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Enhancement of motor skill learning by a combination of ideal model-observation and self-observation

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Abstract

Background: Observational learning is an effective pedagogical approach that can be used as a method to improve motor skill acquisition and also a useful instrument to promote psychological variables such as self-efficacy by emphasizing the motivational aspect. Although, little research is known about the model type and the observation conditions which will optimize learning.

Aim: This study aimed to clarify the effect of using a combination of ideal model-observation and self-observation on self-efficacy and learning the forehand service of table tennis.

Materials and Methods: Forty females were assigned to one of four experimental groups. All groups received the same instructions concerning how to perform the task, filled out a self-efficacy questionnaire, and then performed 10 pre-test trials. The acquisition phase included six sessions. The retention test was done 72 hours after the last acquisition session. Mixed ANOVA with repeated measures and Bonferroni post hoc tests were conducted, and one-way ANOVA was used to determine group significant differences.

Results: The results indicated that observing the combination of skilled and learning models led to the highest self-efficacy for learning, compare with other experimental models. Also, significant learning of the task was shown in the acquisition phase in which the performance of all three experimental groups was clearly superior to the control group. Although in this phase there was no significant difference between the performances of two groups of combined skilled-learning and skilled. The results of the delayed retention test indicated that the performance scores of the combined skilled-learning group were significantly higher than the other three groups. Also, in this phase, the difference between the combined skilled self-observation and control or skilled groups was not significant.

Conclusion: Demonstrating a skilled model is the most popular type of observational learning among the instructors and physical education teachers, it is suggested that adding a learning model to that leads to better performance and enhancing the self-efficacy.

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1. Introduction

Mastering of the skill components in any sport is crucial to long-term success in that sport. Modeling or observational learning is one technique commonly utilized by coaches and instructors to facilitate the learning of sports skills. In fact, modeling has been defined as one of the most effective tools to transmit values, attitudes, patterns of thinking and behaviors" [1]. In addition, it has been proven to be an effective way to promote skill learning and change the psychological responses such as self-efficacy [2].

The observational learning, is defined as a process in which either the self-observation or the observation of another person, enhances the learning of motor skills [3]. It has been proven to be an effective intervention, when used without or with physical practice, and for both laboratory and applied tasks within the various setting [4, 5].

The researchers often use psychological factors (such as self-efficacy) as well as physical performance to assess the effectiveness of the skill-based modeling experiences. Self-efficacy is the belief of the personal ability to accomplish a certain achievement [6, 7]. To execute a behavior, one must believe that he or she can perform the behavior. Without this belief, the possibility of enacting this behavior decreases. Thus, in social cognitive theory, self-efficacy plays an important role in predicting human behavior. Increased self-efficacy is not only a result of experiencing successful performance, but also influenced by vicarious experiences [7]. Individuals convince themselves that they can successfully perform it when another person can do [8, 9]. Therefore, observational learning is an effective instrument for promoting self-efficacy [10]. The observing a successful person in performing a similar task can increase the efficacy of the observer.

Early modeling studies used Bandura's social learning theory as the theoretical construct to examine modeling both in the fields of psychology and motor behavior [6]. Bandura's (1977) theory suggests that learners encode desired behavior symbolically. Once the desired behavior is encoded, they can then use it as a guide for further learning. Furthermore, Bandura suggests that by providing vicarious experiences which have been cited as two powerful sources of self-efficacy information, modeling can enhance the learner's self-efficacy to perform the modeled skill [1, 6, 11].

Studies that have measured changes in psychological variables, support the positive effects of modeling on self-efficacy, motivation, and other self-regulatory variables in both sports [12, 13, 14], and rehabilitation settings [15].

After reviewing the literature on the use of the observation, it is noted that many researchers are concerned with 'who' is the most beneficial model to observe. The obvious model types are related to the observation of others or the observation of the self. For observing other individuals, it can be grouped into a skilled model (shows the correct execution of the skill), or a learning model (the observer sees the individual move from unskilled to skilled performances). Considering self-observation the as a model, one can observe oneself through self-observation (basic video playback).

