INFLUENCE OF FUNDAMENTAL MOVEMENT SKILLS ON BASIC GYMNASTICS SKILLS ACQUISITION

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Abstract

This study was set to determine the existence of transfer of fundamental movement skills to the level of specialized gymnastics skills. 75 children (30 boys and 45 girls) represented the participants of the study. Fundamental movement skills were analyzed as well as twelve basic gymnastics skills according to the physical education curriculum that represent different apparatus in gymnastics all round competition. Significant influence of fundamental movement skills on all skills (criteria) is noticeable. According to the results of regression analysis, the participants who had better initial results in fundamental movement skills for surmounting obstacles also had better results of gymnastics skills in final measurement point. Highly structural connection of elements lies in the basis of high correlation of fundamental movement skills for surmounting obstacles and gymnastics skill springboard jump on the vault in sitting position which confirms Osgood's theory of positive transfer of similar skills.

Keywords*: level of performance, object manipulation, skills transfer, surmounting obstacles.*

INTRODUCTION

When learning gymnastics skills one has to stick to methodological principles of complex motor skills acquisition after reaching suitable level of simple motor skills (Delaš Kalinski, Miletić & Božanić, 2011). The acquisition of skills which isn't in accordance with current abilities of the one who learns could result in failure. In that matter, each gymnastics skill has a potentiality of vertical and horizontal progression which makes gymnastics one of the most attractive sports nowdays. In this sport, one can distinguish a path from natural movement to very complex acrobatic figures. Gymnastics is made of numerous discrete skills which turn to complex closed serial skills with the use of extraordinary inventiveness and originality.

The wide range of movements and positions makes it possible for children to develop a quality fund of sensory and motor pathways and make a positive stimulus on their psychosomatic status. Highly developed motor abilities and large movement skills fund can enable better everyday functioning. During that time, motor learning needs to be perceived as a process of gradual skills acquisition. This process starts with first incorrect, clumsy and slow attempts, over basic structures acquisition, to superior performance of skills in different circumstances.

Fundamental movement skills (FMS) are skills that unable children to interact and explore their environment. Besides being fundamental and irreplaceable in most human abilities and features, these

movement structures make a firm base for the development of more advanced and complex movement skills (Gallahue & Donnelly, 2003; Payne & Isaacs, 2002.).

Although some FMS, like walking, are learned naturally throughout the developmental process, most of these skills have to be learned and further improved (Gallahue & Donnelly, 2003). A child whose FMS are not developed accordingly won't have quality basis upon which further specific movement patterns are developed. Besides, if FMS are not mastered in young age, motor activities advancement throughout life can be disrupted (Williams, 2003).

Gymnastics belongs to a group of basic sports that are defined as physical activities which contain such educational possibilities that can only partially be overcome with other sport disciplines. Also, doing basic sports in educational process of children from early age develops morphological characteristics that are fundamental for other sports (Gallahue & Ozmun, 2006).

Numerous studies that deal with abilities needed for successful gymnastics skills performance have been published: speed (Bradshaw, 2004; Lindner et al., 1991), strength (Lindner et al., 1991; Bradshaw & Rossignol, 2004), endurance (Bradshaw & Rossignol, 2004), agility (Daly et al., 2001), flexibility (Kirbi et al., 1981; Delaš et al., 2007; Maffulli et al., 1994), balance (Lindner et al., 1991; Peltenburg et al., 1982), and explosive strength (Bencke et al., 2002; Jemni et al., 2006; Delaš et al., 2007; Delaš et al., 2008). However, little research that point out to the selection and influence of FMS for quality basic and complex gymnastics skills acquisition exist (Leguet, 1987) and they all refer to the period of 80's and 90's. It is important to scientifically justify these relationships now days since International Gymnastics Federation (FIG) throughout their Foundation courses also uses these pedagogical tools.

