

# The effectiveness of acquisition and retention of free throw skill by beginner basketball players through different methods: implicit learning of equipment modification (ILQM) and explicit learning (EL)

## Authors' Contribution:

- ✍ A Study Design
- 📁 B Data Collection
- 📊 C Statistical Analysis
- 📄 D Manuscript Preparation
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Received: 12 December 2016; Accepted: 15 June 2017; Published online: 27 December 2017

AoBID: 11379

## Abstract

### Background & Study Aim:

In recent years, investigators have proposed and developed many new techniques for teaching motor skills. In such manner, implicit motor learning may be one of the most remarkable. This study aimed to verify the hypothesis that the effect of implicit learning of equipment modification (ILEM) method on acquisition and retention would be better than explicit learning (EL) method.

### Materials & Methods:

Forty male beginner students (age  $9.93 \pm 0.55$  years) following the pre-test, were randomly placed into one in all two groups: EL – full size in mini basketball group ( $n = 20$ ); ILQM – equipment modification group ( $n = 20$ ). All participants were attending 10 training sessions (each session included 4 blocks, and each block included 15 trials) during the period of the study. After the 10 season practice program, a post-test took place, followed by a retention test which was conducted one week later in which there was no free throw basketball practice.

### Results:

Results confirmed our hypothesis. The results revealed statistically significant differences in improvement between pre-test and post-test of each group. Pairwise comparisons of the test effect indicated that performance during the pre-test was significantly poorer than post-test and retention test ( $p < 0.05$ ). The independent-samples t-tests were conducted to follow up the significant between two groups. There were significant difference mean ratings scores of post-test ( $t(20) = 17.031, p < 0.05$ ) and retention test ( $t(20) = 14.702, p < 0.05$ ) between two groups.

### Conclusions:

The influence of a modified court to be a key variable in the promotion of skill acquisition and retention with novice players relative to the influence of a modified ball and court size.

### Keywords:

AAPEHRD's basketball test • motor skills • self-efficacy • shoot • technique

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### Conflict of interest:

Authors have declared that no competing interest exists

### Ethical approval:

The research was approved by the University Ethics Committee

**Provenance & peer review:**

Not commissioned; externally peer reviewed

**Source of support:**

Departmental sources

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**Basketball** – *noun* 1. a game played by two teams of five players who score points by throwing a ball through a basket mounted at the opponent's end of a rectangular court 2. a large round ball of the type used in the game of basketball [74].

**Basket** – *noun* 1. (in basketball) a mounted horizontal metal hoop with a hanging open net, through which a player must throw the ball in order to score 2. (in basketball) a goal scored by throwing the ball through the basket, which is worth 1, 2 or 3 points depending on circumstances [74].

**Free throw** – *noun* (in basketball) an opportunity to shoot at the basket unhindered by the opposing players, awarded to a player who has been fouled [74].

**Motor skill** – a skill for which the primary determinant of success is the quality of the movement that the performer produces [75].

**Motor skills** – *plural noun* the ability of a person to make movements to achieve a goal, with stages including processing the information in the brain, transmitting neural signals and coordinating the relevant muscles to achieve the desired effect [74].

**Motor skill learning** – *noun* the acquisition of new motor skills, either as a child or as part of sports training [74].

**Skill acquisition** – *noun* the process of learning a skill, either by being taught or by observation [74].

**Skill retention** – *noun* the fact of remembering learned skills [74].

## INTRODUCTION

In recent years, investigators have proposed and developed many new techniques for teaching motor skills. In such manner, implicit motor learning may be one of the most remarkable. An important subject for teachers is to what degree and when implicit learning can be incorporated in physical education classes, where motor skill learning takes place in groups. By explicit motor learning, students at first learn a new motor skill by acquiring declarative knowledge about the method in which to execute the to-be-learned skill [1, 2]. In physical education, but the same is bound to be true in sports, this usually involves a teacher prescribing and/or explicating how to execute the skill optimally.

