Effects of observing real, animated and combined model on learning cognitive and motor levels of basketball jump shot in children

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Abstract

Study aim: The purpose of the present study was to investigate the effects of observing the real, animated and combined model demonstrations on cognitive and motor learning of a basketball jump shot.

Material and methods: Forty-five subjects with mean age of (11.03 ± 1.7) were randomly divided into three groups: real, animated and combined model demonstrations. Subjects were asked to perform basketball jump shot task during a four-step process. In total, participants shot 150 shots (10 shots in the pretest, 120 shots and 40 observations in the practice phase, and 10 shots in the posttest and the retention test). Accuracy scores and cognitive status were assessed as dependent variables.

Results: Results showed that observation of real, animated and combined model demonstrations had significant effects on motor and cognitive learning of a basketball jump shot. Moreover, there was no significant difference between observing animated model and real model demonstrations at motor level, however, animated model demonstration group performed better than real model group at cognitive level. Finally, combined model demonstration group performed better than both animated and real model demonstrations groups.

Conclusions: Results suggested that observing animated model demonstration is an appropriate approach for learning basketball jump shot even in children. It is also recommended to use animated model demonstration as a complement to real model.

Keywords: Observation – Model demonstration – Motor learning – Cognitive learning

Introduction

Model demonstrations are extensively used by instructors and coaches as a teaching strategy to facilitate acquisition of new coordination patterns, especially in sport settings [14, 22]. A reason for skill demonstration is to show how it is implemented. Skill demonstration for beginners is an effective means of understanding concept of movement. Gentile [22] considers this as the first goal of learning process. Gentile's view of skill demonstration includes: 1) it is useful to see skill before performing it, and 2) most important point is that the trainer should repeat skill demonstrations as much as necessary. Modeling is considered as use of observation as a tool for conveying information about how to perform a skill [22]. There are two prominent perspectives on observational learning: first is Social Cognitive Theory [5] which states that observer symbolically encodes information about skill when presented. Learner can then

use this coded information to guide performing the action. According to this theory, modeling is effective when it follows four sub-processes including attention, retention, production, and motivation [33]. Second perspective is based on Direct Visual Perception in which the visual system is capable of automatically processing visual information, forcing the motor device to act based on what the visual device has discovered [10, 27].

Generally, techniques such as live modeling (skilled or beginner modeling) and video modeling (film and photo) and sometimes computer modeling (animations) are used to help the learners to acquire each observational learning process that leads to stabilization of information contained in a represented memory [8]. Observing skilled model demonstrations perceive information about unchanging patterns of movement and imitates displayed strategy, and observing beginner model demonstrations engage observers in a more proactive way rather than encouraging them to imitate observed performance [22]. Previous studies indicate that live

modeling, either beginner [9, 23] or skilled models [17, 25] can be effective for learning motor skills.

On the other hand, video and animated modeling are often designed to display information in a way that incorporate changes over time and help to understand and facilitate learning [2, 11–13]. According to Cognitive Load Theory [28], educational animations are generally ineffective in generating high side-loads; and therefore, they are shown in separate sections to reduce their cognitive load [4]. In a review study, it has been reported that in some situations, educational animations lead to more learning than section-by-section display, especially when animation is more realistic and involves procedural-motor knowledge [18].

In a study, it has been shown that observing an animated model demonstration (one-second segmental presentation) has positive effects on cognitive level of balance performance [19]. Ayres et al. [3] showed that effects of educational animations on learning to knit and to complete a puzzle is greater than static pictures (segment animation). Wouters et al. [36] also found that animated model demonstration along with verbal instruction can prevent visual channel overload and affect learning. Arguel and Jamet [2] also demonstrated that observing animated model demonstration has positive effect on learning the first aid principles.