The main problem of this research is to determine the existence of skills transfer between FMS and some basic artistic gymnastics skills. Empirical confirmation of such statements are often missing, but experiential knowledge of gymnastics experts witness the important role of FMS in gymnastics motor skills acquisition. In addition, due to gymnastics characteristics and benefits that active participation gives, experts state that gymnastics motor skills often have positive transfer on other motor skills. Although, hypothetically, a positive skills transfer from FMS to gymnastics skills can be expected, no experimental confirmation exists. In that matter, this research has an original scientific significance in experimental skills transfer research. Such transfer results can be expected according to: (1) identical elements theory (Thorndike, 1914) which originally hypothesized that transfer was based on the number of common elements shared by two skills. Osgood (1949) specified that rather than identical elements, it was similarities between the stimulus and response conditions of the two fundamental task; and (2) appropriate processing theory (Morris, Bransford & Franks, 1977) hypothesized that positive transfer is expected when practice conditions require learners to engage in problem – solving processes similar to those that the criterion task requires. More recent studies support earlier findings and indicate that such practice should be as variable as possible so that learners can explore and discover their own solutions, as well as the need for practice sessions to mimic the range of variations experienced during a competition (Williams & Hodges, 2005).

The main aim of this research is to determine the existence of transfer of FMS to the level of specialized gymnastics skills. This could be determined by measuring the influence of FMS in initial measuring point on the level of specialized gymnastics skills in the final point of measurement.

Before the realization of the main aim certain preliminary work has to be done: (1) determination of the metric characteristics of FMS and gymnastics skills, and (2) analysis of differences between the initial and final measurement point in gymnastics

skills for determination of the learning process.

METHODS

75 children (30 boys and 45 girls) represented the participants of the study. They were all in the age of seven (± 6 months) from „Petar Bakula“ elementary school, Mostar, Bosnia and Herzegovina. Boys averaged 132.0 cm in height and 31.4 kg in weight and with a BMI of 17.3, while girls averaged 129.6 cm in height and 29.3 kg in weight and with a BMI of 16.8. Boys and girls in current research were treated as a unique sample because physical education curriculum from grade 1 to 4 implies coeducation. In this developmental period girls and boys are similar in morphological, motor and functional features (Babin, Bavčević & Prskalo, 2010) as well as in fundamental movement skill development (Appache, 2005; Mc Kenzie et al., 1998).

FMS are analyzed according to research of Žuvela (2009) and Žuvela et al. (2011) in which FMS assessment instruments for young school children were constructed and validated. The first phase of those researches included the construction of 24 tests for assessment of FMS: six tests for each of the four motor skills area (object manipulation skills, resistance overcoming skills, space covering skills and surmounting obstacles skills) (Mraković, Metikoš & Findak, 1993). After metric indicators being precisely defined, the tests which had the highest factor scores were chosen to enter the final product: polygon. The following tests that are supposed to represent the certain motor area the best are: tossing and catching the volleyball against a wall consecutively; running across obstacles; carrying the medicine balls; and straight running.

The variables for basic gymnastics skills assessment were chosen according to the physical education curriculum and represent different apparatus in gymnastics all round competition. Certain aspects were respected when choosing the skills: (1) the variables were also teaching topics that need to be adopted in high level; (2) all skills can be practicable according to school's material terms; (3) according to previous research (Delaš Kalinski, 2009), same and similar gymnastics motor skills were applied in 7 year old pupils according to their abilities and pre-knowledge.

The following basic gymnastics skills were analyzed:

1. Bridge (MO)
2. Forward roll (KNP)
3. Descended backward roll (KNTK)
4. Blade stand (SNL)
5. Handstand against wall (SNRVP)
6. Dominant frontal cartwheel (PSČ)
7. Ring swinging with backswing mount (LJSZK)
8. Straight jump of springboard (SNDOD)
9. Springboard jump on the vault in sitting position (NSRK)
10. Switching positions on the rings (PVSK)
11. Walking on a small beam (HNG)
12. Jump-off of small beam (SPNNG)

The research was carried out during the first semester of 2011/2012 school year. Experimental procedure was conducted in school gym during official physical education classes led by highly experienced professional teacher. The procedure lasted 18 weeks in total, 39 school units, respectively. Artistic gymnastics motor skills formed the basis of the program (12 topics). Some of the traditional teaching topics from the official curriculum were inserted in the program as well (14 topics). Those topics contributed to the diversity of the experimental program itself and served as an excellent psychophysical preparation. Also, some of them served as an introduction to the methodology of the gymnastics motor skills training.