Masters et al. (e.g., [3-7] argue that motor skills can either be acquired implicitly or explicitly, and this affect subsequent performance of the skill. Implicit motor learning refers to the acquisition of skills with little to no working memory involvement (e.g., [7] – the formulate responsible for the temporary storage and manipulation of information in the brain [8, 9].

As a result, an individual that learns a skill implicitly has a minimal conscious awareness of how the skill is performed. In contrast, explicit motor learning is a highly conscious process, and the performer can verbalise the methods used to execute the skill (e.g., [3, 10, 11]). Learning a skill implicitly rather than explicitly has been shown to be helpful to future performances. For example, the performance of a skill learnt implicitly is pliable to psychological stress [3, 4, 10] and physiological fatigue [12, 13], and performance does not refuse when required to complete a cognitively demanding secondary task (e.g., [5, 11]). Possibly most relevant to children, however, is that implicit learning places minimal demands on working memory, which is still improving throughout childhood [14, 15]. In fact, skill

acquisition is increased in children when practice places fewer demands on working memory [16].

Some practice techniques have been proposed that purpose promote implicit motor learning (e.g., analogy learning [4]; dual task practice [17]; errorless practice [11]; marginally perceptible feedback [18]; and reduced feedback [5]). Another technique that may recall implicit learning, specifically for children, is the use of modified equipment. Modifying equipment to make appropriate to the physical size of children permit skills to be performed with greater ease [19-23]. Based on the errorless learning paradigm, which proposes that the reduction of errors during performance limits explicit hypothesis testing [12, 24, 25], the employ of modified equipment by children was predicted to reduce working involvement during skill performance.

Free throw (FT) ability is an important skill required of a basketball player [26]. It provides an opportunity for a team to score free or uncontested points and is frequently the deciding factor in a close game or even of a tournament title [27]. FT, in general, makes up 20 to 25% of all points scored in a game [28, 29]. Children normally lack the strength and physical characteristics required to use the equipment used in adult sports. Many studies proposed game modifications as a method to adapt the game to children's interests, possibilities, and needs [30, 31]. Investigation of basketball support use of basketball equipment suitable for children's physical characteristics and training needs [31-33].

The ball is one of the most important parts of the equipment that mediates confrontation in team sports. The literature consulted in the area of motor learning and improvement recommends a ball with a smaller circumference (63.83 cm) to learn to dribble [21]. An enhance in the circumference tends to make throwing more

difficult [34]. A literature review of youth basketball found many studies that analysed the effect of ball dimensions through shooting tests. These researches indicated that a ball of smaller dimensions (496-538.65 g and 70.8-73 cm) guided to better shot technique [33] or did not impair it [32], satisfied the children's preferences [33], increased levels of perceived self-efficacy [35], and increased shot efficacy [33, 36] or did not impair it [32, 35].

Studies have indicated that modify of ball mass may improve shot performance and other ball handling skills. The shot is the action that youth basketball players most prefer [37]. Children claim to derive the most fun from shooting, and it is one of the aspects they feel the best performing [38]. Shooting near the basket produces higher percentages of efficacy [39-41]. Thus, such shots are the ones that should be favoured. Depriving children of these experiences means limiting their practice in the most important content of the game. Working on shooting variability is essential in youth basketball. Quantity and the variability of practice are essential variables in the process of training children [42, 43].

The objective of this study was to verify the hypothesis that the effect of implicit learning of equipment modification (ILEM) method on acquisition and retention would be better than explicit learning (EL) method.

## MATERIAL AND METHODS

### Participants

Forty male beginner students (age  $9.93 \pm 0.55$  years, height  $1.39 \pm 4.16$  m, body mass  $31.65 \pm 3.23$  kg), without previous basketball's free throw experience, volunteered to participate in the study. All were right-handed and free of injuries at the time of data collection. All subjects following the pre-test were randomly placed into one in all two groups: **EL** – full size in mini basketball group ( $n = 20$ ); **ILQM** – equipment modification group ( $n = 20$ ). All participants were attending 10 training sessions (each season included 4 blocks, and each block included 15 trials) during the period of the study. After the 10 season practice program, a post-test took place followed by a retention test, which was conducted one week later in which there was no free throw basketball practice.

