

INDIVIDUAL DIVERSITY IN THE RATE OF BASKETBALL SKILLS LEARNING PHYSICAL EDUCATION STUDENTS

by

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In the study the changes in technical competence of students in one year (two semesters) curriculum of basketball training were analyzed. In particular individual diversity was assessed and the degree to which it depends on the sex factor. Forty four women and 52 men, students of the Institute of Physical Culture of the University of Szczecin took part in the study. The measurement method was a set of technical competence tests (Heidelberg Basketball Test). The level of skill in the following areas was assessed: 1) lay up shots (Lus), 2) shots from different sectors (SFS), 3) passes of the ball to marked squares (PB), 4) dribbling the ball in slalom (OBS). Absolute single-basis and chain increments were calculated between subsequent dates of measurements. The differences in results between subsequent dates was analyzed in the Patnaik test for dependent trials with the assumption of uniform variance. To test the differences in results between the group of women and men the Kolmogorov-Smirnov test was used. It was found that the level of changes in technical competence in men and women after the completion of the program of training is statistically significant ($p \leq 0.01$), although it is individually very diversified. In a few individual cases no improvement or even small decrease in the level of changes in technical competence in basketball was noted. Sex of the subjects is not a clear determinant for the margin of changes in the level of technical competence. Only in the test of shots from different sectors higher increase of results ($p \leq 0.05$) was observed in men than in women. The decisive factor determining the margin of changes in the level of technical competence in basketball in physical education students was the starting level of this competence (women $D=56.8\%$, men $D=29.9\%$). Subjects who presented a lower initial level of technical competence achieved greater improvement in results in the area of tested skills.

Key words: technical competence, basketball, susceptibility to training, sexual differentiation

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Introduction

In the experimental studies of reactions and differences in changes which take place in a group of individuals who exercise in the same way, the current level of phenotype (initial level of a given feature) reveals its importance. The question of the significance of the initial level of a feature is one of the most controversial ones. Milicerowa (1969) emphasized the fact of significant stability of ranking in terms of physical fitness that individuals keep for any length of development and exercise. Also Godik (1988) noted an increasing level of dependence between the results obtained in the trials of physical fitness tests of boys in the course of ten years of training. Wachowski (1977) found on the basis of experimental studies that as a result of the training process higher initial level of strength and power corresponds to greater increase of the same features (correlation of approx. 0.4-0.6). This means that the changes in the level of studied features are directly proportional to their initial level.

The analysis of changes in human physical fitness considered on the background of the group, indicates other regularities. Wolański and Pařízková (1976) found that in the group of contemporaries subjected to the program of exercise, the level of physical fitness does not increase to the same extent, however the inside-group diversity decreases. Wyżnikiewicz-Nawracała (1988) who analyzed the development of motor co-ordination in children in the first year of school education, reached similar conclusions. This author found a general tendency to decrease the range of results in groups, although for individual tasks it was ambiguous. The review of experimental studies indicates that the correlation between the initial level of VO_{2max} and the changes in this variable after the training was significant and negative (r =approx. -0.5). In the studies of individual differences which appeared after training in the range of maximum oxygen intake in young men, it was found that individuals with lower initial level of VO_{2max} were more susceptible to training, and thus the improvement in this variable was higher (Bouchard et al. 1997).

The views concerning the significance of the sex factor for post-training changes are also ambiguous. There are premises indicating higher reactivity to training of males and thus, higher genetic stability of females (Szopa et al. 1996). However, in empirical studies this fact has not always been confirmed. When searching for the conditions of mastering of special fitness of children playing handball, Žak and Sakowicz (1995) found strong sexual differentiation in the area of the studied elements of technical competence. Directed handball training has resulted in higher (relatively two

times higher) increments in the level of special fitness for girls than for boys. Also the view of Lorti et al. (1984) on the lack of sufficient scientific confirmations in the field of the effect of sex factor on training susceptibility, puts this question among the unanswered ones.