Within the reviewed articles, the most popular model employed by researchers interested in observation interventions was a skilled model. They provide a standard

reference which observers can detect their own errors and make appropriate corrections, which facilitates constructing a mental representation [16-21]. In contrast, indicated opposite finding about the role of expert models in physical education and suggested that learning models can more actively promote the learning of sports skills in gymnastics [22], swimming [23, 24], and soccer [25]. They advocated that the use of learning models, gradually improves their performance, since they provide more information about strategy execution and error correction than expert models. Bandura noted that novices may feel that the demonstration of movements of expert models is beyond their abilities and therefore they are unable to fully imitate them [26] and believes that the similarity between the model and the observer enhances attention and retention processes in observational learning and thus leads to better learning outcomes [1].

The influence of self-observation on the performance and learning of various sports skills is also an accepted approach [27-30]. Self-observation usually focuses on correcting errors in motor performance, but can also be useful as a learning model [31]. According to social learning theory, learners should observe their performance while learning a motor skill to know how much they have mastered the skill, how much they should try and when they can evaluate the learning strategy correctly [1]. On the other hand, novice learners gain vicarious experience by observing similar models to promote skill learning [32]. When observing expert models, they cannot experience this similarity [33]. Therefore, viewing oneself as a model can maximize the similarity between the model and the observer [12, 34]. For example, significant improvement in the acquisition phase was found in a group of middle school students who observed themselves as a model while performing gymnastics skills [22]. In addition, self-observation significantly improved the freestyle swimming skills of elementary school students after the intervention [23].

Similarly, the self-observation group was found to perform better in crawl swimming during the acquisition phase [24]. This is confirmed by another study that found the students in the self-observation group performed better in soccer [25].

Due to the contradictions between the results of the comparative studies about the effects of various models on acquisition as well as psychological factors such as self-efficacy, some combined model researches were introduced. Anderson and Campbell (2015) found that combining self-observation with expert modeling has a positive effect on the skill acquisition by enhancing results [35]. Robertson, Germain and Ste-Marie (2018) suggest that combining self-observation with a skilled model is more suitable for motor skill learning than self-observation alone [36]. On the other hand, some studies have shown that observing both the learning and the expert models leads to better learning of a task than observing a learning or an expert model [37, 38].

Most of the articles that implement different types of models are investigated in a laboratory environment to influence skill acquisition. It is clear that other combined model types should be introduced to gain a better understanding of the wide variety of observational applications in different situations [39]. Also, in this study, it would determine whether combining models with different skill levels affects the development of error detection and better

task learning. So, this research was conducted to clarify the effect of using a combination of ideal model-observation and self-observation on the self-efficacy and learning the forehand service of table tennis.

2. Material and Methods

2.1. Methodology

The present study is Quasi-experimental and it is executed by a pretest, and posttest with a control group design.

2.2. Participants

Forty undergraduate students (Mean + SD= 21.12±1.35 years of age) from Yazd University voluntarily took part in this experiment. None of them had prior experience with the experimental task, and they were all unaware of the particular goals of the experiment. After filling in the personal information questionnaire and signing the consent form, they were divided into four groups of skilled model group, the combined skilled-learning group, the combined skilled-self-observation group, and the control group.

2.3. Task and Tools

We tested the accuracy of forehand service by doing Liao and Masters (2001) accuracy test in table tennis leveled its scores on a 5-value scale [40].

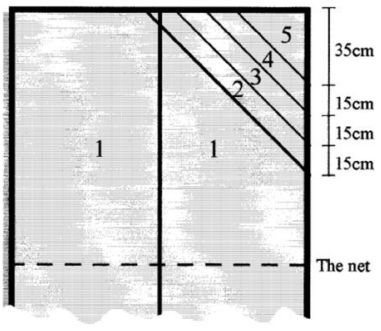

Figure 1. The target and scoring areas on the table tennis table

Self-efficacy was measured using a personalized self-efficacy questionnaire, created based on Bandura's guidelines regarding such scales [11, 41]. The validity of the questionnaire content was confirmed by professors, and the Cronbach's alpha coefficient was 0.79. The questionnaire asked the participants how confident they were about their ability to execute the desired task with success. The participants rated their self-efficacy on a 10-point Likert scale, ranging from 1 (I cannot do it) to 10 (very sure I can do it). A higher score indicates a higher sense of self-efficacy. A full-HD Sony Alpha A6000 camera with a zoom of 3.1 was placed in front of the participants and fully covered the experimental set-up. This camera could be seen by participants but its presence was not distracting. A 15-inch laptop (Lenovo Flex 2) was used to play the video for the modeling groups.

