

# The impact of variability and distribution of practice on student's learning of basketball throw skill

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## Abstract

**Purpose:** The practice organization is an important factor in sports environment and education. This study aimed to investigate the impact of variability and distribution of practice on basketball throw skill learning among female elementary school students.

**Material:** Based on the pre-test scores of 15 attempts (5 throw from any distances of 3, 3.5, and 4 meters), 90 volunteer participants were distributed in 6 homogeneous groups of 15 participants (three massed practice groups and three distributed practice groups with blocked, increasing, and decreasing practice arrangements). In acquisition stage, the participants practiced for 9 sessions. After 72 hours, all participants conducted the retention test. Changing the angle at a distance of 3.5 meters, the transfer test was conducted at the same day.

**Results:** The findings showed that the variability and distribution of practice did not impact on participants' performance in acquisition, retention, and transfer stages.

**Conclusions:** For development of contextual interference effect, the variability in parameters of a motor program is not enough.

**Keywords:** massed practice, distributed practice, variable practice, constant practice.

## Introduction

The motor skills constitute a large part of human life. It is for many years that scientists and trainers try to identify factors affecting the skills performance and skillful movements. All those who train motor skills know that the learning of these skills is not possible without practice. The people train skills to increase their potential to perform the skills in future. The practice aims to achieve skillful performance features. There are four characteristics which define skillful performance: improvement, consistency, stability, and persistence. In different situations, there are different training methods to improve them. The variability of practice is one of the features which increase the likelihood of success in achieving skillful performance. There are several studies which support the impact of practice variability on optimization of practice's beneficial effects. The main challenge in this feature is this question: which aspect of skill should be changed and how this variability should be provided in exercise sets [1]?

The practice organization is one of the important factors in sports environment, rehabilitation process, and education. The teacher, therapist, or coach should decide who to distribute the practice time of a skill? It seems that two things are important in this process: first, the length and frequency of exercise sessions per week and second, the rest time between practice sets [1]. Some coaches increase practice time, instead of increasing the effectiveness of training. However, it seems the practice time is not the most important factor in planning and the quality of practice should also be considered. Therefore, it is very important to organize practice to increase its effectiveness [2]. The distribution and organization of practice in the

form of practice program may provide a proper context for deeper and more meaningful processing of motor and cognitive concepts and better acquisition of motor skills [1]. In response planning stage, the individuals may use scheme to estimate parameter value in attempts. This process will be led to a movement which is based on past experience in using this program. Some evidence suggests that variable practice impacts on creating schemas [3].

The contextual interference effect is one of the practice variability theories; it was proposed by William Battig [4]. According to Battig, there are two important sources for this interference. First, the order of performing different skills; if a skill is repeated frequently, only one skill will be maintained in working memory and as a result, the activity of working memory and the need for attention will be reduced. While, if various skills are periodically practiced, the created interference will be high. Second, the nature of skills; if the skills have similar nature, the interference will be lower [4]. Battig suggested that the contextual interference effect is applicable for motor and verbal areas [5]. Shea and Morgan were pioneers in testing Battig claims and for the first time, they applied the contextual interference for motor skills. The result of this test showed the effects of contextual interference [6]. According to Magill [1], on the other hand, the interference of practicing several skills in one session may led to improved learning. In this method, the need to focus on skill and problem solving will lead to more effective learning [7]. Also, the dynamic system approach emphasizes on the need to expand the perceptual-motor space and discover better methods to overcome the problems of skills' degrees of freedom [8].

Travlos observed the contextual interference effect in volleyball service skill acquisition and retention stages

and stated that the special practice improves athletic performance in both stages [9]. Also, Rahavi, Shojae, Estiri, and Naghizadeh compared the performance of blocked, random, and serial groups in basketball skills. Investigating the effect of contextual interference on motor programs learning, they found significant difference in retention stage; the random practice group performed better than other groups [10]. Pauwelz, Vancleef, Swinnen, and Beets also reported that the contextual interference impacts on computer visual-motor task learning among young and elderly people [11]. Correa, Walter, Torriani-Pasin, Barros, and Tani did not find contextual interference in a serial task and found that the practice amount had no effect on it [12]. Lotfi, Khalaji, Bahram, and Farrokhi did not report any significant difference between blocked, serial, and random groups in acquisition and transfer stages of basketball throw skill and stated that the creation of contextual interference effect requires more training [13]. Mokhtari Dinani, Farrokhi, Lotfi, and Nazarian investigated a bimanual coordination task and found that the variability of practice impacts only on parameters learning [14].