Existing literature has revealed positive impact of real and video modeling on learning different motor skills. Moreover, research showed that there are no significant differences between the efficiency of these two types of modeling on motor skill learning [7, 24, 26]. However, Abutarbush et al. [1] showed that effects of video-training on learning a therapeutic task is greater than live (real) modeling. According to aforementioned research, findings on the effects of real and video model demonstrations on learning motor and cognitive skills are inconsistent. Furthermore, development of technology made it possible to use alternative training methods. On the other hand, application of animations in learning motor skills as an alternative method has been less explored. Moreover, Lee et al. [18–21] have emphasized that perception and cognition play a mediating role in learning motor skills and also Weeks [32] pointed out that cognitive learning is as important as motor learning through modeling. The purpose of this study was, therefore, to investigate the effects of observing real, animated, and combined model demonstrations on learning a basketball jump shot at both cognitive and motor levels.

Materials and methods

Study design and population

The present study utilized a causal-comparative (with pretest-performance test-retention test) approach. Participants were 45 students from fifth and sixth grade of

elementary schools who were selected by using a simple random sampling method. To do this, we first compiled a list of eligible students and then randomly selected 45 of them using the random number method in an Excel software. To this end, we inserted all numbers of students in the Excel software. Then, by using the RAND-BETWEEN, we selected 45 students. Next, participants were randomly assigned into three groups including real model demonstration, animated model demonstration, and combined model demonstration groups, each consisted of 15 students. The inclusion criteria were beginner, right-handed, lack of movement disorders, and completion of research consent. Participants and their parents signed an individual informed consent form. Research protocol was evaluated and confirmed by an institutional research ethical committee.

Measuring tools

Jump shot motor test: Method proposed by Zachry et al. [37] was used to score jump shots. Accordingly, a five-point scale was used to measure the accuracy of jump shot. Scoring modes were respectively (zero points) for when “ball doesn’t touch backboard or rim”, (one point) when “ball touches backboard”, (two points) when “ball touches backboard and rim”, (three points) when “ball touches rim” and (four points) for “getting ball into rim”. The researcher measured the jump shot motor test.

Basketball jump shot cognitive test: A researcher-made questionnaire was used to determine cognitive level of basketball jump shot skills (Figure 1). Questionnaire consisted of seven multiple choice questions with three options based on International Basketball Federation’s rating codes for technical implementation of jump shot skill. A score would be deducted for each wrong answer. Therefore, score of each subject was between zero and seven. Reliability of questionnaire was 0.79 by Cronbach’s alpha. Content validity of this questionnaire was confirmed by ten physical education professors. These professors were specialized in sport pedagogy as well as they used to be Basketball players in regional or national levels.

Procedure

After organizing groups, the pre-test was performed at both motor and cognitive levels. At cognitive level, all subjects completed paper-printed cognitive questionnaire by a pen, and at motor level, subjects completed ten trials and results were recorded on information sheets. All subjects spent four sessions as treatment sessions and had 30 attempts each session (120 attempts in total) on basketball jump shot skill. During the training phase, real model demonstration group observed a skilled person performing jump shot. The practice was that after presentation of two performances by skilled person, subjects performed jump shot six times (10 performances per session and 30 training

Figure 1. Overview of basketball jump shot skill

attempts in total). Second group practiced same way as first group (two times observing animation and then six training attempts). Subjects watched educational animations on a laptop screen. Conventional animation techniques have been used for preparation of educational animation. First, performance of skilled basketball player, who was a semi-professional basketball player with five years' experience at the regional level, was filmed (one that was also used for real model demonstration group), then it was converted into cartoon images (using Photoshop software), and finally GIF Animator software was used to create dynamic images. In combined model demonstration group, for each real or animated model demonstrations, six training attempts were performed. At the end of last session, two groups received a performance-test and then after 72 hours, they received a retention test at both cognitive and motor levels.

Ethical approval

This study was approved by University's Ethics Committee. The participants voluntarily participated in the present study and written informed consent was obtained from the subjects and their parents.

Data analysis

Shapiro-Wilk test was used in order to ensure the normality of the data. Analysis of variance (ANOVA) with

repeated measures was used to compare group means, and Bonferroni post hoc test was used as follow-up test. Significant level was set at $p < 0.05$.

Results

Table 1 shows means and standard deviations of participants' demographic characteristics.

Mean and standard deviation of groups in the pretest, performance test and retention test in cognitive and motor levels are presented in Table 2.