All procedures were approved by the University Ethics Committee for the ethical use of human subjects, in accordance with current national laws and regulations. Participants (or their parents) gave their written informed consent to involvement in the study after receiving both a verbal and a written explanation of the experimental design and its potential risks. They were informed that they could withdraw from the study at any time without prejudice to their sports involvement.

### Tasks and apparatus

In the full size in mini basketball group, each participant learned a basketball shooting task while in a standing posture (400 cm from the front of the basket). A regulation mini basketball (485 g, 69-71 cm) and rim (circumference 45 cm, adapted height 260 cm) were used. In the equipment modification group, each participant learned a basketball shooting task while in a standing posture (300 cm from the front of the basket). A ball of smaller mass (440 g, 69-71 cm) and rim (circumference 45 cm, adapted height 200 cm) were used.

### Skill evaluation

The learning of FT, the performance in each attempt was determined by American Alliance for Health, Physical Education, Recreation and Dance (AAPEHRD's) basketball test: 3 point to hit the ball into the basket without hitting the hoop or the board, 2 scores to hit the ball into the basket while hitting the board or the hoop, 1 score to not to hit the ball to the board or the hoop.

### Statistical analysis

The statistical analysis of the data was performed with SPSS v. 16.0 for Windows. Initially, the data sets were analysed using descriptive statistics (mean  $\pm$  standard deviations). Kolmogorov-Smirnov tests confirmed data normality and homogeneity, respectively. In order to evaluate the participants' performance in the acquisition stage, Some one-way ANOVA with repeated measures was applied. Significant interactions as a result of these analyses were investigated through the use Bonferroni correction where appropriate. Afterwards, Independent t-test was used to compare the mean means performance between the two groups in posttest and retention test. Statistical significance was set at  $p < 0.05$ .

**Technique** – *noun* a way of performing an action [74].

**Technique** – specific procedures to move one's body to perform the task that needs to be accomplished [76].

**Shoot** – *verb* 1. (of pain) to seem to move suddenly through the body with a piercing feeling 2. in a sport such as a football or a basketball, to kick, hit or throw a ball in an attempt to score a goal or point [74].

**Self-efficacy** – *noun* confidence and efficient stress-management techniques that positively affect an athlete's performance [74].

## RESULTS

Results confirmed our hypothesis. The mean scores for two groups were greater in the post-test and retention test than in the pre-test (Table. 1).

The result of this research showed a significant difference in improvement between pre-test and post-test of each group (Figure1). Pairwise comparisons of the test effect indicated that performance during the pre-test was significantly poorer than post-test and retention test ( $p < 0.05$ ). Post hoc tests revealed the significant development between pre-test and post-test in two groups ( $p < 0.05$ , Bonferroni inequality). The independent-samples t-tests were conducted to follow up the significant between two groups. There were significant difference mean ratings scores of post-test ( $t(20) = 17.031, p < 0.05$ ) and retention test ( $t(20) = 14.702, p < 0.05$ ) between two groups (Table 2).

## DISCUSSION

IL (implicit learning) method promoted acquisition and retention of FT better than EL (explicit learning) method. The results indicated that free throw (FT) acquisition and retention were higher with the equipment modification than full-size equipment. These results suggest that the equipment modification could be a strategy to improve free throw acquisition and retention than full size.

Results confirmed our hypothesis, acquisition and retention of free throw basketball skill improved

with the 440-g ball and modified court size when compared to the regulation ball and standard court size. This result seems to be in line with the studies we consulted about facilitating ball handling when decreasing ball mass [21, 33, 36, 44]. Also, this result is in line with the investigation we consulted that the shots near the basket produce higher percentages of performances [39-41]. The improvement in acquisition and retention was higher for the 440-g ball and modified court size than the regulation ball and standard court size. The decrease in the weight of the 440-g ball and modified court size, in comparison to the regulation ball and standard size, produced an improvement in acquisition and retention.

