ORIGINAL ARTICLE
EXTREME SPORTS

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
E Funds Collection

Mohsen Afrouzeh[1ABCD], Mehdi Sohrabi[1BCD], Ali Reza Saberi Kakhki[1BC], Sobhan Sobhani[2ABCDE]

[1] Department of Motor Behavior, Faculty of Physical Education and Sport Sciences, Ferdowsi University of Mashhad, Mashhad, Iran
[2] Department of Physical Therapy, School of Rehabilitation Sciences, Shiraz University of Medical Sciences, Shiraz, Iran

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 ±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 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.

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

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

Author's address: Mehdi Sohrabi, Department of Motor Behavior, Faculty of Physical Education and Sport Sciences, Ferdowsi University of Mashhad-International Campus, Mashhad, Iran; e-mail: m_afrozeh@yahoo.com

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 score2.(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 ±0.55 years, height 1.39 ±4.16 m, body mass 31.65±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 ± 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 post-test ret-test	7.70 15.45 14.75	1.78 1.19 0.78	sphericity assumed	628.133	2	314.067	245.904	.000	.928
				Greenhouse-Geisser #	628.133	1.546	406.372	245.904	.000	.928
				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 post-test ret-test	4.45 9.45 8.6	1.23 1.63 2.01	sphericity assumed	209.633	2	104.817	128.347	.000	.871
				Greenhouse-Geisser #	209.633	1.703	123.072	128.347	.000	.871
				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

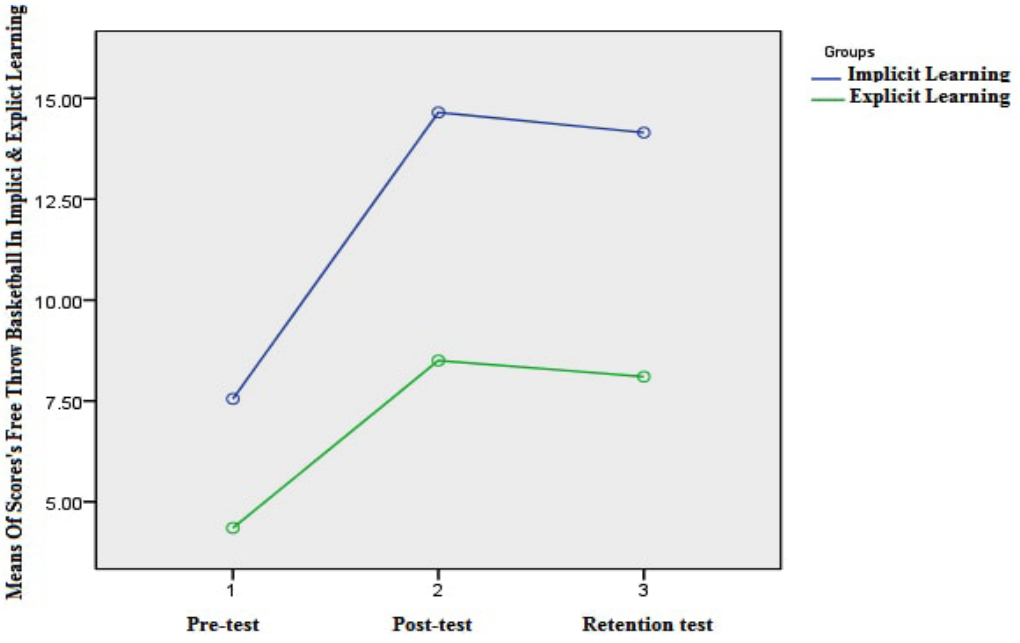

Figure1. Means of score's free throw basketball in pre-, post- and retention test of ILQM and EL groups.

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 17.031	38 37.138	.000 .000	6.15000 6.15000	.36110 .36110	5.41899 5.41843	6.88101 6.88157
retest	1.747	.194	14.702 14.702	38 33.612	.000 .000	6.05000 6.05000	.41151 .41151	5.21694 5.21335	6.88306 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.

