



# CAN MULTIMEDIA ENHANCE TACTICAL TEACHING-LEARNING-TRAINING IN SOCCER? THE CASE OF SPHERO™

original paper

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## ABSTRACT

**Purpose.** The study aimed to compare the players' and coach's individual perception of tactical competence before and after an intervention based on imagery techniques and a multimedia resource (Sphero™).

**Methods.** Sphero™, a teleguided miniature ball rolling in any direction, was applied to teach tactics before and during training sessions and games over a 5-week specific training program. The ball was used to represent a game ball, and cones were placed on a miniature soccer pitch to simulate the play and explain the coach's directives. The execution and the understanding of pre-game directives were respectively evaluated by the coach and the players themselves, before and after the training program. An empirical pre-post treatment was used to compare 245 rates provided by 14 players of an under-14 amateur soccer team in Canada. Descriptive analysis was performed and the *t*-test or Wilcoxon test (*z*) were used for paired comparison (pre- vs. post-training). The statistical significance of the results was set at  $p < 0.05$ .

**Results.** After 5 weeks of training with the use of Sphero™, results showed that the players appreciated their ability to play in accordance with directives, and that the coach was able to observe his directives through how they played, although the assessment scores of understanding remained the same.

**Conclusions.** A teaching setup involving Sphero™ allowed a good understanding but training was necessary to reach better assessment scores for the actual application of the directives.

**Key words:** association football, team sports, cognitive approach, ecological approach, interactive instrument

## Introduction

The teaching-learning-training process includes many elements that enhance the knowledge of the participating players, such as imagery. Imagery is commonly used as a training technique to help high performance athletes train skills in sports like motor and mental skills [1]. An imagery process consists in imagining a performance rather than truly performing. Nevertheless, performance in collective sports is largely influenced by the tactical component. Tactics refers to 'what to do' and requires players to develop capabilities to make sound decisions in the play [2]. Hence, good decisions are dependent on a good tactical knowledge [3]. In that sense, training strategies such as imagery supported by visual content can be utilized

to enhance the development of tactical knowledge and, optimally, to make young soccer players adopt collective intelligence [4, 5].

Amongst imagery techniques, video modelling is studied and used owing to the ability of video to represent what could be corrected or repeated, or even to identify relations between events and results. Advances in sport analysis show how useful it is to athletes' performance to provide feedback of actions and to engage conversation between coaches and players with an interactive video support [6]. Furthermore, researches have shown a positive impact of discussing tactics with visual content such as magnet or drawing boards, as well as the importance of the point of view of representation of the play [7]. Moreover, interactive learning enabled by interactive instruments

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responds to theories suggesting that the generation born in the 2000s have a different style of attention and that young players would benefit from interactivity, defined as the experience of a reciprocal activity with a system [8, 9]. The usage of multimedia in competition and training is therefore gaining interest as it overcomes the monotony of traditional technical exercises.

Extensively, multimedia offer possibilities that can enhance the effect of explanations and learning by using imagery thanks to the display features. In particular, 3D displays provide a greater efficiency in learning [9] and interactive objects are suggested to provide more engagement than screens [10]. When players form team circles during pauses, instruments that they could manipulate would therefore allow the whole team to intervene in a discussion, a possibility that is limited when using a magnetic board or an electronic tablet because of their size and the reduced number of players who can reach the devices. The limited size of videos or 2D visual content also makes the representation of the game elements hard to see when many players are gathered to receive the coach's directives. Therefore, we hypothesize that to walk around, to touch, and to move physical instruments would optimize the understanding of tactics by analysing the relations between the elements of the game. As experimented in other studies, this analysis process would then contribute to a better individual performance in the game, and, by adding up, a better collective performance [11, 12]. In that sense, to involve players in the play analysis with the help of interactive instruments may favour to maintain their attention when transmitting them directives or discussing tactics.

Therefore, this exploratory study aimed to compare the players' and coach's individual perception of tactical competence before and after 5 weeks of specific training that involved imagery techniques featuring the usage of an interactive instrument (Sphero™) to enhance the clarity of key tactical directives.

## Material and methods

### Experimental design

A quasi-experimental pre-post treatment was applied to analyse the impact of a technology on the progression of 14 athletes after 5 weeks of specific training [13]. The team was given 4 identical directives before the first evaluated game, during exercises, and before the second evaluated game. The technology was used to simulate tactical actions that players must implement in order to accomplish the given directives. The players' understanding and execution were assessed.

### Participants

The study was performed with the FC Boisbriand under-14 amateur soccer team, near Montreal, in Canada (each player had at least 2 years of competitive soccer experience). All participants were aged 13–14 years and were affiliated to the competitive club team competing in the regional championship labelled 'AA'. The team played in a competitive league and comprised 21 players. Owing to summer vacations, only 14 players participated in the investigation activities.