The participants were introduced to the skills that needed to be performed before the actual measurements of the FMS and gymnastics skills videotaping. Furthermore, every assignment and skill was explained and then demonstrated. Before the

beginning of the assessment, participants had one probe and none of the tests were administered before the examiners were completely sure that the participants understood the assignment. After initial evaluation and videotaping, parents' approvals were collected and kinesiological treatment begun.

Videotaping of the final gymnastics skills learning stage was conducted after 18 weeks of experimental kinesiological program. This was followed by evaluation of the gymnastics skills by five judges. All judges were gymnastics coaches with more than 10 years of practice in the sport. The methodology of the skills' quality assessment (knowledge of performance) according to five-point Likert scale was based on research of Delaš Kalinski (2009), Miletić et al. (2004) and Božanić & Miletić (2011). A student was assigned 5 points if the performance was carried out without any mistakes and 1 point if the student was unable to perform the element. Small mistakes in the performance were graded with 4 points, medium mistakes with 3 points and great mistakes in performance were graded with 2 points.

The data were analyzed with the use of STATISTICA Windows 7.0 program, and the level of significance was set at $p<0.05$. Mean values, standard deviations, Kolmogorov-Smirnov test, Inter-item correlation and Cronbach alpha coefficients were calculated in terms of evaluating the objectivity and sensitivity of each of the FMS and gymnastics skills in initial and final measurement point. T test for dependent samples was used to determine significant changes in level of gymnastics motor skills from initial to final measurement point. For determining the transfer of FMS in initial measurement point (predictors) to the level of acquisition of gymnastics skills in the final measurement point (criterions), 12 regression analyses were calculated.

RESULTS

Table 1. *Metric characteristics of the FMS in initial measurement point (K-S -Kolmogorov-Smirnov test of normality, IIr – Inter-item correlation, αc - Cronbach alpha coefficient).*

Variable	Mean	SD	MIN	MAX	K-S	IIr αc
	10.90	2.49	6.61	17.96	0.11	0.93
MBIHO	10.20	2.10	6.21	17.10	0.13	
	10.46	2.12	6.51	17.22	0.15	0.97
	7.47	2.30	4.26	14.33	0.11	0.96
PREPR	7.16	2.23	4.34	16.00	0.12	
	7.31	2.23	4.50	15.00	0.13	0.98
	12.63	2.17	6.21	20.00	0.06	0.83
ODINP	11.24	1.97	6.89	16.32	0.09	
	11.79	1.82	6.77	16.11	0,10	0.92
	5.31	0.63	4.26	7.12	0.07	0.80
PPRTR	5.33	0.66	4.11	7.81	0.09	
	5.34	0.58	4.31	7.00	0.06	0.91

d=0.15 for N=75 ($p<0.05$)

Legend: MBIHO - tossing and catching the volleyball against a wall consecutively, PREPR - running across obstacles, ODINP - carrying the medicine balls, PPRTR - straight running

Table 2. *Descriptive statistics of gymnastics skills in initial (I) and final (F) measurement point: (Cronbach alpha (αc) and Kolmogorov Smirnov tests (K-S)).*

Variable	Mean (I)	SD (I)	αc (I)	K-S (I)	Mean (F)	SD (F)	αc (F)	K-S (F)
MO	1.84	0.96	0.97	0.24	3.64	1.08	0.98	0.14
KNP	1.90	0.66	0.96	0.20	3.56	0.82	0.96	0.14
KNTK	1.71	0.61	0.95	0.22	3.50	1.00	0.98	0.12
SNL	1.93	0.88	0.96	0.14	2.56	1.25	0.97	0.12
SNRVP	1.18	0.41	0.96	0.42	2.55	1.25	0.98	0.15
PSČ	1.46	0.76	0.98	0.37	2.67	1.32	0.99	0.11
LJSZK	1.79	0.71	0.96	0.21	3.25	0.85	0.96	0.11
SNDOD	1.57	0.53	0.92	0.17	3.20	0.90	0.97	0.14
NSRK	1.73	0.65	0.95	0.16	3.08	1.11	0.98	0.10
PVSK	1.27	0.60	0.98	0.45	2.49	1.45	0.99	0.23
HNG	2.23	0.55	0.93	0.18	3.55	0.84	0.96	0.10
SPNNG	2.16	0.43	0.93	0.35	3.66	0.81	0.96	0.12

d=0.15 za N=75 ($p<0.05$)