Ambiguity of views concerning the individual susceptibility to training stimuli, has become the inspiration to undertake studies in the group of physical education students. In the study an attempt was made to present the progress in the area of achievements of students undergoing the curricular basketball training and assess to what degree these achievements are diversified in the group of students exercising similarly and for the same time and to what extent it depends on the sex factor.

The main aims of the study were as follows:

1. Specifying the range and direction of changes in the level of technical competence in basketball in men and women undergoing annual training program.
2. The analysis of individual diversity of achievements of men and women in the area of learning the technique of basketball.
3. Specifying the role of sex and the significance of the starting level for projecting achievements in the area of raising the level of technical competence in basketball.

Material and methods

The study involved the third year students of the Institute of the Physical Culture at the University of Szczecin. It was conducted during basketball training in the academic year 1997/98. Eight groups started the classes, three female groups and five male groups. Competitive athletes were excluded from the study. Thus, it was possible to consider in the final analysis the results of 96 students (44 female and 52 male).

At the time of initial measurements (October 1997) the average age, body height and mass of females and males was equaled respectively 20.8 and 21.1 year, 167.0±6.9 cm and 179.7±7.7 cm, 58.4±7.6 kg and 77.2±9.4 kg.

To measure the level of technical competence a set of special fitness tests, Heidelberg Basketball Test – HBT was used (Bös et al. 1987). The following trials were used: lay up shots (LUS), shots from different sectors (SFS), passes of the ball to marked squares (PB), dribbling the ball in slalom (DBS). Technical competence was measured on three occasions. Students were undergoing a 60-hour program of basketball training in which subjects related to the learning and mastering of technical and tactical elements of the game were covered.

The analysis of results was carried out both on the basis of the normalized and absolute values. The studied features were described using arithmetic mean, standard deviations and coefficients of variation. Absolute single-basis and increments between subsequent dates of measurements were calculated. To measure the differences in the results the Patnaik's test (q) and the Kolmogorov-Smirnov test (D) were used. To analyze the relations between the considered variables a correlation method and multiple regression were used. To analyze the statistical significance of multiple regression the F-Snedecor test was used.

Results

The changes in the level of technical competence were assessed on the basis of the analysis of results from three measurements taken on three dates. The first measurement describes the initial level of technical competence of the subjects. On the second occasion the effects of learning of technique of movement after the first semester of basketball training were assessed. The third measurement describes the final level of technical competence in basketball presented by the subjects after annual training program. The results of individual tests of technical competence taken on three occasions were subjected to statistical analysis which is presented in table 1.

Table 1. The description of the HBT test results in three measurements in tested subjects

| HBT | Women | | | | Men | | | |
|------------|-----------|---------|------|-------|-----------|---------|------|-------|
| | \bar{x} | q | SD | V (%) | \bar{x} | q | SD | V (%) |
| LUS1 [pts] | 3.93 | 25.67** | 1.97 | 50.10 | 6.13 | 27.33** | 2.63 | 42.83 |
| LUS2 [pts] | 7.48 | | 2.76 | 36.89 | 10.75 | | 2.37 | 22.02 |
| LUS3 [pts] | 9.16 | | 1.51 | 16.47 | 11.81 | | 1.61 | 13.63 |
| SFS1 [pts] | 3.36 | 17.46** | 2.02 | 60.17 | 5.42 | 23.91** | 2.77 | 51.17 |
| SFS2 [pts] | 5.91 | | 2.60 | 44.07 | 9.71 | | 2.62 | 27.00 |
| SFS3 [pts] | 7.41 | | 2.17 | 29.30 | 11.21 | | 2.44 | 21.80 |
| PB1 [pts] | 13.18 | 31.99** | 2.09 | 15.89 | 16.10 | 26.36** | 1.99 | 12.38 |
| PB2 [pts] | 15.86 | | 1.50 | 9.48 | 19.33 | | 1.64 | 8.49 |
| PB3 [pts] | 18.20 | | 1.11 | 6.11 | 20.37 | | 1.56 | 7.66 |
| DBS1 [s] | 17.00 | 21.06** | 1.32 | 7.76 | 14.89 | 16.36** | 1.05 | 7.04 |
| DBS2 [s] | 15.81 | | 0.85 | 5.38 | 14.21 | | 0.89 | 6.29 |
| DBS3 [s] | 15.02 | | 0.65 | 4.34 | 13.80 | | 0.88 | 6.39 |