2.4. Models

In the present study, the videotape was used in order to show the observational model to each participant of three experimental groups. A female expert table tennis player instructor served as the skilled model. She executed 10 forehand services of table tennis demonstrating the correct technique. The participants in the skilled model group were models for participants in the combined skilled-learning group. Each participant of the combined skilled-learning group watched five trials of the skilled model video and then 5 trials of the skilled model. The combined skilled self-observation group watched five trials by herself that had been performed in the previous session after watching five trials of the skilled model video.

2.5. Procedure

In the training protocol steps, all

participants received equal verbal instructions about how to perform forehand service of table tennis. Then, they performed 10 trials to control the warm-up decrement effect. After, filling out the self-efficacy questionnaire pretest was taken which included performing 10 trials. The participants were divided into four groups (three experimental groups and one control group). The acquisition phase consisted of six sessions (two days per week). At the beginning of each session, the participants of experimental groups watched 10 trials of the related model's videotapes individually (in the combining groups five trials of each model) without any explanation, and then they performed the skill. During each session, subjects of the experimental groups performed 30 services (3 blocks of 10 trials). Two minutes were the time of rest between blocks. The retention test was taken 72 hours after the acquisition phase including 10 trials after filling out the self-efficacy questionnaire, without watching the videotape.

2.6. Statistical analysis

Descriptive statistics were used to describe the raw scores of each group. To analyze the data, first, the Shapiro–Wilk test was used to determine the normal distribution of data. To determine significant differences between the groups and different sessions during the acquisition phase, the mixed linear models (repeated measure) and Bonferroni post hoc test were used, and to determine the group's differences in other test stages, one-way analysis of variance (ANOVA) test was employed. The calculations were done in SPSS (20.0 version) software, and the statistical significance was considered at the $P<0.05$ level.

3. Results

3.1. Self-efficacy

Descriptive data of self-efficacy can be observed in Table 1 for each group at the pretest and the retention test.

Results of one-way ANOVA revealed no differences between four groups (three experimental and one control group) at the pretest ($F_{(3,39)}=0.259$, $P=0.854$). It indicated that all four groups were at the same level before the acquisition phase and the significant differences have been caused in self-efficacy levels by the interventions (Table 2).

Table 1. Descriptive data of self-efficacy at the pretest and the retention test

Group Stage	Skilled	Combined skilled-learning Mean(SD)	Combined skilled-self observation Mean(SD)	Control Mean(SD)
Pretest	3.30(0.423)	3.70(0.396)	3.50(0.401)	3.20(0.512)
Retention	4.50(0.224)	6.70(0.423)	4.60(0.163)	3.40(0.267)

Table 2. Results of one-way ANOVA for self-efficacy scores at the pretest

Group	Mean(SD)	df	F	P
Skilled	3.30(0.423)			
Combined skilled-learning	3.70(0.396)	3		
Combined skilled-self observation	3.50(0.401)	39	0.259	0.854
Control	3.20(0.512)			

Self-efficacy questionnaire data were analyzed using one-way ANOVA at the retention test. It yielded significant differences between all groups ($F_{(3, 39)}$= 23,265, *P*=0.001; Table 3).

Pair-wise comparisons using the Bonferroni correction procedure showed a significant difference between combined skilled-learning and other groups. Also, there was a significant difference between combined skilled self-observation and control groups, but the skilled and other groups didn't differ in self-efficacy scores (Table 4).

Table 3. Results of one-way ANOVA for self-efficacy scores at the retention test

Group	Mean(SD)	df	F	p
Skilled	4.50(0.224)			
Combined skilled-learning	6.70(0.423)	3	23.265*	0.001
Combined skilled-self observation	4.60(0.163)	39		
Control	3.40(0.267)			

* Sign shows significant in 0.05 level

Table 4. Results of Bonferroni's post hoc test for self-efficacy scores at the retention test

Group	Group	MD	p
Skilled	Combined skilled-learning	-2.200	0.001
	Combined skilled-self observation	-0.100	1.000
	Control	1.100	0.060
Combined skilled-learning	Skilled	2.200	0.001
	Combined skilled-self observation	2.100	0.001
	Control	3.300	0.001
Combined skilled-self observation	Skilled	0.100	1.000
	Combined skilled-learning	-2.100	0.001
	Control	1.200	0.032

3.2. Forehand service of table tennis performance

Descriptive data can be observed in Table 5 for each group and every measurement stage.