### Instruments

A teleguided ball called Sphero™, built in Boulder, Colorado, United States, was selected from among 4 technological devices. The final selection was made in accordance with: (i) context-specific criteria such as usability and portability, (ii) Shneiderman's universal usability [14], and (iii) a selection of Nielsen's heuristics [15]. Sphero™ fulfilled most of the selected criteria and was similar to a soccer ball as a potential representative instrument. Sphero™ is a spherical robotic product commercialized as a toy and is wirelessly controllable through a Bluetooth® protocol. The 'ball' has a rotatory motor that makes its sphere-shape cap roll and go in any direction. In order to make it roll, customers must download the free application provided by the manufacturer, supported by devices such as touch screen phones or tablets. The device is therefore auto-empowered as long as its inner battery allows the activation of the motor. The battery is rechargeable by the provided dock. A household synthetic-grass carpet was spray-painted to represent a soccer field. The length of the lines was calculated to scale with the measures provided by FIFA. The carpet let Sphero™



Figure 1. Teaching set-up with Sphero™ and a carpet

to roll more easily when performing the analysis activities. The drawings also allowed to simulate tactics in a representative space (Figure 1).

### Procedures

The coach defined the following game model: (i) organize the offensive plays on the flanks of the pitch during the defensive-offensive transition; (ii) tighten the lines to eliminate gaps: balance together; (iii) rapidly put pressure on the new player with the ball when losing the possession of the ball: do not allow the long pass; (iv) keep rhythm in the ball possession: pass and move. The model proposed 4 game principles which oriented the pre-match speeches as well as the content of the 5-week specific training program, which involved the imagery activities by using Sphero™ [16].

Sphero™ was applied 5 times per week through the 5-week training program, before training and games. The teaching simulation set included: (i) Sphero™ controlled through an iPad to represent the ball, (ii) the carpet representing a soccer pitch, and (iii) 2 sets of cones of 2 different colours to represent players. The set was used to represent each element of the game, and their manipulation helped to simulate their interaction in key moments. This instrument was mostly driven by the coach as the players were asked to move the cones. The interaction required some players to execute the tactical directives, moving the cones depending on the position of the ball, the available space, and the position of the opponents.

A typical training session was built of game-based approach exercises, where players would be required to apply the game principles explored in the imagery activities, preceding and following on-field exercises. In fact, all exercises were designed so that the rules obliged players to perform the movement enlightened during the imagery activities. All training sessions had a duration of 75 minutes and included at least 45 minutes of situations of play. The rest of the time was dedicated to the training of physiological and technical abilities.

The researcher (a person to collect data) solicited the players to fill in a customized questionnaire during the warm-up and after the game. The questionnaire was previously validated by 2 soccer researchers and coaches with 10 years of experience and with a PhD degree (i.e., construct validity) and were utilized to collect Likert scale scores (from 0 to 7) that rated the players' understanding and their execution of the given tactical directives during 2 official games. Without specific order, the researcher called the players one

by one to answer the questions on the screen, away from where the group kept warming up or stretching, so that no participant could be influenced by the answers of their teammates. The coach and the player took up to 2 minutes to answer all the questions.

The first assessed game was followed by the training program and the second game was assessed subsequently. The players were first asked to scale how well they understood the 4 directives early after the coach's pre-game speech. This measure was meant to show how representative the directives were to the players in the contest of their respective knowledge and experience. Immediately after the games, the players would also scale how well they implemented the directives. This second scale would show how well the players thought they had executed what had been asked to do. Both ratings were limited to 2 questions based on an individual and a collective point of view. The individual point of view referred to the actions and directives that concerned the players themselves, and the collective point of view concerned the actions of the whole team. The results for each data collection were compiled in an automatically generated .csv file and transferred to a computer.

Sequentially, the coach was asked to assess the execution of each directive for each player and to provide an overall qualitative subjective evaluation of the performance on the following standpoints: (i) respect of the tactical system, (ii) respect of the game model, and (iii) comparison with the previous assessed match. The results of the games were also noted as absolute performance indicators in order to compare with the relative evaluation. Scales and comments were then saved on a computer.

### Data analysis

A total of 245 scores based on Likert scale (from 0 to 7) were compiled to rate the players' understanding and their execution of the tactical directives during official games. The scores were compiled into 2 main spreadsheets and were compared to analyse the perception and the improvement between the pre-training and post-training games. Descriptive analysis covering absolute and relative frequencies as well as medians and interquartile intervals (IQIs) was performed. The Kolmogorov-Smirnov test was used to verify data distribution. The Wilcoxon test for related samples served to compare medians from both test situations (pre- vs. post-training). The statistical significance of the results was accepted at  $p < 0.05$ . The Statistical Package for the Social Sciences® (SPSS) 20.0 was used for statistical analysis.