Lack of strength is the main reason for children's unsuccessful FT performance [35, 45, 46]. The lack of strength, in addition to preventing the ball from reaching the basket, also hinders the adequate placing and use of body levers. This leads to unsuccessful FT [46]. Weaker players increase their horizontal movements to generate the necessary speed to allow the ball to reach the basket [47-50]. This causes a decrease of angle and releases height of the ball [47, 48, 51]. An increase in speed release and a decrease of angle and release height of the ball reduce shot performance [52, 53]. Nevertheless, shot success was higher with the 440-g ball and modified court size. As the ball weight and court size increased, shot success decreased. This result coincided with those Pinar et al. [40]. They found that the percentage of successful shots with the 440g ball from distances smaller

**Table1.** Descriptive statistics and test of the within-subjects effect of two groups of beginner basketball players.

Group moreover, method	Test	Mean	SD	Statistics	Type III sum of squares	df	Mean square	F	Sig.	Partial Eta Squared
ILQM (n = 20)	pre-test	7.70	1.78	sphericity assumed	628.133	2	314.067	245.904	.000	.928
	post-test	15.45	1.19	Greenhouse-Geisser #	628.133	1.546	406.372	245.904	.000	.928
	ret-test	14.75	0.78	Huynh-Feldt ##	628.133	1.657	379.178	245.904	.000	.928
				lower-bound	628.133	1.000	628.133	245.904	.000	.928
EL (n = 20)	pre-test	4.45	1.23	sphericity assumed	209.633	2	104.817	128.347	.000	.871
	post-test	9.45	1.63	Greenhouse-Geisser #	209.633	1.703	123.072	128.347	.000	.871
	ret-test	8.6	2.01	Huynh-Feldt ##	209.633	1.854	113.075	128.347	.000	.871
				lower-bound	209.633	1.000	209.633	128.347	.000	.871

# see [77]; ## see [78]; **Sig.** significance

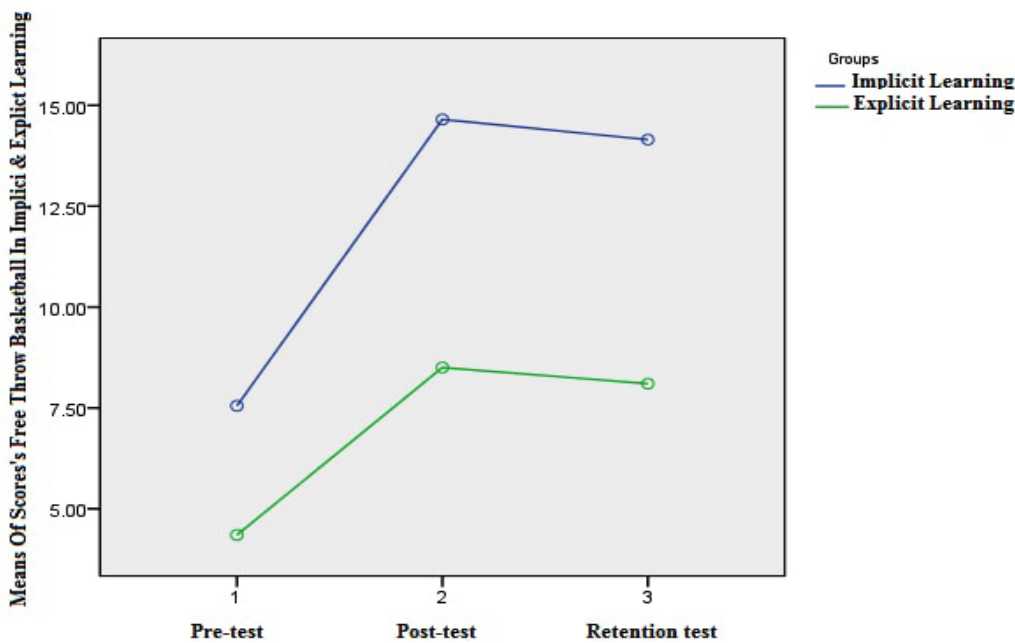


Figure1. Means of score’s free throw basketball in pre-, post- and retention test of ILQM and EL groups.

