the retention effect of differential learning approach would be higher than the traditional learning on learning Round off.

Previous studies:

- Yahya Yıldırım etal. (2020) study titled (The effect of differential learning method on the international tennis number level among young tennis player candidates) to estimate the effects of Differential Learning concept in comparison with the traditional training methods on learning tennis stroke techniques, retention of skills, and improving the mobility time of young tennis player, twenty four young tennis player doing a tennis course in Istanbul were involved in this study. They divided to two groups one named differential training group and another named control group. Both groups were performed training three days /week for 10 weeks. Result for this study showed that, differential training group is more effective than traditional training group in learning tennis strokes and retention of learning, and there were no statistically significant difference observed in mobility time for both groups.

- Study Bozkort (2018) titled (The Effects of Differential Learning and Traditional Learning Trainings on Technical Development of Football Players) to study the effects of traditional versus differential training on the technical development of young football players under 15 years old technical training for football player under 15 years old who have been continuing football training. The sample was twelve (12) football players from youth football team of Istanbul Kavacik club on the football field with synthetic grass in 2016. The 12-football player divided to two groups. The researcher in this study used the Mor-Christian soccer-passing test, German Football Association agility/dribbling test, and feet-juggling test. Results suggest no clear difference for the superiority of the differential learning approach of the technique tests in comparison to the classical training approach. But for differential group players were able to improve their performance in all tests and techniques better than classical group. As a recommendations for this study is to provide advice to coaches to use these methods, which showed positive results in the study variables, to be used in designing training programs for players

- Santos sara (2018) study titled (Differential learning as a pioneering training approach to improve creative and tactical behavior in soccer( ) to identify the effects of differential learning, built in small games program on tactical behavior and creative of youth football player. 40 player under 13 years and under 15 years were divided to two experimental groups. All players were tested using pre- post test design using small- side games conditions. The differential group participated a five month program in differential learning program, the control group participated the same time typical small side games program. Results in this study suggested that differential leaning group showed better of the development of creative components, and provided a decrease in fails during the game. In addition to the differential lerning group seemed to favor regularity in pitch-positioning behavior for the distance between

players' dyads. Overall, these findings confirmed that differential learning nurtures regularity of positioning behavior.

- Bekmann (2013) study titled (Investigation of the effects of different ranges of variation of differential learning and teaching in a broad sense on selected basic technical skills in indoor hockey) to study the influence of spatial (movement execution, movement result) and temporal variations (temporal distribution of the training stimuli) on the acquisition and learning performance of large motor sports movements is examined using the example of two basic technical skills of indoor hockey. The results of the experiments support the findings on differential learning and teaching, according to which an increase in variation in the acquisition phase leads to greater acquisition and learning performance. In addition, the assumption is confirmed that there is a connection between the variation range and the learning rate in the form of an optimal trend. Here individual factors (e.g. the learning biography) as well as the phase in the learning process (acquisition, learning) seem to have an influence on the scope and structure of a range of variation necessary for optimal adaptation. In addition, the findings indicate different appropriation and learning effects due to the sole variation of the temporal distribution with otherwise the same training stimuli.

Method:

Methodology used:

Experimental approach designed with two experimental groups, differential lernen gorup and the other experimental group was traditional lenring group using pre and post measurement have been used

participants

thirty two accademic students (boys M = 18.37, SD = 0.40 years) that they completed at least one course in gymnastics in the previous terms. They completed three trails in the skill of (hand stand and Cartwheel) as a pretest for each person, the main of the three test trails is calculated. Students parallelized to two groups according to pre-test results: differential learning group wheareas the other group was tranditional learning group. All participants were informed about the protocol of this study. All procedures were done in the sport Hall of the university..

The homogeneity of the research sample:

Tables (1)

The researcher performed homogeneity for the basic research sample using the skew coefficient in the variables (age - height - weight) and illustrate this

variables	unit	Main	SD	kurtosis	skewness
Age	Year	18.38	0.40	-1.25	0.498
length	Cm	169.20	3.50	0.823	0.594
weight	kg	66.01	4.44	-1.36	0.680

It is clear from Table (1) the arithmetic mean, standard deviation and the value of the skewness coefficient of the basic research sample

in the growth rates (age - height - weight), as the skewness coefficients for these variables were confined between (±3), which indicates the moderation and homogeneity of the sample distribution in these variables.