Table 3. *Results of regression analyses between FMS in initial measurement point and gymnastics skills in final measurement point.*

	MBIHO	PREPR	ODINP	PPRTR	R	R^2	p
	Beta	Beta	Beta	Beta			
MO	-0.01	-0.34*	-0.13	0.03	0.38	0.14	0.02
KNP	-0.11	-0.38*	-0.08	-0.07	0.52	0.27	0.00
KNTK	-0.13	-0.31*	0.09	-0.17	0.47	0.22	0.00
SNL	-0.09	-0.43*	0.03	-0.04	0.49	0.24	0.00
SNRVP	-0.03	-0.51*	0.03	-0.05	0.54	0.29	0.00
PSČ	-0.08	-0.43*	-0.06	-0.08	0.55	0.30	0.00
LJSZK	-0.07	-0.52*	0.07	-0.09	0.59	0.35	0.00
SNDOD	-0.10	-0.31*	0.11	-0.32*	0.57	0.33	0.00
NSRK	-0.01	-0.54*	-0.21	0.00	0.65	0.42	0.00
PVSK	-0.08	-0.44*	-0.05	-0.05	0.54	0.29	0.00
HNG	-0.14	-0.38*	-0.11	-0.04	0.55	0.30	0.00
SPNNG	0.03	-0.30*	-0.13	-0.25	0.55	0.30	0.00

Legend: MBIHO - tossing and catching the volleyball against a wall consecutively, PREPR - running across obstacles, ODINP - carrying the medicine balls, PPRTR - straight running; * - significant predictor

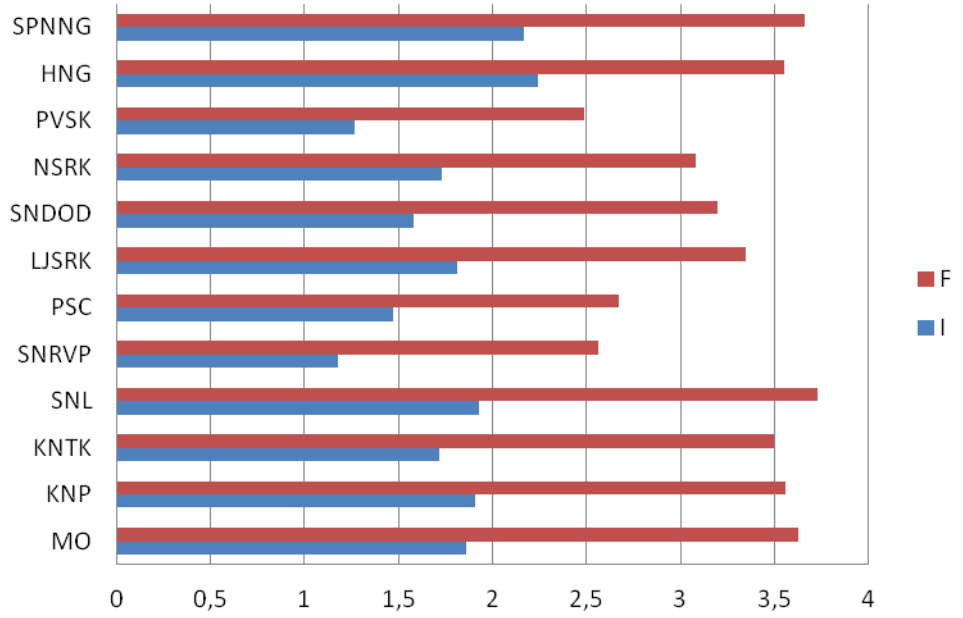

Figure 1. *Analysis of differences between initial (I) and final (F) measurement point in evaluation of gymnastics skills according to t test for dependent samples.*

According to descriptive statistics and K-S test results (Table 1) all FMS tests have satisfactory sensitivity. It is obvious from Table 2 that initial sensitivity in gymnastics skills tests proved not to be good, while in final measurement point the same tests have good sensitivity results. FMS objectivity parameters prove to be satisfactory, where Cronbach alpha ranges from .91 to .98 (Table 1) while for gymnastics skills tests Cronbach alpha ranges from .92 to .98 (initial) and .96 to .99 (final).