REFERENCES

1. Fitts PM, Posner MI. Human Performance. Belmont, CA: Brooks/Cole; 1967
2. Anderson JR. Acquisition of cognitive skill. Psychol Rev 1982; 89(4): 369-406
3. Masters RS. Knowledge, knerves and know-how: The role of explicit versus implicit knowledge in the breakdown of a complex motor skill under pressure. Brit J Psychol 1992; 83(3): 343-358
4. Liao CM, R.S. Masters RS. Analogy learning: A means to implicit motor learning. J Sport Sci 2001; 19(5): 307-319
5. Maxwell J, Masters R, Eves F. The role of working memory in motor learning and performance. Consciousness and Cognition 2003; 12(3): 376-402
6. Poolton J, Masters R, Maxwell J. The relationship between initial errorless learning conditions and subsequent performance. Hum Movement Sci 2005; 24(3): 362-378
7. Masters RS. Poolton JM. 4 Advances in implicit motor learning. In: Hodges NJ, William AM, editors. Skill acquisition in sport: Research, theory and practice. Abingdon: Routledge; 2012; 59
8. Baddeley AD, Hitch G. Working memory. Psychol Learn Motiv 1974; 8: 47-89
9. Baddeley A. Working memory. Curr Biol 2010; 20(4): R136-R140
10. Hardy L, Mullen R, Jones G. Knowledge and conscious control of motor actions under stress. Brit J Psychol 1996; 87(4): 621-636
11. Maxwell J, Masters RS, Kerr E et al. The implicit benefit of learning without errors. Q J Exp Psychol Sec A 2001; 54(4): 1049-1068
12. Poolton J, Masters R, Maxwell J. Passing thoughts on the evolutionary stability of implicit motor behaviour: Performance retention under physiological fatigue. Conscious Cogn 2007; 16(2): 456-468
13. Masters R, Poolton J, Maxwell J. Stable implicit motor processes despite aerobic locomotor fatigue. Conscious Cogn 2008; 17(1): 335-338
14. Gathercole SE, Pickering SJ, Ambridge B et al. The structure of working memory from 4 to 15 years of age. Dev Psychol 2004; 40(2): 177-190
15. Luciana M, Conklin HM, Hooper CJ et al. The development of nonverbal working memory and executive control processes in adolescents. Child Dev 2005; 76(3): 697-712
16. Capio C, Poolton JM, Sit CH et al. Reducing errors benefits the field-based learning of a fundamental movement skill in children. Scand J Med Sci Spor 2013; 23(2): 181-188
17. Maxwell J, Masters R, Eves F. From novice to no know-how: A longitudinal study of implicit motor learning. J Sport Sci 2000; 18(2): 111-120
18. Masters RS, Maxwell JP, Eves FF. Marginally perceptible outcome feedback, motor learning