For comparing performance among participants in the pretest, one-way ANOVA analysis was used. The findings reflected no significant differences between variances ($F_{(3,39)}$=2.553, *P*=0.071; Table 6).

A graphic illustration of task performance during the acquisition phase is shown in Figure 2.

Acquisition of forehand service of table tennis was examined using four (three learning and one control groups) × 6 (acquisition sessions) ANOVA with repeated measures on the second factor. It yielded significant effect of group ($F_{(3,39)}$=15.685, *P*=0.001) and session ($F_{(3,39)}$=55.387, *P*=0.001) as well as significant group × session interaction ($F_{(3,39)}$=3.403, *P*=0.001).

Table 5. Descriptive data of different groups in sessions and tests

Group / Stage	Skilled	Combined skilled-learning Mean(SD)	Combined skilled-self observation Mean(SD)	Control Mean(SD)
Pretest	10.70(0.684)	12.00(1.453)	8.80(1.052)	8.80(0.389)
Session1	33.30(2.773)	38.90(6.192)	27.10(0.849)	19.90(3.413)
Session2	41.40(0.718)	47.4.(7.070)	31.30(1.033)	21.10(2.527)
Session3	46.80(0.800)	57.10(6.582)	39.20(2.289)	23.40(2.911)
Session4	51.10(4.122)	61.30(8.047)	44.90(1.767)	24.90(2.685)
Session5	55.30(2.785)	67.60(8.483)	47.80(1.849)	26.90(3.491)
Session6	58.00(4.017)	77.80(6.726)	53.90(2.11)	28.10(3.244)
Retention	12.50(0.806)	18.80(1.482)	10.40(0.859)	6.90(0.348)

Table 6. Results of one-way ANOVA for forehand service of table tennis scores at the pretest

Group	Mean(SD)	df	F	p
Skilled	10.70(0.684)			
Combined skilled-learning	12.00(1.453)	3	2.553	0.071
Combined skilled-self observation	8.80(1.052)	39		
Control	8.80(0.389)			

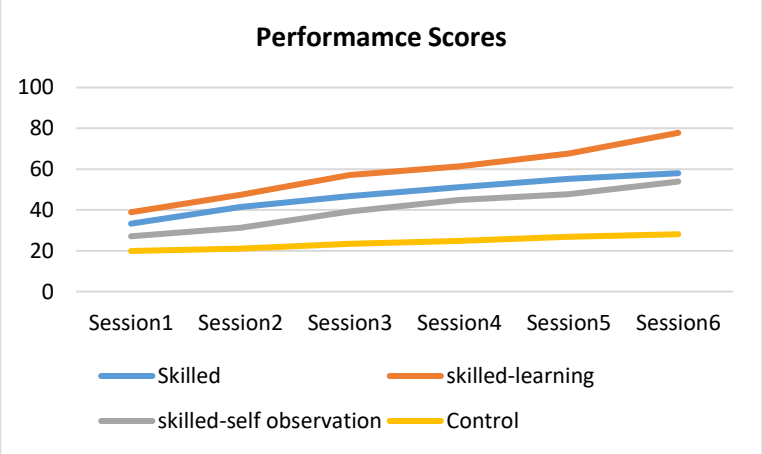

Figure 2. Mean of performance scores during the acquisition phase

The means indicated that all experimental groups improved their performance during the acquisition phase with the combined skilled-learning group better on average. Also, they showed that performance in the control group was significantly lower than experimental groups. Pair-wise comparisons using the Bonferroni correction procedure showed there were significant differences between all the experimental and control groups. Also, there was a significant difference

between combined skilled-learning and combined skilled-self-observation groups.

The performance during the retention test was also shown in Table 7. The retention test data was analyzed using one-way ANOVA. Results revealed a significant effect for all four groups ($F_{(3,39)}$=26.984, *P*=0.001).

Results of Bonferroni's post hoc test indicated that there is a significant difference between combined skilled-learning and other three groups. Also, there is a significant difference between skilled and control groups, but we couldn't find significant differences between combined skilled self-observation and skilled or control groups (Table 8).