Table (2)

Arithmetic averages and standard deviations of the growth variables (age, height, weight) of the research sample (N1=N2=16)

variation	unit	Differential group N= 16		Traditional group N=16		t value
		M	SD	M	SD	
age	year	18.40	0.41	18.34	0.39	0.22
length	Cm	169.80	3.50	168.60	3.50	0.28
weight	kg	66.80	3.88	65.40	5.50	040
handstand	point	7.50	2.3	7.20	2.5	0.8959
cartwheel	point	6.3	3.4	6.5	3.2	-0.273

It is evident from Table (2) that there are no statistically significant differences at the level of 0.05 between the two experimental control groups in growth rates (age - height - weight), which indicates that the two research groups are equal in these variables. Also, there were no statistically significant differences at the 0.05 level between the two experimental groups in the scores of the handstand skill test and the side somersault test on the hands (wheel) as one of the basic skill determinants to learn the forward somersault skill on the hands with a quarter turn in gymnastics, which indicates the equivalence of the two research groups in this variables.

Procedures and mesurements

During the acquisition bothe groups were performed eight training units, every training unit was 90 min for 4 weeks. At the begining of training units participant performed warmimg up and stretching.

The **'Differential learning'** group was based on the indications for differential learning according to Schöllhorn (1999), tabel (1) shows a list of possible variations of the round off. In this experiment differential learning group completed stochastic movement variations and Increasing the number of movement fluctuations (i.e., exploring a range of movement solutions) in a random manner. in addition to teacher/trainer didn't give the students any correction's feedback and there was no coaching instruction for correct technique. The variations affected either a single aspect or several simultaneously. The exercise variations corresponded to the safety standard of students learning, and they were also adapted to the performance requirements of the university units.

The **'tranditional learning'** group completes a methodical series of round off with blocks of repetitive movements that build on one to another, in addition the students in this group was perfromed the skill with corrective feedbacks. The contents of traditional technique training are based on the classic methodical exercise series for learning the round off

(Timmermann 2001). Methodical exercise series pursue a gradual approach to the motor skill to be learned according to the methodical didactic principles "from easy to difficult, from simple to complex" and "from known to unknown". Traditional training aids were learnen the skill with the normal step by steb. At the beginning of the exercise program there were lernen with support from teacher. After many repetitions, a round off was performed under normal condition. Series of images and movement demonstrations by the teacher served to illustrate the target movement. In the three interventions,

At the end of every trainig unit both groups performed the cool dowen with the same dauer and same contents. Results were checked using post test and retention test. In the post and retention test all participants completed a three trails in round off in competetive conditions after the last unit of aqusition (Post test) and after one week (retention test). All trails are recorded on video and demonstrated to three gymnastics judges (experience more than 10 years) in randomized order. The competition judges evaluate each attempt with the help of the hand support round off evaluation sheet according Ata et al. (2005) on a scale of 0-20 points (tab 1). For each person and test, the main of the three trails is used for the statistical evaluation.

Table 1: Analysis criteria for evaluating the Rondat (ata, 2005)

Aspect	indicator	Points = 20
Begining the movement	taken a step with your dominant leg	1
	Practice the quarter-turn action	1 ∑ = 4
	forward with your legs together, arms by your sides	1
	Bent Hib – leg angel	1
Support time	Hib straight	1
	Arm straight	1
	Leg straight	1
	Rotation in long axis	2 ∑ = 11
	Head between arms, eyes forward and down	1
	Closed legs	2
	Impression with hands	3
Fly period	Body rotate free in the air	2 ∑ = 2
landing position	1/2 rotate (body is aligned and player facing the direction he started from.	1
	Upper body staight	1 ∑ = 3
	Landing in control	1

Statistical analysis:

the data were analyses using SPSS 25.0 package software. The OneWay ANOVA statistical test wer used to analyzed the intergroup differences, wheares for the pretest, posttest and retention test the repeated measures tests was perfeormed for differences between this tests. for interpreting the statistical analyses, the level of significance was set at $p<0.05$

Results and discussion

The test reliability was checked before analysis the results. The assessments were carried out by two judge separately and independently of one to another. As already mentioned, the analysis were carried out based on video recordings. Some of the analysis criteria listed in Table 2 required the video recordings to be played back in slow motion (e.g. the actions in the support phase). The observer agreement (interrater objectivity) was determined using the Pearson correlation coefficient. Overall, the coefficients show a satisfactory to good agreement between the two observers (r=0.97) this results shown in table (3)

Table (3)

Observation agreement by evaluation motor performance of round of between the 2 judge (N=32)

correlation	Round off
(r)	0.97

Pretest:

As a result of the pretest, subjects performed three trails of the skill of Handstand and Cartwheel then the arithmetic mean was calculated for the total score of each participant in every skill. subjects were distributed to the test groups according to the principle of the same rank sum (example: subjects in ranks 1 and 4 were assigned to the differenial lerning group, subjects in ranks 2 and 3 to the tradinial lenrning group, etc.). In this way, the same level of input power was guaranteed in both groups (t (30) = -0.273; p = 0.71). it was determined that there was no significance between the two groups in the pretest.