Legend: * – ($p \leq 0.05$); ** – ($p \leq 0.01$)

An increase in the level of technical skills was observed in both sexes. The differences between the results of HBT tests were statistically significant ($p \leq 0.01$). In all HBT tests the values of coefficients of variation decreased, while the mean values of the results on subsequent measurements

increased. Dribbling the ball in slalom (DBS) is the exception in the group of men in the third measurements, in which the value of the coefficient of variation was slightly higher than the coefficient of variation in the second measurement.

To confirm and illustrate the manner in which the diversity in results in the studied groups decreases, the relation between the initial level of the studied technical skills and the changes in this level after the completion of the course (i.e. the difference in the results between the third and first measurement) were analyzed. The above relations are presented in table 2.

Table 2. The correlation coefficient between initial level of technical skill and its changes

| HBT | Women | Men |
|-----|----------|----------|
| LUS | -0.650** | -0.790** |
| SFS | -0.360* | -0.607** |
| PB | -0.848** | -0.676** |
| DBS | -0.870** | -0.567** |

Legend: * - ($p \leq 0.05$); ** - ($p \leq 0.01$)

The values of correlation coefficients are negative and in all cases statistically significant ($p \leq 0.01$). In case of the SFS tests the statistical significance was at $p \leq 0.05$. The individual diversity in the effects of learning of basketball technique in men and women was analyzed. The focus was on the changes in results between the third and first measurement. Table 3 presents the values of the obtained changes in results of the set of HBT tests found in the studied men and women.

Table 3. The description of HBT results changes in tested subjects

| LUS change [pts] | W | M | SFS change [pts] | W | M | PB change [pts] | W | M | DBS change [s] | W | M |
|------------------|----|----|------------------|----|----|-----------------|----|----|----------------|---|----|
| +2 | 3 | 3 | -1 | 1 | 0 | 0 | 0 | 2 | 0.00 ÷ +0.50 | 0 | 4 |
| +3 | 5 | 7 | 0 | 0 | 1 | +1 | 0 | 2 | -0.50 ÷ 0.00 | 4 | 7 |
| +4 | 2 | 8 | +1 | 3 | 2 | +2 | 3 | 5 | -1.00 ÷ -0.50 | 4 | 13 |
| +5 | 12 | 6 | +2 | 4 | 4 | +3 | 5 | 8 | -1.50 ÷ -1.00 | 9 | 13 |
| +6 | 17 | 5 | +3 | 7 | 3 | +4 | 9 | 9 | -2.00 ÷ -1.50 | 9 | 9 |
| +7 | 2 | 14 | +4 | 11 | 7 | +5 | 10 | 13 | -2.50 ÷ -2.00 | 8 | 2 |
| +8 | 2 | 3 | +5 | 8 | 6 | +6 | 10 | 8 | -3.00 ÷ -2.50 | 4 | 4 |
| +9 | 1 | 6 | +6 | 8 | 10 | +7 | 4 | 3 | -3.50 ÷ -3.00 | 1 | 0 |
| - | - | - | +7 | 1 | 5 | +8 | 2 | 2 | - | 2 | - |
| - | - | - | +8 | 1 | 6 | +9 | 1 | 0 | - | 2 | - |
| - | - | - | +9 | - | 3 | +10 | 1 | - | - | 0 | - |
| - | - | - | +10 | - | 2 | | | | - | 0 | - |
| - | - | - | +11 | - | 2 | | | | - | 1 | - |
| - | - | - | +12 | - | 1 | | | | - | - | - |

To assess the differences in the effects of learning the technique of playing between the group of women and the group of men, average increments of results in individual HBT tests found after one year of training, were compared (table 4).