Table2. Results of the independent-samples test of post-test and retention test of groups.

Research stage	Lévene’s test equality of variance		t-test for equality of means						
	F	Sig.	t	df	Significance equal-tails test	mean the difference	standard error difference	95% confidence interval of the difference	
								lower	upper
post test	.441	.511	17.031	38	.000	6.15000	.36110	5.41899	6.88101
			17.031	37.138	.000	6.15000	.36110	5.41843	6.88157
retest	1.747	.194	14.702	38	.000	6.05000	.41151	5.21694	6.88306
			14.702	33.612	.000	6.05000	.41151	5.21335	6.88665

Sig. significance

(44%) and greater (32.9%) than 4m was higher than the 39.44% and 20%, respectively, achieved by the participants of the study by Piñar et al. [40]. In contrast, the results do not coincide with those Satern et al. [32] and of Chase et al. [35]. In their free-throw tests, they found no positive effect of the ball with a lower mass.

These results may be related to several arguments. In accordance with Palao et al. [37] and Piñar et al. [38], the children must have seen that their preferences were satisfied and they had more fun when playing with the 440-g

ball. The participants would have experienced more reinforcement of their actions [54-56]. Nevertheless, there could be two reasons for efficacy being with modified ball mass. Firstly, as mentioned previously, strength is usually an argument suggested in the literature reviewed [35, 45, 57]. Secondly, most youth basketball shots are two-point shots [39, 41, 58-60]. Also, shots from a distance of less than 4m and from inside the free throw lane are the most frequent during the game [39-41, 58, 61, 62]. So, shots near the basket produce higher percentages of performance [39-41]. This increases the levels of

perceived self-efficacy and reinforces shooting from zones where the players are more successful [55, 63]. Due to the above reasons, the shooting pattern with regard to distances and ball mass seems to be so well established that it was affected by a modification in ball mass and court size. The modified component produce any critical fluctuation in the context to cause the behaviour to change [40, 58, 61, 64, 65].

From a motor learning perspective, practising skills in environments that better replicate the “representative” environment in which the skill is performed is thought to aid perception-action coupling [66-69]. For example, altering the task constraints in basketball may enhance children’s development of regulating movements based on the important information perceived from their opponent. It is also argued that modifying the task allows children to explore their movements in search of the most appropriate solution, and this is believed to facilitate an unconscious process of learning [69]. However, we must be careful drawing this conclusion, as the implicit motor theory suggests that searching for new solutions is often a conscious process, and this typically results in accumulation of explicit knowledge about the skill; thus, skills are learnt consciously rather than unconsciously, e.g. [5, 11] for a review of implicit motor learning research, see [7]. Most of the implicit motor learning research has used adults as participants (for an exception, see [16] and, therefore, there is clearly a need to

investigate further this issue in children, where important cognitive functions are still developing (e.g. language development [70]; working memory development [71].

## CONCLUSIONS

The current study found the influence of a modified court to be a key variable in the promotion of skill acquisition and retention with novice players relative to the influence of a modified ball and court size. However, it is quite likely that a range of task and equipment scaling combinations could be successfully employed dependent on the skill of the participants [72, 73].

The critical feature is that the task affords learners significant opportunities to establish a basic pattern of coordination before being exposed to more difficult practice conditions. In conclusion, this study has highlighted the negative influence of employing adult constraints for children learning basketball skills. Task and equipment scaling was found to be a useful vehicle for simplifying the task for the learner while allowing the key information sources within the practice environment to be presented in a perception-action coupled manner. Such an approach is consistent with Davids and co-authors constraints-led approach to coaching, as the task remained representative while allowing the children an appropriate opportunity to develop key information–movement couplings.

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**Cite this article as:** Afrouzeh M, Sohrabi M, Saberi Kakhki AR et al. The effectiveness of acquisition and retention of free throw skill by beginner basketball players through different methods: implicit learning of equipment modification (ILQM) and explicit learning (EL). *Arch Budo Sci Martial Art Extreme Sport* 2017; 13: 71-78