Table (4)

Arithmetic averages and standard deviations in the pre-measurement between the experimental group and the control group (N1=N2=16)

variation	unit	Differential group		Traditional group		(t)value	p value
		M	SD	M	SD		
Hand stand	Point	7.50	2.3	7.20	2.5	0.8959	0.18
Cartwheel	Point	6.3	3.4	6.5	3.2	-0.273	0.71

The result from Table (3) explained that there are no statistically significant differences at the level of 0.05 between the two experimental groups in the scores of the handstand skill test and cartwheel test that might

two of the basic skill determinants to learn the round off in gymnastics, which indicates the equivalence of the two research groups in these variables.

posttest and retention test:

Table (5 and 6) illustrates the results of main and interaction effects for the motor performace in the pre-, post, and retention tests. the Results show that there was a statistical significant difference between the two groups in the Post test (F(1,32)= 44.47 p0.00 and retention test (F(1,32)= 71.59 p0.00. Both groups improved their Performance in the course of the post and retention phase and it was significant, The group effect is also significant. The variable practicing diffenrential leneing group achieved better performance than the traditional learning group.

Table (5)

Descriptive statistics in the pre. poet., and retention tests for classic and differential groups (N1=N2=16)

		N	Mean	SD	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
						Lower Bound	Upper Bound		
Pre-test	classic	16	7.4375	.79553	.19888	7.0136	7.8614	5.00	8.33
	differentiell	16	7.3958	.71200	.17800	7.0164	7.7752	5.67	8.33
	total	32	7.4167	.74295	.13134	7.1488	7.6845	5.00	8.33
Post test	classic	16	10.5000	.77936	.19484	10.0847	10.9153	9.67	12.00
	differentiell	16	12.2083	.66528	.16632	11.8538	12.5628	10.33	13.00
	total	32	11.3542	1.12303	.19853	10.9493	11.7591	9.67	13.00
Retention	classic	16	9.3958	.80938	.20234	8.9645	9.8271	8.00	11.00
	differentiell	16	11.3750	.46944	.11736	11.1249	11.6251	10.00	12.00
	total	32	10.3854	1.19770	.21172	9.9536	10.8172	8.00	12.00

Table (6)

ANOVA Main and interaction effects for the motor performance in the pre-, post and retention test

		Sum of Squares	df	Mean Square	F	Sig.
Pre-test	Between Groups	.014	1	.014	.024	.877
	Within Groups	17.097	30	.570		
	Total	17.111	31			
Post test	Between Groups	23.347	1	23.347	44.471	.000
	Within Groups	15.750	30	.525		
	Total	39.097	31			
Retention	Between Groups	31.337	1	31.337	71.589	.000
	Within Groups	13.132	30	438		
	Total	44.469	31			

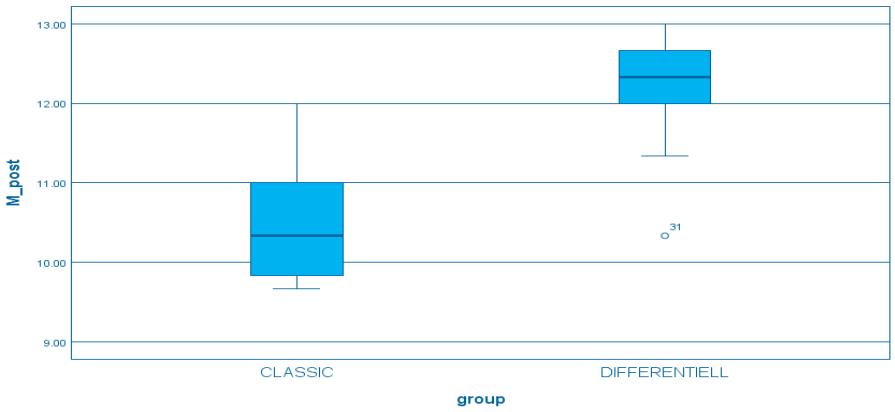
Hypothesis 2 is thus confirmed!

In order to test the differences between the two groups under consideration in the post and retention tests, the NPR test was conducted, which is shown in Table No 7. Wilcoxon tests show that this learning effect solely on the differnteial group practitioners mor better than the calssical learning group wilcoxon in the posttest were 149.500 and in the retention 141.500 Mann Whitney in the post test were 13.00 and in ythe retention 5.00 and in the post test z = -4.34 and in the retention test z = -4.66 and all result schowed that there were a statistical significant effect between the two groups and to the differential group

Table (7)

Npr test between the two groups in the Post test and retention test

NPar Tests	Post	Retention
Mann-Whitney U	13.500	5.500
Wilcoxon W	149.500	141.500
Z	-4.344	-4.667
Asymp. Sig. (2-tailed)	.000	.000
Exact Sig. [2*(1-tailed Sig.)]	.000[b]	.000[b]