Figure 1 shows analysis of differences between initial and final measurement point in evaluation of gymnastics skills determined by t tests for dependent samples. According to significant differences gained we can establish significant progress in all of the skills which is a proof of efficient motor learning process. The biggest differences between the means in initial and final measurement point were noticed in blade stand (1.93 - 3.73), while the smallest differences occurred in dominant frontal cartwheel (1.47 - 2.67).

Table 3 represents the regression analyses results between the predictors (initial FMS) and different criterions (represented by gymnastics skills in final measurement point). Generally, significant influence of FMS (object manipulation, surmounting obstacles, resistance overcoming, space covering) on all skills (criterions) is noticeable. The level of significance in all analyses is 0.00, accept in bridge element, where the significance is 0.02. It is also noticeable how FMS for object manipulation and resistance overcoming haven't got significant influence on any of the gymnastics skills, while FMS for space covering has significant predictive influence only in straight jump of springboard element (Beta = -0.32). Opposed to this, FMS for surmounting obstacles has a significant statistical influence on all of the applied gymnastics skills.

By further inspection, we notice that the highest correlation exists between the predictors and the springboard jump on the vault in sitting position element (R=.65). Coefficient of determination has a value of 0.42 which means that the predictors explain 42% of criterion variance. The value

of partial regression coefficient (Beta) in surmounting obstacles is -0.54. Opposed to high correlation value, the lowest R value (R=.38) was noticed in bridge element. Coefficient of determination has a value of 0.14 which means that the predictors explain 14% of criterion variance. Beta coefficient in surmounting obstacles is -0.34. In all other analyses the FMS predictors explain 22% to 35% of criterion variance – depending on a gymnastics skill.

Significant partial regression coefficient of FMS for straight running is noticeable only in straight jump of springboard element. This is also the only gymnastics skill in which two different FMS areas play significant roles – surmounting obstacles and space covering skills.

DISCUSSION

Questionable sensitivity of gymnastics skills tests in initial measurement point has been expected since the tasks on the beginning of the learning process are somewhat difficult for the children and their acquisition demands time and practice. For that matter, only the final level of gymnastics skills has been used for the research of transfer of knowledge. This kind of development in gymnastics skills acquisition has been researched by Delaš, Miletić & Božanić (2011) in 7 year old boys and girls. When comparing the results it can be noticed that the level of gymnastics skills (bridge, blade stand and forward roll) in the initial point of this research is lower than in the mentioned study. However, the values of means in the retention point do coincide. Regardless that the authors analyzed the level of skills separately by gender, we can conclude that the period of 18 weeks and 39 school lessons is enough for appropriate acquisition of basic gymnastics skills but that the possible differences in initial point occurred due to pre-knowledge or physical activity of children which are assumptions that need to be researched more thoroughly.

According to the results of regression analysis, the participants who had better initial results in FMS for surmounting obstacles also had better results of gymnastics skills in final measurement point. Highly structural connection of elements lies in the basis of high correlation of FMS for surmounting obstacles and gymnastics skill *springboard jump on the vault in sitting position* which confirms Osgood's theory of positive transfer of similar skills.

According to the results of differences between initial and final measurements of gymnastics skills it can be concluded that the treatment was well planned and realized because students improved all gymnastics skills. These results can directly be applicable in physical education curriculum preparation where specific training frequencies need to be determinate and optimal gymnastics skills frequencies defined.

Students recorded the biggest progress in blade stand skill, while the smallest progress was made in dominant frontal cartwheel. A total frequency for blade stand was seven, while dominant frontal cartwheel had only one frequency more. Despite the fact that blade stand can be considered as simple gymnastics skill and dominant frontal cartwheel as complex gymnastics skill this treatment prescribed the same training time. So, the answer to the question what influences effective learning besides skill complexity needs to be found elsewhere. It is possible that style and learning strategy also have an effect on learning (Gardner, 2006; Kolb, 2005; Gregorc, 2006) within which authors analyze four kinds of premises: environmental, emotional, sociological and psychological. Besides this, fatigue, anxiety and lack of motivation can also affect motor learning efficiency (Coker, 2009). For more precise learning development parameters, more research needs to be done besides skills complexity.