In their theory, Guadagnoli and Lee suggested that the cognitive processing level during practice depends on practice challenging level [15]. The nature of practice, practice situation, and learner's level interact to determine the challenge in practice attempts. Due to difference in tasks types, skill level of participants, acquisition attempts, and limitation of attempts to duration of research project, there is rarely an overall result for practice arrangement and sometimes, conflicting results are reported [15]. Fromer stated that the contextual interference effect emerges by interacting with individual characteristics and the people who have higher intelligence benefit more from contextual interference [16]. Guadagnoli and Lee believed that the regular challenges during exercise will lead to optimal learning environment for learners [15]. According to challenge hypothesis, the more the people get skilled during practice, the less will be functional task difficulty and the nominal task difficulty will be constant. This means that by changing skill levels, the practice difficulty levels will also change. When the learner achieves higher levels of skills, these challenges will be increasingly more difficult. A gradual increase in contextual interference may be one of ways to prepare learner for appropriate challenge level and eventually, learn a task. The systematic increasing contextual interference is one of practice arrangements which have recently been proposed in motor learning literature and refers to the gradual increase of contextual interference during practice [17]. Pasand, Fooladiyanzadeh, and Nazemzadegan investigated the volleyball skills and reported that in acquisition stage, the blocked group had a better performance and in retention and transfer stages, the random and gradual contextual interference increase groups had better performance than blocked group [18].

On the other hand, Garcia, Moreno, Reina, Menayo, and Fuentes compared the effects of intensive and distributed practice on acquisition and retention of single

and continuous skills. They reported that at the end of practice, the distributed practice group had better outcome. In delayed retention stage, the intensive practice group performed the single and continuous skills significantly better than other groups [19]. Leite, Ugrinovitch, Carvalho, and Benda reported that although the massed practice impacts on elderly people and weakens their learning, it has no impact on task learning of young people [20]. Also, Dail and Christina considered the golf swing as a single task and found that those who perform distributed practice have better performance than those who performed intense practice; in retention stage, there was no significant difference between two groups [21]. Given the multiplicity of factors affecting the incidence of contextual interference effect and variability of practice and the possibility of interaction between this effect and results of intervention in distribution of practice, this study aims to investigate the impact of variability and distribution of practice on acquisition, transfer, and retention stages of basketball throw skill learning among female elementary school students and introduce the most appropriate method of practice distribution and tasks arrangement in every training session to improve the learning process of similar skills.

### Material and Methods

*Participants:* From among volunteers who were right-handed female students aged 12-10 years, 90 participants were selected; they completed consent forms. Based on the pre-test scores of 15 attempts (5 throw from a distance of 3, 3.5, and 4 meters), they were distributed in 6 homogeneous groups of 15 participants (three massed practice groups and three distributed practice groups with blocked, increasing, and decreasing practice arrangements).

*Research Design:* In acquisition stage, the participants practiced for 3 weeks, 3 sessions per week, and 3 sets with 15 repetitions in each session. In distributed practice groups, the participants rested for 30 seconds after each throw and 3 minutes after each set. In massed practice groups, the participants thrown 15 times in each set and rested for 3 minutes after each set. During the training period at the end of each session, the average performance of participants in each group was recorded. After resting for 72 hours, all participants conducted the retention test, like the pre-test. Changing the angle at a distance of 3.5 meters, the transfer test was conducted at the same day.

A demographic questionnaire and AAHPERD's basketball throw modified test were used as research tool. In this test, if the ball falls directly into the basket has 5 points, if the ball hit the ring but does not fall the basket has 3 points, if the ball hit the board and ring and does not fall in basket has 2 points, and if the ball hit the boards has 1 point. The balls which go out without hitting the board and ring have zero point.