**Ethical approval**

The research related to human use has complied with all the relevant national regulations and institutional policies, has followed the tenets of the Declaration of Helsinki, and has been approved by the Committee of Ethics in Research for Student Projects Involving Human Beings (CERPÉ 1) of the School of Management Sciences of the Université du Québec à Montréal. It follows the norms established by the Normative Framework for Research Ethics with Human Beings (resolutions 2012-CE-12051 and 2012-A-15722) and by the Tri-Council Policy Statement of the Ethical Conduct for Research Involving Humans (2010).

**Informed consent**

Informed consent has been obtained from the legal guardians of all individuals included in this study.

**Results**

Table 1 presents medians (IQIs) of the self-evaluation scores provided by the players evaluating their understanding and execution of the directives. The results show a difference between pre- and post-training evaluations of the execution in the individual perspective. It was observed that the players had a better opinion of the execution of the directives after the 5 weeks of training, whereas no significant improvement was detected for the understanding scores.

Medians (IQIs) scores presented in Table 2 were provided by the coach and show the evaluation of players' execution of the directives. The results illustrate a significant difference in the execution of 3 out of 4 directives according to the coach's evaluation ( $p < 0.05$ ). The difference reveals a progression in how the players implemented the directives after the specific training. The content of each directive and their repercussion on tactical decision-making will be discussed in the next section.

Table 3 provides qualitative evaluation of performance for the following elements: respect of the tactical system, respect of the game model, appreciation relative to the previous match. The score was also noted as an absolute performance qualifier in order to compare with relative evaluation. The data show a qualitative difference with respect to the tactical performance in terms of the game model, the relative appreciation of the team performance as well as the final game results (9–0 loss vs. 8–3 win). Note that owing to time constraints, the 2 evaluated games were played against different opponents.

**Discussion**

The presented study aimed to compare the players' and coach's individual perception of tactical competence before and after the intervention based

Table 1. Medians (interquartile intervals) of the scores provided by the players for the self-evaluation of their understanding and execution of the directives

Measure	Understanding of directives, individual point of view	Understanding of directives, collective point of view	Execution of directives, individual point of view	Execution of directives, collective point of view
Pre-training	6.00 (1.00)	6.00 (1.00)	5.00 (1.00)	5.00 (2.00)
Post-training	6.00 (1.00)	5.00 (1.00)	6.00 (2.00)	6.00 (0.00)
z-value	-0.812	-1.127	-2.254	-2.491
p-value	0.42	0.26	0.02*	0.01*

\* statistically significant differences ( $p < 0.05$ )

Table 2. Medians (interquartile intervals) of the scores provided by the coach for the evaluation of players' execution of the directives

Directive	Execution in the pre-test evaluation	Execution in the post-test evaluation	z-value	p-value
1: reorganize through flanks	4.00 (1.00)	5.00 (1.00)	-2.701	0.007*
2: eliminate gaps	5.00 (0.00)	5.00 (1.00)	-1.134	0.25
3: quickly put pressure when losing the ball	3.00 (0.00)	6.00 (1.00)	-3.126	0.002*
4: rhythm: pass and move	4.00 (1.00)	5.00 (2.00)	-2.124	0.03*

\* statistically significant differences ( $p < 0.05$ )

Table 3. Coach's qualitative evaluation and score

Evaluated variable	Pre-training	Post-training
Respect of the tactical system	The tactical system seems well understood since the beginning of the season	The tactical system seems well understood since the beginning of the season
Respect of the game model	Scarce cohesion in the team structure and several balls easily lost	Directives were applied for almost the whole game length; more confidence was shown in the ball conservation
Relative appreciation of the team performance	Almost no ball possession, players intimidated by the opponents, few players only would read the play and majority would react too late	Best application of coach's directives, game rhythm constant, creativity in ball possession, and discipline in defensive phases
Game result: absolute performance evaluation	9-0 loss	8-3 win

on the use of imagery techniques and a multimedia resource (Sphero<sup>TM</sup>). The imagery activities consisted in soliciting the players to grab and move instruments representing the game elements, that is the ball and the players, while discussing the game model. This interactive way to depict the game model led the team to show concluding performance results as well as differences in their perception of their own execution of the coach's directives. The participants experimented with different tactical movements and discussed what these implied in situations chosen by the coach during the training sessions. Three principal reasons are discussed to explain the improvement: the training methods, the capability to transfer the knowledge from verbal directives to the play, and the cognitive capabilities of players in the given age category.

