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Original empirical article

THE INFLUENCE OF DIFFERENT LEARNING MODELS ON THE ACQUISITION OF SPECIFIC ATHLETIC THROWING SKILLS

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Abstract. *The goal of this research was to establish the effects of two experimental models for motor skill learning in the acquisition of skills from the field of athletic throws (Discus Throw, Shot Put and Javelin Throw). The sample of subjects has been represented by 47 students of the first year of undergraduate kinesiology studies divided into the E1 (N=24) and E2 (N=23) groups. The E1 group has acquired their throwing skills through blocked practicing and the E2 group through random practicing in 12 classes of experimental work. The results given by a multivariate analysis of variance show that both ways of practicing significantly influenced the level of acquisition of the Discus Throw, Shot Put and Javelin Throw skills. However, the random way of practicing also enables a longer retention of the acquired specific skills.*

Key words: *Motor skills, motor learning, students, throw*

INTRODUCTION

Motor learning denotes changes of inner processes which define the capabilities of an individual to perform a specific motor skill task (Schmidt & Wrisberg, 2000). According to Eliot and Madalena (1974) motor learning or the formation of a motor skill is the capability of reaching defined goals with efficiency above the one possessed by an inexperienced person. What is meant by a motor skill is the capability of a "smooth and harmonious" performance of a motor skill task.

While defining the process of motor skill learning, kinesiological involvement (practicing) represents one of the necessary factors without which no improvements on the level of acquisition of specific motor skills can be expected. Having that context in mind,

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it could be said that there are two ways of practicing which give the best basis for the acquisition of different motor skills and those are: "random practise" and "blocked practice".

"Random practice" is defined as the way (order) of practicing in which a person performs a greater number of different motor skill tasks in an undefined order, while "blocked practice" is defined as the way of practicing in which a person through repetition practices the same motor skill task (Schmidt & Wrisberg, 2000). The results of previous research indicate that *blocked* practice is a better way of learning only at the beginning of the process of learning a motor skill, until reaching the conception of the movement structure during the verbal-cognitive stage of learning (Adams, 1971; Fitts & Posner, 1967; Gentile, 1972). After that, *random* practicing should follow (Shea, Kohl, & Indermill, 1990), which in general is defined as a more efficient way of practicing, if acquisition is seen through the retention process (Schmidt & Wrisberg, 2000). The methods of practicing in athletic throw acquisition are almost identical to the methods applied in other sports. A review of previous research (Moreno et. al., 2003; Vera, Alverez, & Medina, 2008; Jones & French, 2007) leads us to the conclusion that with the application of different ways of practising during the process of acquisition of the analyzed motor skills, satisfactory effects can be achieved.

Competition activity in athletic throwing disciplines takes place in highly standardized conditions (the weight of the throwing implements, circle of meters in diameter, the length of the run up) which are defined by the International Association of Athletics Federations (IAAF) and sportspersons are ranked based on accurately measured results given by precise distance measuring equipment. Based on these defining conditions and rules, the acquisition of certain skills necessary for the realization of athletic throw activities surely represents a necessary dimension without which the efficient performance of the given activities would not be possible. Kinesiologists have as their goal the training process in which, in the shortest time possible, with minimum energy waste, optimal results will be achieved. In that context, the right choice of teaching methods in a process of planning and programming has a highly important role.

Taking this into consideration, the basic goal of this research is to establish the effects of two experimental activities on the acquisition of specific athletic Discus Throw, Shot Put and Javelin Throw skills of the first year undergraduate students studying kinesiology.

METHOD

Sample of subjects

The research has been carried out on a sample of 47 students of the first year of undergraduate studies at The Faculty of Kinesiology in Split. The sample has been divided into two groups: the first experimental group (E1; N=24) and the second experimental group (E2; N=23). The subjects had no previous experience with the Discus Throw, Shot Put and Javelin Throw technique. The experimental work was realized within 4 weeks. During that period the subjects were tested during 12 classes of experimental work, 3 times a week for 90 minutes (2 classes).