After filling out the consent form and demographic questionnaire, a total of 90 female right-handed eligible beginners were selected and participated in a preparatory training session. Then, all participants performed

AAHPERD’s basketball passing pre-test which consisted of 15 attempts (5 throw from any distance); all throws were scored and recorded separately. The mean of 15 attempts was considered as pre-test score. Based on pre-test scores, the sample distributed homogenously in 6 groups: 1) Massed increasing group, 2) Massed decreasing group, 3) Massed blocked group, 4) Distributed increasing group, 5) Distributed decreasing group, and 6) Distributed blocked group. In acquisition stage, the participants practiced for 3 weeks, 3 sessions per week, and 3 sets with 15 repetitions in each session. In distributed practice groups, the participants rested for 30 seconds after each throw and 3 minutes after each set. In massed practice groups, the participants thrown 15 times in each set and rested for 3 minutes after each set. At the end of last session after 10 minutes of rest, all participants performed the pre-test which consisted of 15 attempts (5 throw from any distance). After resting for 72 hours, all participants conducted the retention test, like the pre-test. Changing the angle at a distance of 3.5 meters, the transfer test was conducted at the same day.

*Statistical Analysis:* The mean and standard deviation were used for statistical description of data, Shapiro-Wilk test was used to assess the normality of data distribution,

and Levene’s test was used to evaluate the homogeneity of variances. The one-way analysis of variance was used to compare scores of pre-test in study groups. The factor analysis of variance was used to evaluate the effect of distribution and variability of practice and their interaction on acquisition, retention, and transfer stages at significance level of 0.05.

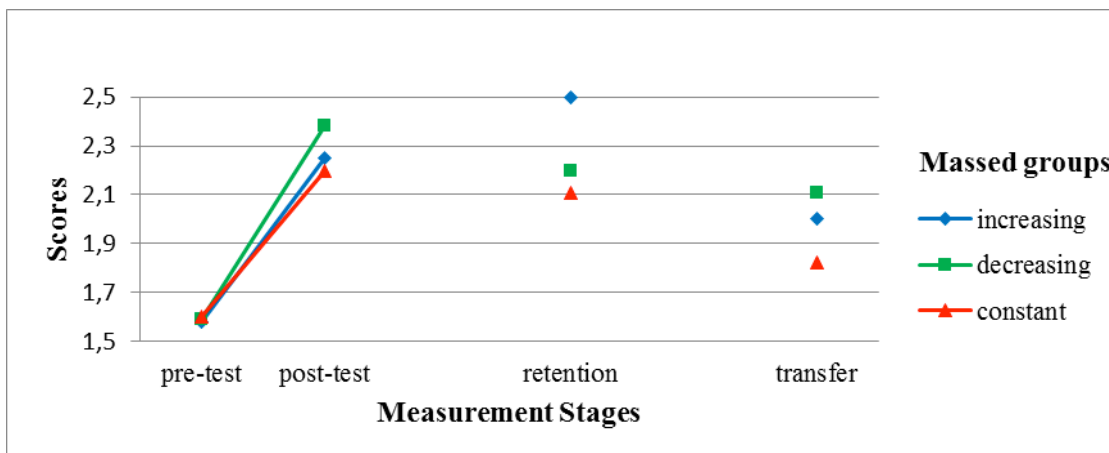
**Results**

The demographic characteristics of subjects showed that the mean of age was  $11.28 \pm 0.63$  years old, the mean of height was  $1.47 \pm 0.09$  m, and the mean of weight was  $43.49 \pm 9.24$  kg. There was no significant difference between groups in terms of these three indicators.