First of all, we used a one-way ANOVA to analyze the differences between three groups in pre-test. The results showed that there were no significant differences between groups in both motor ($F = 0.82$ and $p\text{-value} = 0.345$) and cognitive level ($F = 1.15$ and $p\text{-value} = 0.104$) in the pre-test. This indicates that all groups started the experiment at the same level.

We compared the differences between three groups during the pre-test, the performance test, and the retention test at both cognitive and motor level by using a 3 (Group: real, animated and combined model demonstrations) $\times$ 3 (Test: pre-test, performance test, and retention test) ANOVA with repeated measures on last factor. The results are presented in Table 3.

Table 1. Demographic characteristics of participants in groups

Group	N	Age [year]	Height [cm]	Weight [kg]
Real model demonstration	15	10.02 $\pm$ 1.9	145.23 $\pm$ 3.7	40.54 $\pm$ 6.1
Animated model demonstration	15	11.06 $\pm$ 0.8	143.12 $\pm$ 5.1	38.33 $\pm$ 3.4
Combined model demonstration	15	12.01 $\pm$ 1.2	148.03 $\pm$ 1.7	41.61 $\pm$ 5.2

Table 2. Results of pretest, posttest and retention test

Groups	Pre-test				Performance				Retention			
	Cognitive		Motor		Cognitive		Motor		Cognitive		Motor	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Real model demonstration	1.13	0.74	14.26	1.75	3.93	0.70	34.00	2.92	3.40	0.50	32.60	2.77
Animated model demonstration	1.20	0.77	14.13	2.41	5.33	0.97	33.60	3.13	4.33	0.89	31.93	2.89
Combined model demonstration	1.26	0.59	13.80	1.97	5.66	0.89	38.06	2.34	4.80	0.6	36.60	2.35

Table 3. Results of repeated variance analysis for 3 (groups) in 3 (stages) in cognitive and motor levels

Sources		SS	df	MSE	F	<i>p</i> -value
Cognitive level	Group	28.63	2	14.31	21.37	0.001
	Test	356.68	2	178.34	300.41	0.001
	Test * Group	12.11	4	3.03	5.10	0.001
Motor level	Group	219.08	2	109.54	11.63	0.001
	Test	12596.85	2	6298.43	1.25	0.001
	Test * Group	144.74	4	36.18	7.23	0.001

* Significant at $p < 0.05$, SS: sum square; MSE: mean square error, sig = level of significance.

At the cognitive level, the results showed that the main effect for Group ($F = 21.37$ and $p\text{-value} = 0.001$), Test ($F = 300.41$ and $p\text{-value} = 0.001$) and interaction between Group and Test ($F = 5.10$ and $p\text{-value} = 0.001$) were significant. First, these results indicate that all types of demonstrations (e.g., real, animated, and combined models) have positively and significantly increased the performances of participants at cognitive level. Moreover, the results of the Bonferroni post hoc tests revealed that both animated and

combined model demonstration groups performed significantly better than real model demonstration group in the performance test and the retention test. However, there was no significant difference between animated and combined model demonstration groups (see Figures 2 and 3).

At the motor level, the results showed that the main effect for Group ($F = 11.63$ and $p\text{-value} = 0.001$) and Test ($F = 1.25$ and $p\text{-value} = 0.001$) and also interaction of Group and Test ($F = 7.23$ and $p\text{-value} = 0.001$) were

Figure 2. The means of experimental groups across pre-test, performance test, and retention test at cognitive level

Figure 3. The means of experimental groups across pre-test, performance test, and retention test at motor level

significant. Again, we found that all types of demonstrations (e.g., real, animated, and combined models) have positively and significantly increased the performances of participants at motor level. Furthermore, the results of the Bonferroni post hoc tests revealed that combined model demonstration group performed significantly better than real model and animated model demonstrations group in the performance test and the retention test. However, there was no significant difference between real and animated model demonstration groups (see Figures 2 and 3).