Measurements

The sample of variables consisted of three specific athletic skills: the Discus Throw, Shot put and Javelin Throw. The judges followed the instructions they had been given while evaluating specific skills, which included a list of minor and major mistakes in the performance of the analyzed skills. With such defined instructions, the judges were meant to give more objective final marks.

Both sample groups acquired Shot Put skills through the O'Brian technique. The O'Brian technique in a Shot Put is a rotation(al) structure consisting of a pushing and pushing back move, with which the thrower tries to accomplish a better result. While giving marks for the Shot Put, the following major mistakes were taken into consideration: the wrong basic holding position of the shot in the hand, a jump with two legs and/or the absence of one, a Shot Put from the shoulder, the "basketball throw", a foul due to a loss of balance and posture of the wrong leg in the power position.

Minor mistakes in the Shot Put are: irregular upper arm and elbow position, disbalance while pivoting, too short a momentum with the leg that circles around, bad velocity of the implement at release, shorter effect on a shot at release and stepping over (unconsciously) (Bondarčuk, 1994).

The subjects were supposed to demonstrate their Javelin Throw skills through 7 steps of a straight run and 5 crossover strides. The major mistakes in the Javelin Throw are: the wrong hold on the javelin (grabbing and holding of a javelin in the run up), throwing the javelin on the wrong leg (same hand-same leg), hitting the floor with the tail of the javelin and stepping over-running over the line. The minor mistakes are: a smaller or bigger distance between the javelin and the head, irregular rhythm of running, uncontrolled movement of the javelin while running from straight ahead to crossover, a bad release angle, irregular position of the javelin (bent arm) and bad velocity of the javelin at release (Bondarčuk, 1994).

In the Discus Throw, the traditional rotation(al) technique, the following major mistakes have been considered: the movement of the front leg, uncontrolled implement throw - foul flight of the discus, irregular throw-stepping out of the circle due to loss of balance and throwing the discus while running in the circle. Minor mistakes taken into consideration while evaluating: wrong position of arms while throwing, uncontrolled activity performance - throwing only by hand, a bad angle of discus release, fouls while getting out of the circle (unconsciously) and bad velocity of discus at release (Bondarčuk, 1994).

The experimental program

At the beginning of the experimental program, the subjects were introduced to the goal and the plan and the program of the experiment. Based on this, the subjects were evaluated for their Discus Throw, Shot Put and Javelin Throw skills at the beginning of the process (initial measurements). The evaluation was realized in a way that the throwing performances were recorded and later evaluated by three experts. Every subject had one try and three "real" throws that were evaluated to demonstrate their current throwing skills.

After the initial measurements, the subjects of both groups commenced the process of acquiring athletic throwing skills. In order to establish the effects of different practicing models, the subjects of the E1 group acquired their athletic skills through *block* practice and the E2 subjects through a *random* way of the practicing. The choice of previously mentioned ways of practicing was based on previous conclusions in which it was stated that random and blocked ways of structuring practice were the best ways of practicing in acquiring new motor skills (Schmidt & Wrisberg, 2000).

After 12 classes of experimental work, the subjects were evaluated with the same procedure as in the initial measurements (transitive measurement). In order to establish the effects of the retention process, after two weeks (the final measurement) the students were retested, that is, their performances were recorded by the same methodology as in the two previous measurements. This way an attempt was made to establish "the amount of lost skills" (Schmidt & Lee, 2005), that is, which of these mentioned models of practicing has influenced the memorizing process more, and with this the automatization of the analyzed athletic skills. During the retention process the students acquired some other skills in order to establish the real effects of the retention process, so the subjects have not acquired or repeated their athletic throwing skills.

Data analysis

With the purpose of analyzing the objectivity of judges for their athletic skills evaluation, an intercorrelation matrix of judges was taken for every skill, an inter item correlation (II r) and Cronbach alpha (ac). The homogeneity of the variable particles was analyzed by the appliance of the univariate analysis of variance (the F test) while the sensitivity of tests was tested by the Kolmogorov-Smirnov procedure (the KS- test). Major and partial differences in specific athletic skills between the two groups of subjects in the evaluated fields were established by the multivariate (MANOVA) and univariate analysis of variance (ANOVA) for the independent samples. The differences between the evaluated skills among the analyzed groups of subjects were established through a multivariate and univariate analysis of variance for dependent samples.