The reasons why participants had higher level of FMS for surmounting obstacles and therefore learned all gymnastics skills easier could be: (1) their structural similarity or, (2) structural complexity of two motor skills areas (FMS

for surmounting obstacles and gymnastics skills). Lots of FMS for surmounting obstacles (like jumping, landing, vaulting, wriggling and climbing) represent basic gymnastics skills in their original or modified form (like landing with or without running start, with or without swing, on one or both feet etc.). This is why it isn't always possible to categorize a skill exclusively in a certain group of FMS or gymnastics skills. This is a reason why artistic gymnastics is classified as basic kinesiological activity (sport).

According to their basic structure FMS for surmounting obstacles are similar to basic gymnastics skills, but besides that they are connected to FMS for space covering (like walking, running, crawling) and FMS for resistance overcoming (like hanging) in a modified form. These connections make FMS for surmounting obstacles probably the most complex skills when compared to other FMS areas. This complexity is probably the reason why statistically significant influence on all gymnastics skills occurred.

In case FMS for surmounting obstacles and gymnastics skills are observed through demands for some motor abilities their similarity can be noticeable. Arm, leg and shoulder strength, as well as coordination, balance and speed are crucial for gymnastics skills performance. On the other hand, arm and shoulder strength and coordination play an important role while climbing, coordination is vital in wriggling and jumps, vaults and landings demand leg power and coordination as well. Once again it can be concluded that this type of FMS (surmounting obstacles) probably belongs to a group of complex FMS because their movement structure clearly depends on multiple factors and engage a series of body regions. So, the importance of FMS for surmounting obstacles is apparent as it serves as a great base for all gymnastics skills upgrades.

In further result interpretation it is important to emphasize that the generalization of chosen tests for FMS (object manipulation, surmounting obstacles, resistance overcoming, space covering) was done according to research of Žuvela (2009). To successfully learn basic gymnastics skills students don't need to possess high levels of FMS for object manipulation (throwing, catching, juggling) or FMS for resistance overcoming (lifting, carrying, pushing, pulling). FMS for space covering (crawling, walking, running, rolling) are important for successful performance of straight jump of springboard element. According to this, it is possible that the students who had also higher and lower level of FMS gained different grades in gymnastics skills (from 1 to 5). Also, it can be concluded that higher initial level of FMS for surmounting obstacles is necessary for the seven year olds to be more successful in learning process of gymnastics skills. Therefore, this group of motor skills (FMS) has massive importance in forming the anthropological basis (Findak et al., 2000) on which gymnastics skills can be easily adopted.

In conclusion, while determining the transfer of initial FMS level on final gymnastics skills level one area of FMS for surmounting obstacles clearly allocated. The students who had higher level of FMS for surmounting obstacles learned the gymnastics skills more easily and where more successful in mastering all analyzed gymnastics skills. The reason could be the structural similarity and structural complexity of the two groups of skills. Gained results confirm the theory about positive learning transfer based on similarity of skills. Further research is necessary to determine other factors of influence on efficiency of gymnastics skills acquisition besides skill complexity, such as styles and strategies of learning, as well as student motivation. It is also important to determine the influence of physical and anthropometric qualities on transfer of gymnastics skills, since research (Collard et al., 2007) show that the transfer of gymnastics skills on other sport activities most probably depends on those qualities.

In the light of PE curriculum, it is crucial for the teachers to know that

gymnastics elements can be implemented in the program earlier than provided because results prove their appropriateness. Also, if FMS skills for surmounting obstacles are insufficiently applied in PE classes, one can expect later difficulties in learning basic gymnastics skills. The strong connection of gymnastics skills and natural forms of movement (FMS) allocates the necessity of gymnastics skills application in PE classes, especially because this fact confirms similar goals of the programs.

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