Table 4. The differences between mean increments of results in subsequent HBT tests and the statistic signification of the differences in the distribution of results between men and women

| HBT | WOMEN | | MEN | | ABSOLUTE DIFFERENCE | D _(0.05) =0.2786 |
|------------|-----------|------|-----------|------|---------------------|-----------------------------|
| | \bar{x} | SD | \bar{x} | SD | | |
| LUS (pts.) | 5.23 | 1.57 | 5.68 | 2.09 | 0.45 | 0.2133 |
| SFS (pts.) | 4.05 | 1.80 | 5.79 | 2.74 | 1.65 | 0.3304* |
| PB (pts.) | 5.02 | 1.70 | 4.27 | 1.87 | 0.75 | 0.1135 |
| DBS (s) | - 1.99 | 1.13 | - 1.09 | 1.38 | - 0.90 | 0.2797* |

* - $p \leq 0.05$

Table 5. The multiple regression analysis with the choice of the best subsets of variables determining the indicator of changes in the technical skill (ICTS)

| Number of variables | WOMEN | | | MEN | | |
|---------------------|------------------------------|----------------|---------|------------------------------|----------------|---------|
| | the best subset of variables | R ² | F | the best subset of variables | R ² | F |
| 4 | 1, 2, 3, 4 | 0.568 | 12.85** | 1, 2, 3, 4 | 0.299 | 5.01** |
| 3 | 2, 3, 4 | 0.568 | 17.53** | 1, 2, 3 | 0.294 | 6.66** |
| 2 | 3, 4 | 0.547 | 24.73** | 1, 3 | 0.277 | 9.38** |
| 1 | 3 | 0.486 | 39.71** | 3 | 0.203 | 12.74** |

** - $p \leq 0.01$

Independent variables:

1 – lay up shots (LUS); 2 – shots from different sectors (SFS); 3 – passes of the ball to marked squares (PB); 4 – dribbling the ball in slalom (DBS)

Statistically significant differences ($p \leq 0.05$) between average increments of results of the HBT test in analyzed groups were noted in the test of shots from sectors (SFS), where higher increments of results were in the group of men, and in the dribbling tests (DBS), where the group of women was characterized by greater improvement. In lay up shots (LUS) and passes to marked squares (PB), differences between arithmetic averages of changes in results after an annual program in males and females were not confirmed statistically.

The analysis of the relation between the initial level and the effects in technical competence in basketball was based on the joint assessment of differences in results in individual HBT tests between the third and the first measurements (table 5). In order to specify the overall level of the changes in technical competence of the subjects the indicator of the changes in the

technical skill (ICTS) was calculated. This indicator is a product of variables of standardized differences in the results of four HBT tests between the third and the first measurement. The value of ICTS describes the effects of the changes in the level of technical competence in basketball after annual training program. ICTS was accepted as an endogenous variable. To assess the relations between ICTS and the starting level in individual tests a coefficient of multiple correlation was used. In the group of females the initial level of technical skills accounts for 56.8% of the variance of changes in the area of studied elements. The model of two variables including passes to specified squares (PB) and dribbling the ball in slalom (DBS) accounts for 54.7% of the ICTS. The starting level of the trial PB itself determines ICTS in 48.6%.

In the group of males the changes in technical skills are determined in 29.9% by the starting level of these skills. The determination model of two variables included the trials of lay up shots (LUS) and passes of the ball to specified squares (PB) which explain the studied phenomenon in 27.7%. A variable with the strongest determination force is, similar to the group of women, the starting level in the test of passes to marked squares (PB). This variable explains the value of the indicator of changes of technical competence (ICTS) in 20.3%.