All statistical and mathematical procedures were performed at the Faculty of Kinesiology – University of Split, Croatia, using the Statsoft's Statistica software.

RESULTS AND DISCUSSION

The review of standard objectivity indicators (Tables 1, 2 and 3) can leave us with the conclusion that there is a relatively high consistency among the judges, that is, good metric characteristics of objectivity tests for the evaluation of throwing skills in the initial, transitive and final measurements.

Table 1. Descriptive statistics (Mean - M, St.dev. - SD), Objectivity results, Intercorrelation between referees (R), Inter-Item correlation (IIr) and the Cronbach Alpha coefficient (α), Homogeneity results, ANOVA results (F test), Kolmogorov-Smirnov test (K-S) of Discus Throw - DT

initial measurement								
	R 1	R 2	R 3	I I r	α	M±SD	F test	K-S
R 1	1.00	0.85	0.86			1.20±0.29		
R 2	0.85	1.00	0.79	0.83	0.93	1.18±0.24	0.51	0.19
R 3	0.86	0.79	1.00			1.19±0.27		
transitive measurement								
	R 1	R 2	R 3	I I r	α	M±SD	F test	K-S
R 1	1.00	0.92	0.89			1.81±0.73		
R 2	0.92	1.00	0.92	0.91	0.96	1.77±0.61	1.86	0.12
R 3	0.89	0.92	1.00			1.72±0.64		
final measurement								
	R 1	R 2	R 3	I I r	α	M±SD	F test	K-S
R 1	1.00	0.85	0.86			1.20±0.29		
R 2	0.85	1.00	0.79	0.83	0.93	1.18±0.24	0.51	0.07
R 3	0.86	0.79	1.00			1.19±0.27		

* denotes significant coefficients; K-S for N=47, p<0.19

Table 2. Descriptive statistics (Mean - M, St.dev. - SD), Objectivity results, Intercorrelation between referees (R), Inter-Item correlation (IIr) and the Cronbach Alpha coefficient (α), Homogeneity results, ANOVA results (F test) , Kolmogorov-Smirnov test (K-S) of Shot Put - SP

initial measurement								
	R 1	R 2	R 3	I I r	α	M±SD	F test	K-S
R 1	1.00	0.57	0.59			1.12±0.18		
R 2	0.57	1.00	0.89	0.72	0.86	1.24±0.27	8.56*	0.18
R 3	0.59	0.89	1.00			1.18±0.25		
transitive measurement								
	R 1	R 2	R 3	I I r	α	M±SD	F test	K-S
R 1	1.00	0.69	0.76			1.67±0.44		
R 2	0.69	1.00	0.79	0.75	0.90	1.81±0.50	4.52*	0.12
R 3	0.76	0.79	1.00			1.80±0.52		
final measurement								
	R 1	R 2	R 3	I I r	α	M±SD	F test	K-S
R 1	1.00	0.78	0.82			1.59±0.42		
R 2	0.78	1.00	0.89	0.83	0.93	1.81±0.59	11.32*	0.10
R 3	0.82	0.89	1.00			1.75±0.58		

* denotes significant coefficients; K-S for N=47, p<0.19

Table 3. Descriptive statistics (Mean - M, St.dev. - SD), Objectivity results, Intercorrelation between referees (R), Inter-Item correlation (IIr) and the Cronbach Alpha coefficient (α), Homogeneity results, ANOVA results (F test) , Kolmogorov-Smirnov test (K-S) of Javelin Throw - JT