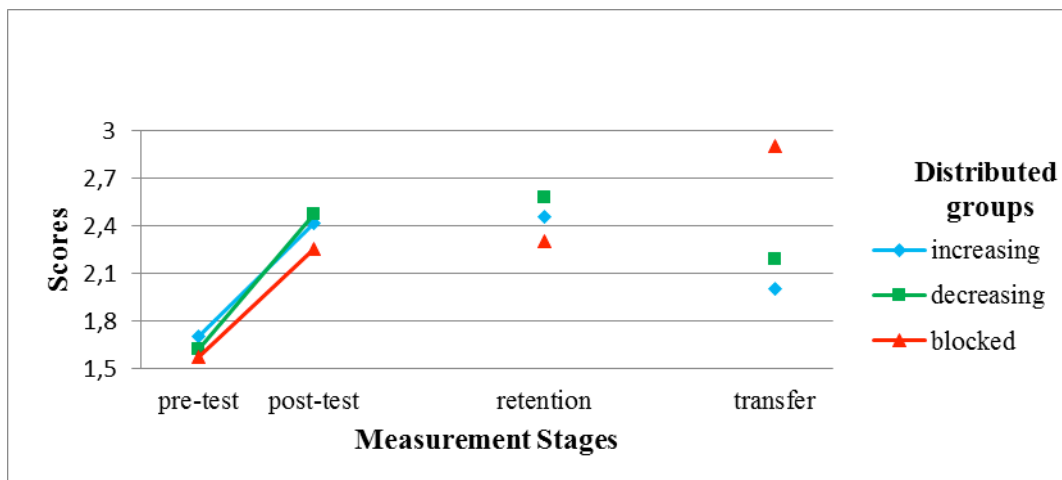
The mean of scores in various stages of measurement including pre-test, post-test, retention test, and transfer test in massed practice groups and distributed practice groups is provided in Figures 1 and 2.

Shapiro-Wilk test was used to evaluate the normality of data distribution. The results showed that the data had normal distribution ( $P > 0.05$ ). The homogeneity of variances was tested using Levene’s test and was confirmed ( $P > 0.05$ ).

The results of one-way analysis of variance to compare



**Figure 1.** The mean of scores in various stages of measurement in massed practice groups.



**Figure 2.** The mean of scores in various stages of measurement in distributed groups.

**Table 1.** Results of multivariate ANOVA in different stages of measurement

Measurement stage	Index Effect	df	F	P	Effect size
Acquisition	Distribution	1	0.887	0.349	0.011
	Variability	2	0.089	0.342	0.026
	Distribution × Variability	2	0.098	0.907	0.002
Retention	Distribution	1	1.78	0.186	0.022
	Variability	2	1.59	0.216	0.037
	Distribution × Variability	2	0.82	0.443	0.02
Transfer	Distribution	1	0.765	0.384	0.009
	Variability	2	1.61	0.205	0.038
	Distribution × Variability	2	0.67	0.511	0.016

the mean of pre-test scores in six groups showed that there was no significant difference between groups ( $F_{(5, 84)} = 0.074$  and  $P = 0.996$ ).

The factor analysis of variance was used to investigate the effect of distribution and variability of practice and their interaction on accuracy of basketball throw in acquisition, retention, and transfer stages. The results of analysis are summarized in Table 1.

According to table, the effects of distribution of practice, variability of practice and their interaction on participants' basketball throw skill is not significant.

### Discussion

The findings showed that the distribution and variability of practice do not impact significantly on acquisition, retention, and transfer of basketball passing skill. This is consistent with findings of Lotfi et al and Mokhtari Dinani et al [13, 14]; it is also inconsistent with findings of Garcia et al and Rahavi et al [10, 19]. The inconsistency may be due to participants' different skills and ages. The results of variability of practice effect may be explained by second part of Magill and Hall's hypothesis; according to it, the parameter change in tasks which are controlled by a generalized motor program cannot lead to active processing and movement pattern reproduction and is not enough to cause interference.

Although some studies have not mentioned the number

of repetitions and rest time on a constant basis, the number of attempts selected for this study is almost the mean of figures in the literature. One reason for contradiction between the results of this research and other research may be the interference of variables such as skill level, task type, and practice amount (number of practice trials, practice sessions, and duration of acquisition period). The distributed practice may impact significantly if the performance of skill causes severe physical, muscular, neurological, and cognitive exhaustion. The complexity of skill is also one of the variables affecting the efficacy and superiority of distributed practice compared with massed practice. However, due to lack of research evidence, more research is still needed in this area.

### Conclusions

Considering the insignificant difference in variability of practice group, it may be concluded that for development of contextual interference effect, the variability in parameters of a motor program is not enough. However, there is no unit practice for everyone. More research should be done to achieve a practice pattern and the affecting factors should be studied and compared.

### Conflict of interest

The authors declare no conflict of interest.

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