and implicit processes. Conscious Cogn 2009; 18(3): 639-645

19. Elliott B. Tennis racquet selection: A factor in early skill development. Aust J Sport Sci 1981; 1(1): 23-25
20. Elliott B, Marsh T. A biomechanical comparison of the topspin and backspin forehand approach shots in tennis. J Sport Sci 1989; **7**(3): 215-227
21. Burton AW, Welch BA. Dribbling performance in first-grade children: effect of ball and hand size and ball-size preferences. Phys Educ 1990; 47(1): 48-51
22. Hammond J, Smith C. Low compression tennis balls and skill development. J Sport Sci Med 2006; 5: 575-581
23. Farrow D, Reid M. The effect of equipment scaling on the skill acquisition of beginning tennis players. J Sport Sci 2010; 28(7): 723-732
24. Masters RS, MacMahon K, Pall HS. Implicit Motor Learning in Parkinson's Disease. Rehabil Psychol 2004; 49(1): 79-82
25. Orrell A, Eves FF, Masters R. Implicit motor learning of a balancing task. Gait Posture 2006; 23(1): 9-16
26. Uygur M, Goktepe AAkE, Karabörk H et al. The effect of fatigue on the kinematics of free throw shooting in basketball. J Hum Kinet 2010; 24: 51-56
27. Malone LA, Gervais PL, Steadward RD. Shooting mechanics related to player classification and free throw success in wheelchair basketball. J Rehabil Res Dev 2002; 39(6): 701-710
28. Hays D, Krause J. Score on the throw. Basketball Bull 1987; 4-9
29. Mersky M. Coaching and teaching the free-throw shooter. Basketball Clin 1987; 19(5): 8-11
30. Evans J. Objectivity and game modification: The next step. Aust J Health Phys Educ Recreation 1980; 89: 13-17
31. Kirk D. Framing quality physical education: the elite sport model or Sport Education? Phys Educ Sport Peda 2004; 9(2): 185-195
32. Satern M, Messier S, Keller-McNulty S. The effect of ball size and basket height on the mechanics of the basketball free throw. J Hum Movement Stud 1989; 16(3): 123-137
33. Regimbal C, Deller J, Plimpton C. Basketball size as related to children's preference, rated skill, and scoring. Percept Motor Skill 1992; 75(3): 867-872
34. Burton AW, Greer NL, Wiese DM. Changes in Overhand Throwing Patterns as a Function of Ball Size. Pediatr Exerc Sci 1992; 4(1): 50-61
35. Chase MA, Ewing ME, Lirgg CD et al. The effects of equipment modification on children's self and basketball shooting performance. Res Q Exercise Sport 1994; 65(2): 159-168
36. Isaacs L, Karpman M. Factors effecting children's basketball shooting performance: A log-linear analysis. Carnegie Sch Phys Educ Hum Movement 1981; 1: 29-32
37. Ortega E, Palao JM. Análisis del contraataque en baloncesto de formación. In: CIB'2007. IV Congreso Ibérico de Baloncesto; 2007 Nov 29 - Dec 01; Cáceres, Spain. Cáceres: Facultad De Ciencias Del Deporte; 2007: 103 [in Spanish]
38. Piñar MI, Cárdenas D, Conde J et al. La satisfacción en los jugadores de minibasket. In: CIB'2007. IV Congreso Ibérico de Baloncesto; 2007 Nov 29 - Dec 01; Cáceres, Spain. Cáceres: Facultad De Ciencias Del Deporte; 2007: 47 [in Spanish]
39. Cruz J. Tavares F. Notational analysis of the offensive patterns in cadets basketball teams. In: Hughes M, Tavares F, editors. Notational Analysis of Sport IV. Proceedings of the IV World Congress; 1998 Sep 22-25; Porto, Portugal. Porto: University of Porto; 1998; 112-119
40. Piñar MI, Alarcón F, Palao JM et al. Análisis del lanzamiento en el baloncesto de iniciación. In: Oña A, Bilbao A, editors. Libro de Actas del II Congreso Mundial de Ciencias de la Actividad Física y el Deporte. Granada: Deporte y Calidad de Vida; 2003: 202-208 [in Spanish]
41. Tavares F, Gomes N. The offensive process in basketball–a study in high performance junior teams. Int J Perf Anal Spor 2003; 3(1): 34-39
42. Thomas KT. The development of sport expertise: From Leeds to MVP legend. Quest 1994; 46(2): 199-210
43. Schmidt R, Lee T. Sensory contributions to motor control. In: Schmidt R, Lee T, editors. Motor control and learning: a behavioural emphasis. Champaign, IL: Human Kinetics; 2005: 125-162
44. Pellett TL, Henschel-Pellett HA, Harrison JM. Influence of ball weight on junior high school girls' volleyball performance. Percept Motor Skill 1994; 78(3 suppl): 1379-1384
45. Benham T. Modifications of Basketball Equipment and Children's Performance. National Convention of the American Alliance for Health, Physical Education, Recreation and Dance; 1986 Apr 10-13; Cincinnati, USA. Washington: ERIC Clearinghouse; 1986
46. ClearyTJ, Zimmerman BJ, Keating T. Training physical education students to self-regulate during basketball free throw practice. Res Q Exercise Sport 2006; **77**(2): 251-262
47. Elliott B. A kinematic comparison of the male and female two-point and three-point jump shots in basketball. Aust J Sci Med Sport 1992; 24: 111-111
48. Miller S, Bartlett RM. The effects of increased shooting distance in the basketball jump shot. J Sport Sci 1993; 11(4): 285-293
49. Miller S, Bartlett R. The relationship between basketball shooting kinematics, distance and playing position. J Sport Sci 1996; 14(3): 243-253
50. Liu S, Burton AW. Changes in basketball shooting patterns as a function of distance. Percept Motor Skill 1999; 89(3 Pt 1): 831-845
51. Kouvelioti V, Stavpourous N, Kecris N. Biomechanical Analysis of shooting in basketball: relating research with practice. Inquiries Sport Phys Educ 2006; 4(1): 97-107
52. Brancazio PJ. Physics of basketball. Am J Phys 1981; 49(4): 356-365
53. Tan A, Miller G. Kinematics of the free throw in basketball. Am J Phys 1981; 49(6): 542-544
54. Mace FC, Lalli JS, Shea MC et al. Behavioral momentum in college basketball. J Appl Behav Anal 1992; 25(3): 657-663
55. Vollmer TR, Bourret J. An application of the matching law to evaluate the allocation of two-and three-point shots by college basketball players. J Appl Behav Anal 2000; 33(2): 137-150
56. Romanowich P, Bourret J, Vollmer TR. Further analysis of the matching law to describe two- and three-point shot allocation by professional basketball players. J Appl Behav Anal 2007; 40(2): 311-315
57. Juhasz M, Wilson B. Effect of ball size on shooting characteristics of junior basketballers in comparison to adults. Aust J Sport Sci 1982; 2(2): 16-20
58. López MIP. Incidencia del cambio de un conjunto de reglas de juego sobre algunas de las variables que determinan el proceso de formación de los jugadores de minibasket (9-11 años). In: Castejón Oliva FJ, Fuentes-Guerra FJG, Jiménez FJ et al, editors. Investigaciones en formacion deportiva. Sevilla: Wanceulen; 2013: 343-365 [in Spanish]
59. Mexas K, Tsitskaris G, Kyriakou D et al., Comparison of effectiveness of organized offences between two different championships in high level basketball. Int J Perf Anal Sport; 2005; 5(1): 72-82
60. Arias JL, Argudo FM, Alonso JI. Effect of the 3-point line change on the game dynamics in girls' minibasketball. Res Q Exercise Sport 2009; 80(3): 502-509
61. Piñar MI, Alarcón F, Vegas A et al. Posiciones y distancias de lanzamiento durante la competición en minibasket. In: Díaz A, Rodríguez PL, Moreno JA, editors. Actas del III Congreso Internacional de Educación Física e Interculturalidad. Murcia: Consejería de Educación y Cultura de la Región de Murcia; 2002 [in Spanish]
62. Ortega E, Cárdenas D, Sainz de Baranda P et al. Analysis of the final actions used in basketball during formative years according to player's position. J Hum Movement Stud 2006; 550: 421-437
63. Wilson G, Simons JP, Wilson J et al. The non-emergence of an especial skill: Good is not enough. J Sport Exercise Psy 2007; 29(Suppl): S140-S141
64. Tsitskaris G, Theoharopoulos A, Galanis D et al. Types of shots used at the Greek National Basketball Championship according to the division and position of players. J Hum Movement Stud 2002; 42(1): 43-52