initial measurement								
	R 1	R 2	R 3	I I r	α	M±SD	F test	K-S
R 1	1.00	0.61	0.76			1.25±0.31		
R 2	0.61	1.00	0.74	0.71	0.86	1.30±0.35	2.81	0.18
R3	0.76	0.74	1.00			1.21±0.27		
transitive measurement								
	R 1	R 2	R 3	I I r	α	M±SD	F test	K-S
R 1	1.00	0.83	0.71			1.79±0.57		
R 2	0.83	1.00	0.80	0.78	0.91	2.05±0.62	11.16*	0.05
R 3	0.71	0.80	1.00			2.02±0.68		
final measurement								
	R 1	R2	R 3	I I r	α	M±SD	F test	K-S
R 1	1.00	0.84	0.81			1.90±0.66		
R 2	0.84	1.00	0.87	0.87	0.95	2.06±0.63	9.99*	0.10
R 3	0.81	0.88	1.00			2.12±0.69		

* denotes significant coefficients; K-S for N=47, $p<0.19$

In the analysis of the homogeneity results it is evident how some athletic throwing evaluation tests have a low homogeneity. The review of the evaluations of certain judges (Tables 1, 2 and 3) shows that judge (S1) gave significantly lower marks in general, and that he surely influenced the given results with his strict evaluation. Still, in general it could be said that the homogeneity of the judges in all of the tests for evaluation of throwing skills was satisfactory. The results for sensitivity (Tables 1, 2 and 3) show how all the variables for the evaluation of the throwing skills of the sample of subjects in total (N=47) have been distributed, a distribution which does not differ much from the normal one.

Based on such results, the conclusion could be that all variables for the evaluation of athletic skills have satisfactory metric characteristics. The results of multivariate differences in the initial (WL=0.97; $p<0.76$) and transitive measurement (WL=0.91; $p<0.26$) indicate how there is no statistically significant difference between the E1 and E2 group of subjects. Therefore, one can assume that all of the students commenced the experimental work with similar skills, and, as they are highly homogenous, it is quite logical that they have equally progressed in all athletic throwing skills. The given results support the results of previous research (Meira & Tani, 2001; Moreno et al., 2003; Jones & French, 2007; Smith, Gregory, & Davis, 2003) which indicates that relevant differences cannot be established among the *random* and *blocked* ways of practicing while learning a "complex" motor skill task.

In the final measurement, following the process of retention, the global differences (WL=0.80; $p<0.02$) between the E1 and E2 group of subjects are significant. It means that between the E1 and E2 group of subjects there were certain differences in memorizing the Discus Throw, Shot Put and Javelin Throw skills. The analysis of the results of

partial differences (Table 4) indicates that there are no statistically relevant differences between the groups of subjects. Still, by looking at the arithmetic of certain skills it is easily noticed that there are certain differences which can probably be seen because of the diversities of the realized activities of the two groups of subjects.

Group E2 has better marks in the Shot Put and Javelin Throw and group E1 in the Discus Throw, which is quite logical. The reason lies in the fact that the E1 group had 4 classes based primarily on the Discus Throw during the experimental work in the last 6 classes of the teaching process, while group E2, on the other hand, had constantly been taught all three skills in every class from the first to the last. This way the E2 group has a lower frequency of repeating the Discus Throw compared to the E1 group in the last part of the teaching process. Based on such realized experimental plans and programs, the results indicating the previously mentioned differences are completely expected. The results obtained after the retention process match the results of the previous research, which also indicate that the *random* way of practicing was better for the acquisition of motor skills, bearing in mind the quality of the acquisition through the retention process (Lee & Magll, 1983; Shea, Kohl, & Indermill, 1990; Tsutsui, Lee, & Hodges, 1998).

A review of the results of the global changes between the points of measurements allows us to see that there are certain specifications in the process of specific skill acquisition in the tested groups which is firstly reflected through the results of the changes between the initial and transitive measurements (E1 - WL=0.23; $p<0.000$; E2 - WL=0.13; $p<0.000$).