Table 7. Results of one-way ANOVA for forehand service of table tennis scores at the retention test

Group	Mean (SD)	df	F	p
Skilled	12.50(0.806)			
Combined skilled-learning	18.80(1.482)	3	26.984	0.001
Combined skilled-self observation	10.40(0.859)	39		
Control	6.90(0.348)			

Table 8. Results of Bonferroni's post hoc test for forehand service of table tennis scores at the retention test

Group	Group	MD	p
Skilled	Combined skilled-learning	-6.300	0.001
	Combined skilled-self observation	2.100	0.789
	Control	5.600	0.001
Combined skilled-learning	Skilled	6.300	0.001
	Combined skilled-self observation	8.400	0.001
	Control	11.900	0.001
Combined skilled-self observation	Skilled	-2.100	0.789
	Combined skilled-learning	-8.400	0.001
	Control	3.500	0.086

4. Discussion

In the present study, we wanted to compare the effect of using a combination of ideal model-observation and self-observation on self-efficacy and learning the forehand service of table tennis.

The primary finding from the acquisition sessions indicated that observing the combination of skilled and learning models led to the highest self-efficacy for learning, compare with other experimental models.

Although none of the previous studies have compared the effect of the combination of models on self-efficacy, these results support those previously reported by Weiss, McCullagh, Smith, and Berlant (1998), who examined the effect of both peer mastery and learning models on children's swimming skills, fear, and self-efficacy [42]. Their results indicated that both modeling conditions seemed best for

skill learning gains but the learning model influenced self-efficacy more than the mastery model and control.

Schunk, Hanson, and Cox (1987) investigated the effects of peer model attributes on the children's self-efficacy and skill. The results showed that children who observed learning models judged themselves similar in competence to the models; so, it leads to higher self-efficacy for learning than observing the mastery model [9].

Model similarly is an important contributor to the effectiveness of observational learning. The learners who watch a model that they perceive as being similar to themselves may relate more to the model [11]. As a result, they may pay more attention to the modeled skill; which, in turn, may positively impact their self-efficacy and subsequent performance of that skill.

The learners would be expected to perceive learning model's gradual learning as more similar to their own performances than the rapid learning of mastery models [9].

In addition, significant learning of the task was shown in the acquisition phase in which the performance of all three experimental groups was clearly superior to the control group. Although there was no significant difference between the performances of two groups of combined skilled-learning and skilled in this phase. The results of the delayed retention test indicated that the performance scores of the combined skilled-learning group were significantly higher than the other three groups. Also, in this phase, the difference between the combined skilled self-observation and control or skilled groups was not significant.

This result was inconsistent with Baudry, Leroy and Chollet (2006), who showed that the combined self and expert group improved their performance more than the control group [28]. Barzouka, Bergeles and Hatziharistos (2007) compared the effect of the expert model and the combination model in supporting students' learning of volleyball skills [43]. The results showed that there was no significant difference between two models.

Similar results, however, were obtained by Rohbanfard and Proteau (2011). They found that observing a learning model was not as effective as observing an expert or mixed model of expert and learning models [37]. Also, Andrieux and Proteau (2013) have confirmed our result by reporting that mixed and (partially) expert observation resulted in better long-term retention than a learning model [38].

5. Conclusion

In this study, both skilled and combined skilled-learning groups yielded physical outcomes more than other groups, whereas the combined skilled-learning group was superior. The results suggest that mixed observation provides an accurate pattern of the movement (observing skilled model) that is enhanced against the performance of the less successful model (observing learning model), considering that a beginner is prone to make frequent and larger errors than a skilled one. It might be proposed that an observer has a better chance of detecting them and learning especially when they are compared with the correct pattern which had been performed by an expert model.

Moreover, the combined skilled-learning group was significantly better in the self-efficacy scores. Although demonstrating a skilled model is the most popular type of observational learning among the instructors and physical

education teachers. It is suggested that adding a learning model to that leads to better performance, transferring the related data and enhancing the self-efficacy.

Conflict of interest

The authors declared no conflicts of interest.

Authors' contributions

All authors contributed to the original idea, study design.

Ethical considerations

The authors have completely considered ethical issues, including informed consent, plagiarism, data fabrication, misconduct, and/or falsification, double publication and/or redundancy, submission, etc.

This study was approved by the Ethics Committee of Yazd University (Ethics Code: IR.YAZD.REC.1402.014). All participants have signed informed consent prior to enrolment in the study. This research was conducted ethically in accordance with the World Medical Association Declaration of Helsinki

Data availability

The dataset generated and analyzed during the current study is available from the corresponding author on reasonable request.

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