Discussion

In the course of the analysis it was found that the level of technical competence after the completion of practical basketball training is higher in all students from the initial level. The differences in results of arithmetic means of the four HBT tests were confirmed statistically in both sexes.

The analysis of the values of arithmetic means in three measurements indicates that greater progress was observed between the first and the second measurement than between the second and the third one. Thus, it confirms the regularity in the process of movement learning. The curves drawn as a result of learning of specific senso-motor activities are s-shaped (Włodarski 1976). The curves of learning are constructed on the basis of the results of many subjects. Depending on the speed of learning the curves are more steep or more gentle.

Although the achieved average progress in the level of technical skills after one year of training was statistically significant, individual level of changes was widely diversified. In the vast majority of cases there was an increment in the level of all studied skills. However, in a few cases no progress was noted, and there was even deterioration of results. It seems

that in the case when only time was the measure to assess the skill (dribbling test) errors related to measuring the time could have significant impact on the deterioration of results.

In the theory of learning of activities such an individual irregularity in the increment of results is called plateau. The reason for the period of stagnation manifested by the worsening in the subsequent tests may be the result of fatigue, distraction from the activity, new obstacle or difficulty or weakening of interest (Włodarski 1976). It is difficult to decide what could result in the period of stagnation in the case of a few subjects.

With such a large differentiation in individual results of learning of technique among the subjects it seems that a general knowledge on the scale of susceptibility or sensitivity of individuals to training stimuli is important. Bouchard et al. (1997) determined the effects of future training capabilities on the identification of individual sensitivity of individuals to exercise and its conditions. Among these conditions the following are listed: age, sex, previous experience, phenotype, genetic factors (Terjung 1983, Sharkey 1997). The differences in the effects of learning of technique do not depend on age in this case.

Average results of learning of elements of technique in the studied groups of students suggest that in the group of males the effects occurred sooner than in the group of females. In the studied group of females it was found that the best learning effect was in the test of lay up shots (LUS) where $LUS2-LUS1=3.55$ points is over twice as high compared to the average increment between the third and the second measurement $LUS3-LUS2=1.68$ point. The most gentle learning curve was noted for passes to specified squares (PB), where $PB2-PB1=2.68$ points; $PB3-PB2=2.23$ points.

In the group of men significantly higher increments occurred in the first period of learning for all elements of the game. In the trial of lay up shots (LUS) the increment between the second and the first measurements was over four times higher than the increments in this trial between the third and the second measurements ($LUS2-LUS1=4.62$ points; $LUS3-LUS2=1.06$ point). A similar situation occurred in the passes to specified squares ($PB2-PB1=3.23$ points; $PB3-PB2=1.04$ points) and shots from sectors (SFS) ($SFS2-SFS1=4.29$ points; $SFS3-SFS2=1.50$ points). Smaller differences in average increments between the analyzed measurements were in the trial of dribbling the ball in slalom (DBS), although the curve drawn as a results of the analysis of learning effect of this element of the game maintained its S-shape.

Predisposition to faster and easier learning of movements is considered to be a genetic determinant. Szopa et al. (1996) emphasized in the review of the studies of genetic conditions of motor skills that women present a lower

degree of susceptibility to environmental influences (ecosensitivity), and thus to training. However, in spite of faster effect of learning of elements of technique among men in the first period of training, the final effects of learning were higher in the group of men than in the group of women for one element only. Statistically significant differences between average increments of the HBT tests results after one year of training occurred in shots from sectors (SFS) where higher increments of results were noted for men ($p \leq 0.05$) and in the trial of dribbling in slalom (DBS) in which women in turn were characterized by higher increments of results ($p \leq 0.05$). In the other two tests, i.e. lay up shots (LUS) and passes to specified squares (PB), the differences after one year of training were not statistically significant. This indicates that the rate of learning process in women was more even while men were characterized by more drastic changes.