Reviewing the results of the partial changes (Table 4) it is necessary to say that the E1 and E2 group of subjects progressed in all the evaluated specific skills. Still, it is necessary to emphasize that the average marks of both groups are very low, and so in that context teaching programs organized in this way demands some changes. There have been no statistically significant differences at the level of acquisition of specific motor skills between the transitive and final measurements, either for the E1 group (WL=0.74; $p<0.10$) or the E2 group (WL=0.83; $p<0.33$). This indicates that both the E1 and E2 group of students acquired the analyzed skills at a certain level, that is, both experimental work programs have enabled the students to retain the acquired skills.

Table 4. Descriptive statistics (Mean - M, St.dev. - SD), and the ANOVA results (p-level) between: initial and transitive measurement; initial and final measurement - for each group

Variable	First experimental group (E1; N= 24)			Second experimental group (E2; N = 23)		
	initial M ± SD	transitive M ± SD	final M ± SD	initial M ± SD	transitive M ± SD	final M ± SD
Discus Throw	1.23±0.22	1.81±0.63*	2.08±0.57	1.15±0.27	1.72±0.67*	1.82±0.62
Shot Put	1.18±0.19	1.66±0.46*	1.61±0.53	1.17±0.24	1.88±0.41*	1.85±0.44
Javelin Throw	1.24±0.29	1.90±0.64*	1.96±0.74	1.27±0.27	2.02±0.50*	2.10±0.46

*$p < 0.05$

Generally speaking, the two experimental programs gave certain specifications, that is, diversifications which could primarily be seen in a multivariate space. Therefore, it should be said that changes in the athletic throwing skills of the E2 group were more positive, that is, that students of the E2 group adopted the athletic throwing skills at a higher level and with greater quality.

CONCLUSION

The main goal of the research has been to establish the effects of two experimental programs on the acquisition of specific athletic skills: the Discus Throw, Shot Put and Javelin Throw of students of Kinesiology in the regular teaching process. The results of the research indicate satisfactory metric characteristics of the tests for an athletic throwing skills evaluation. The results of the changes during the teaching process indicate that both the E1 and E2 group students made significant improvements in all the analyzed throwing skills and that during the retention process there were no relevant changes in the level of the acquisition of the analyzed skills. No global differences between the E1 and E2 group in an initial and transitive measurement have been found. Based on the results, it can be assumed that the E1 and E2 group of students have commenced with the experimental work with the same previous skills and that they equally progressed in the analyzed skills during the process of practicing. In the final measurement, following the retention process, there were expected differences in the throwing skills between the E1 and E2 group and in the way the E2 group was more successful at memorizing the acquired skills through the *random* ways of practicing. In general it can be concluded that both the experimental programs, viewed through a planning and programming aspect and justification of the set goals and tasks can be used as adequate programs for the acquisition of athletic throwing skills. Still, the authors recommend that the regular process of the acquisition of athletic throwing skills in specific phases of the practicing process should incorporate the advantages of both experimental works. The process of practicing organized this way would enable the participants to have a more qualitative acquisition or retention of the acquired throwing skills. The results of this research can be applied in a process of planning and programming of the teaching process, regardless of whether it is in Physical Education classes, specialized kinesiology studies or in sports (oriented) schools.

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UTICAJ RAZLIČITIH MODELA UČENJE NA STICANJE SPECIFIČNIH VEŠTINA ATLETSKIH BACANJA

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Cilj ovog istraživanja je bio utvrditi efekte dva eksperimentalna modela učenja motornih veštine u stiecanju veština iz područja atletskih bacanja (bacanje diska, kugle i koplja). Uzorak ispitanika je činilo 47 studenata prve godine osnovnih studija kineziologije podeljenih u E1 (N = 24) i E2 (N = 23) gupe. E1 grupa je stekla svoje veštine bacanja koristeći vežbe blokiranja, a E2 grupa primenom razlicitih vežbi u 12 sati eksperimentalnog programa. Rezultati, dati multivarijatnom analizom varijance, pokazuju da oba načina vežbanja značajno utiču na nivo uspešnosti bacanja diska, kugle i koplja. Ipak, raznovrsni, slučajni izbor vežbi dovodi do višeg nivoa zadržavanje stečenih specifičnih vještina.

Ključne reči: *motoričke sposobnosti, motorno učenje, studenti, bacanje*