With the same starting level, a visible improvement in performance can be observed in both groups. With the exception of one test person (=outlier) in both groups, all students were able to perform a Round off after the interventions. The differential training group performs slightly better than the traditional training group, but the difference between the two groups only shows a tendency. Apparently, one-time, constantly changing movements appear in the area of possible solution space.

to be at least as sufficient for visible performance progress during the acquisition process as example-oriented extensive repetition. Even if the progress in performance of the differentially trained group is not significantly greater than that of the traditionally trained group, it is surprising from a traditional training science perspective that comparably unsystematic training leads to the same progress as goal-oriented systematic learning. While the increase in performance of the traditionally trained group within the given time corresponds to the experience in this area, the same progress in performance is unexpected given an apparently haphazard and at first glance not goal-oriented action for successful learning. This tendency contradicts the assumption that in standardized apparatus gymnastics the supposedly very narrowly defined target execution can only be best controlled through training with many repetitions and precise error corrections geared to the current competition regulations. If we look at the distribution of the point ratings according to the ranks, it is also noticeable that the differentially trained group achieved a higher level than the classic group, especially in the lower range of the ranks. This can be interpreted as individual support on a broad scale, since support is attributed to the differential learning approach, especially in larger groups. If only a small range of movement exercises are offered to a larger group, the probability that these exercises will meet the needs of the entire group and especially of the individual individuals is relatively small. In contrast, if we offer the entire group a variety of exercise alternatives, the likelihood of an exercise that will benefit everyone increases. In general, a first acquisition is associated with relatively large fluctuations in the execution of movements, even if it is repeated. Accordingly, we can assume here that the traditionally trained group also had a relatively large degree of fluctuation, even in the case of repetition (Schöllhorn et al. 2009) and thus comes relatively close to the fluctuation-enhancing concept of the differential approach.

Despite the fluctuations in the phase of initial acquisition in the traditional case, the results indicate that these fluctuations that occur in the case of repetition are too small for optimal learning and that the amplification of the already existing fluctuations actively supports learning. After numerous experiments in different individual and team sports with clear advantages in favor of the differential

learning approach, the present study also points in the same direction in the area of apparatus gymnastics using the example of the round off. Even with normatively very tightly prescribed forms of movement, such as those that occur in gymnastics, extensive fluctuations or their reinforcement in the process of acquisition support the learning process rather than disrupting or even being a hindrance. The differential learning derived from neural and physical principles is therefore not restricted in the area of traditional apparatus gymnastics. Even with world-class athletes, constant fluctuations in the execution of movements can be observed, which can never be repeated and therefore require constant preparation for the new. The differential learning approach with its scanning of the potential limits and the use of the interpolation ability of the human organism is particularly suitable here. What originally began with the assumption of additional information from course-oriented movement analyzes by Rainer Ballreich has now culminated in a complex and sensitive technology (/person) diagnosis in connection with an alternative technology control, which differs significantly from the traditional model of the control loop due to its self-organization tendency for learning processes and has meanwhile stimulated numerous areas outside of sport.

These differences thus confirm Schöllhorn's (1999) prediction that differential learning trains the constant adaptation to changing situations. The results of this study can thus be interpreted as a suggestion to consider differential learning in course-oriented sports as an alternative to traditional learning approaches. Also, there are many studies and research conducted in the learning sprot skills to examining differential learning, and the number of this study gradually increase. this varios expriments repotrted that the variability of practice has a positive effect in learning motor skills (Lage etal. 2015; Bozkurt, 2018; Henz etal. 2018, Yildirm etal., 2020, Strebe 2009).

The theory of differential learning assumes that the brain organizes movements itself and generates the optimal movement response for every situation. Making mistakes is therefore the most important thing in the learning process. The term error is relativized in differential learning and viewed as a natural fluctuation in the execution of movements. Mistakes are therefore unavoidable , but necessary to make the learning process successful. For training practice, this means that movement errors are deliberately incorporated into daily practice. In this way, the process of self-organization in the athlete is triggered in a targeted manner. The systematic variation of initial and final conditions, changing body position during movement, or the changes in the course of movements in terms of duration and rhythm are the parameters to be changed. Studies show that the systematic variation of movements can lead to better learning

and retention performance than classic "grinding" methods (Schöllhorn etal., 2015). In contrast to static system theory, a major objective in dynamic system theory is the process of state changes. Phenomena like fluctuations, their increase and self organization are of primary interest. The differential learning approach is derived directly from dynamic system theory and is verified by sports practice and scientific studies. By increasing fluctuations, a system becomes stable and provides an increased number of modi in order to initiate a self-organizing process. Terms like potential, stability and instability are discussed with respect to their practical consequences. As a result fluctuations and their amplification have been adapted in the differential learning approach and have led to a rethinking of the majority of classical motor learning approaches. Differential learning is convincingly used in sport practice with scientific studies as well as in physio- and ergotherapy

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