On the basis of the analysis of final effects of technique learning it cannot be assumed that in the given conditions sex is a clear determinant of changes in the level of technical skills in basketball. In the literature, however, the sex factor is considered to be one of the basic determinants of sensitivity to training (Bouchard et al. 1997, Sharkey 1997, Terjung 1983). How to explain the lack of differences in the increments of technical skills in basketball between men and women and higher increments of results of the DBS trial in the group of women? It seems that the explanation of this phenomenon could be found in the diversification of the starting level in comparable groups of students. Women were characterized by the low enough initial level, compared to men, for the training resulted in the same if not higher increments, in spite of their generally lower susceptibility to training stimuli. The degree of improvement of effectiveness and motor fitness decreases with the development of the level of skill. This well-known regularity is closely related to the controlling role of the genetic factor (Wolański and Pařízková 1976). On the other hand, however the results of the studies carried out by Žak and Sakowicz (1995) in the group of girls and boys playing handball indicate strong sexual differentiation in the area of increments of technical competence. They were nearly twice as high in the group of females than in the group of males. More significant effects of these exercises on motor skills of girls may be related to the advancement in the somatic development and weaker genetic control of their psycho-motor properties.

The analysis of the results of our own research makes it possible to state that changes in the level of technical competence are determined by the initial level, in such a way that subjects with a lower starting level of technical competence in basketball improve more. Both in the group of men

and women in all HBT tests the increase of mean results on subsequent measurements was accompanied by decreasing values of the coefficient of variation. The only exception was the dribbling the ball in slalom (DBS) test in the group of men during third measurement. The results of the correlation between the initial level of the studied technical competence and the changes in this level after one year of training of the two groups of students confirms that subjects with a lower level of skills at the beginning of training achieve higher increments of results. The values of correlation coefficients are negative and statistically significant in all elements of the HBT test.

The factor of the initial level turned out to be also a strong determinant for the indicator of the changes in the technical skill (ICTS) level in men and women participating in a one-year basketball training program. In the group of women the factor determines the changes in the level of technical competence in basketball in 56.8% while for men is equal to 29.9%. The participation in the curricular basketball training is, especially for people with a lower level of skills, a decisive factor determining their progress.

Similar relation was noted by Drozdowski (1980) in the study of level of selected features of physical fitness during four years of physical education classes. In two selected groups of students different in terms of the initial level of physical fitness, the changes in the level of strength, flexibility, explosive power and endurance were observed. Students with a lower initial level of physical fitness showed higher rate of changes in the studied skills than the group of individuals with better fitness. According to Drozdowski (1980) the groups of "the poorest" students were forced to work more effectively to meet the passing requirements and achieved higher increments of results.

Also during a three-year study of the changes in track and field fitness of physical education students carried out by Kutzner (1982) it was found that a high improvement in the level of fitness in all students was noted mainly thanks to the progress of the poorest students. This regularity was also confirmed by Wolański (1976). The overall tendency of decreasing the range of results in the tests assessing co-ordination in children in their first year of school were also confirmed by Z. Wyżnikiewicz-Nawracała (1987).

The analysis of the changes in the structure of basketball technical competence, presented above, in particular the study of the effects of training in its variation and diversity seems to create more clear view on individual capabilities of sports skills acquisition. In order to increase the effectiveness of this process it is necessary to apply the rule of individualization in the learning of sports technique by physical education students.

Conclusions

1. A one-year program of basketball training is sufficient to cause changes in the level of technical competence in the majority of physical education students. The progress found in the level of technical skills of men and women after the completion of the training program was statistically significant, although individually very diversified.
2. The sex of the subjects was not an unambiguous determinant of effects of the changes in the level of technical competence of physical education students. The increments of the level of skills in the group of men after one year of training was higher than the average increments in the group of women only in one case (shots from sectors).
3. A strong determinant of the shape of changes in the level of technical competence in basketball after one year of training was its initial level. Students initially presenting a lower level achieve higher improvements.

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