65. Wissel H. Basketball: Steps to Success. Champaign, IL: Human Kinetics; 2011

66. Handford C, Davids K, Button C, et al. Skill acquisition in sport: some applications of an evolving practice ecology. J Sports Sci 1997; 15(6): 621-640

67. Chow JY, Davids K, Button C et al., The role of nonlinear pedagogy in physical education. Rev Educ Res 2007; 77(3): 251-278

68. Davids KW, Button C, Bennett SJ. Dynamics of skill acquisition: A constraints-led approach. Champaign, IL: Human Kinetics; 2008

69. Renshaw I, Davids K, Savelsbergh GJP. Motor learning in practice: A constraints-led approach. Abingdon: Routledge; 2010

70. Hulme C, Thomson N, Muir C et al., Speech rate and the development of short-term memory span. J Exp Child Psychol 1984; 38(2): 241-253

71. Alloway TP, Gathercole SE, Pickering SJ. Verbal and visuospatial short-term and working memory in children: Are they separable? Child Dev 2006; 77(6): 1698-1716

72. Button C, Bennett S, Davids K et al. The effects of practicing with a small, heavy soccer ball on the development of soccer related skills. Communication to the British Association of Sports and Exercise Sciences Annual Conference; 1999 Sep 7-10; Leeds, UK

73. Chapman G, Bennett S, Davids K. The effects of equipment constraints on the acquisition of juggling and dribbling in soccer. Communication to 6th Annual Congress of European College of Sports Science (Perspectives and Profiles); 2001 Jul 24-28; Cologne: Germany; 2001

74. Dictionary of Sport and Exercise Science. Over 5,000 Terms Clearly Defined. London: A & B Black; 2006

75. Schmidt RA, Wrisberg CA. Motor Learning and Performance. A Situation-Based Learning Approach. Champaign, IL: Human Kinetics; 2008

76. Martens R. Successful Coaching. London: Human Kinetics; 2004

77. Greenhouse, SW, Geisser S. On methods in the analysis of profile data. Psychometrika 1959; 24: 95-112

78. Huynh H, Feldt LS. Estimation of the Box correction for degrees of freedom from sample data in randomised block and split-plot designs. J Educ Stat 1976; 1: 69-82

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