Discussion

The purpose of this study was to investigate the effects of observing real model (skilled model demonstration), animated model and combined model demonstrations on learning the cognitive and motor level of basketball jump shot. The results showed that observing real model demonstration had significant effects on cognitive level of performance and retention of basketball jump shot. These findings are in line with those of Kampiotis & Theodorakou [19], which showed that observation of real model demonstration affects cognitive level of balance performance. Moreover, observation of real model demonstration had significant effects on motor level during the performance and retention of jump shot. These results are consistent with findings of Haguenaer et al. [16], Barzouka et al. [6] and Hayes et al. [17], which quantify the effects of observing a real model demonstration on learning sports skills. In this regard, the present study indicated that observing real model demonstration by enhancing the motor level and improving cognitive representation or perception of relevant information led to learning a basketball jump shot [20].

On the other hand, observation of animated model demonstration had significant effects on cognitive level during the performance and retention of basketball jump shot. These results are in line with those of Vernadakis et al., [29, 30] who showed that computer training (animation and image) had a significant impact on learning the cognitive level of basketball shot. The results also showed that observation of the animated model demonstration had significant effects on learning the motor level of basketball jump shot. These results are in line with the finding of Ayres et al. [3] and Wong et al. [35]. These findings are not consistent with theory of cognitive load [28], which states that educational animations are generally ineffective due to their high load and transient effects. However, they are consistent with perspective of Hoffler and Leutner [17] stating that when animation is more realistic and involves procedural-motor knowledge, it can reduce side-loads and facilitate learning. From a neurological point of view, when one focuses on human movements, due to mirror-neuron system, transient effects of animation cannot cause a problem for one's learning. The mirror-neuron system allows one to use imitation learning [3]. Therefore, animated modeling also helps the learner to create relevant internal representations of the displayed contents that can subsequently facilitate motor learning [2].

The most important finding of this study was that effects of observing animated model demonstration on learning the cognitive level of basketball jump shot are greater in comparison to observing real model demonstration. Kampiotis & Theodorakou [17] also found that observation of the animated model demonstrations had greater effects on cognitive level of basketball jump shot in comparison to observing the real model demonstrations.

However, Wiksten et al. [34] did not show such cognitive advantages for animated model demonstration. To interpret these findings, it can be mentioned that advantage of viewing animated model over real model demonstration is that it transmits sensory awareness elements that are effective in acquiring cognitive level learning and these sensory elements must be taken into account [23].

By examining learning at the motor level, results showed that there were no significant differences between the effects of observing animated and real model demonstrations. In other words, both modeling methods led to same learning at the motor level without any advantage over each other. These findings are in line with the results of Wiksten et al. [33] who showed no significant differences at the motor level. In spite of these results, Vernadakis et al., [29] showed advantage of animated model demonstrations over real representations in basketball skill and in another study Vernadakis et al. [31] showed opposite results in length jump skill, which are inconsistent with our findings. Probably the reason for the inconsistencies in the results might be that using a separate teaching method and perhaps the type of skills.

Finally, the results showed that combined model provides better motor learning than the real and animated model demonstrations. These results are in line with results of Ghavami et al. [15] and Arguel and Jamet [2]. In other words, Arguel and Jamet [2], in their study on the effects of observation modalities (combined and animated) on first aid knowledge showed that observing combined model demonstration was significantly better than observing animated model demonstration, which is consistent with results of the present study. Ghavami et al. [15] also showed that combined model demonstration is better than static imagery model demonstration in motor learning of handstand balance skills. The results also showed that there were no significant differences between observing real model demonstration and animated model demonstration at the motor level. These findings can be justified on the basis of Newell's view that observation of any kind of model demonstrations can convey relative timing information to the observer.

Conclusion

Overall, all three modeling methods led to learning at both motor and cognitive levels of basketball jump shot. However, cognitive advantage of animated model demonstration was greater than real model demonstration. The results of this study add to the literature by showing the importance of observing an animated model demonstration on learning both cognitive and motor aspects of a sport skill. In addition to theoretical considerations, the above-mentioned results have practical implications in a sports

context. As such, animated model demonstrations can be used as a modeling method for demonstrating sport skills in educational settings. Further research with focusing on other sport skills and different biomechanical constraints are needed to improve the understanding of the impact of animated model on motor learning.

Conflict of interest: Authors state no conflict of interest.

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