#### Training methods

The imagery activities were a guided form of discovery learning, which in this case intended to make players experiment with, discover, and discuss the possible tactical solutions corresponding to the game model. In that context, the players' decision-making was implemented democratically, and the discussion about the solutions was animated through oriented range of problems based on the evaluated directives [17]. At first, explicit learning activities challenged the players to verbalize their thinking since the games proposed during the training sessions call implicit learning in most of the tactical situations. Thereafter, the adoption of a democratic method implied communication between the players and the coach, and the imagery activities helped verbalize new alternatives. Such an interaction was intended to make the players

take over their reasoning and pushed the rationalization of their own decisions [18].

The think-aloud processes were perceived during the discussions and judged as relevant to the development of perceptual skills and tactical knowledge, by learning the 'anchor points' corresponding to the principles being analysed and adopting an if-then reasoning [19]. The exchanges made explicit the anchor points aimed at by the coach in an explicit way. Williams and Davids [20] have questioned which knowledge could be identified as efficiently learnable: tacit or that which you may explicitly declare. According to Raab and Johnson [21], the explicit learning method developed more deliberate processing of important cues to take into consideration while executing the prescribed principles. The authors also show that the repetition of plays in an explicit manner contributes to an increase in one's explicit production, just as the effect of training. This corroborates the fact that all ideas of the games described in the directives seemed clear to the participants, but only repetition of the actions in the play through the whole duration of the specific programme would allow the players to actually assimilate the principles and perform. Thus, their impression was that they would understand everything from the beginning to the end, but would appreciate more success through time.

#### Transfer of knowledge

As the imagery activities aimed to pinpoint key moments of the game, it is suggested that the usage of representation of situations and explicit learning in training have favoured the development of new concrete tactical knowledge. Playing accordingly to this

new knowledge makes the players transfer what was learned from a third-person to a first-person perspective, and to *proceduralize* it during practice [22]. Repeated simulation after games fed new discussions and led the players to *redeclare* what had been experimented on the field, which also contributed to constructing the knowledge by recoding the visual display into *chunks*, to making links explicit, and to developing work memory [23, 24]. Assembling mental training through external imagery and practice through conditioned games helped to keep the tactical solutions in mind, as fresh and clear tasks. This whole process is in concert with the mutual relation between 'doing' and 'knowing,' thus in this case, the transfer would have enhanced procedural learning [25]. However, the whole study was built on the same key points, ensuring a direct link between the principles covered during the imagery activities and training sessions and their applicability in the game directives. This corroborates the results showing that all players would highly rate their understanding of the content as it was often repeated in a short period of time.

In contrast, findings related to declarative tactical knowledge show that representations of the game are not entirely relevant because of the lack of fidelity between the virtual and the real during decision-making [26]. Therefore, fidelity and perception issues illustrate that game and imagery are different learning contexts: any decision made under a condition could only be partially transferred to another one. This would explain that players would not appreciate the success in the execution of the directives in the competitive games at the beginning of the training programme.

#### Cognitive capabilities

The evaluation provided by the coach shows that directives involving a greater amount of stimulus are more difficult to execute by players of this age category, owing to their cognitive capabilities and the abstract nature of the directives. For instance, the directive requiring the whole team to close the gaps between lines is harder to simulate, perceive, and consequently to implement in comparison with the directive requiring putting pressure on the opponent in possession of the ball. The main difference between these two directives resides in the number of involved players when simulating a corresponding situation. This explains the greater capability to understand and execute tactical principles in simpler situations than when dealing with a greater number of stimuli. Moreover, the progression in the collective organization despite the complexity

and variability of the experimented situations during competitions confirms that the players were able to learn up to a certain limit. Raab and Johnson [21] have shown that explicit learning brought players to perform well in highly complex situations, which would be limited to the defensive organization close to the ball after its possession. This would again corroborate the high rates related to the comprehension of the directives and low rates of appreciating their success, as it is one thing to know what to do in theory and another to know what to do at full speed in the heart of action.

It can also be inferred that the analysis of the real game in such a visual and interactive way allowed the players to consolidate their knowledge of core principles of the game of soccer [27]. A better execution of fundamental principles by each participant improved their individual performance and reinforced knowledge needed to adopt specific principles. A robust assimilation of the principles is shown to efficiently direct individual decision-making and to allow players to perform in accordance with a game model, resulting in a better collective performance [16]. This is in line with the results reporting the coach's better appreciation of the execution of the content he had been working on with his team, as the success in the second game reflected the implementation of the principles and his directives.

#### Other considerations

The evaluation performed during the games played before and after the specific tactical training program revealed how new knowledge had been transferred into competitive play. The players were first asked to rate how they understood the individual and collective directives. Given the course of the official games organization, the time pressure during data collection a few minutes before the kick-off could be a factor of bad estimation when surveying their own understanding. In that case, players would have been tempted to overrate their understanding of the simple formulation, which is simpler than what it implies. On the other hand, a player could know 'what to do' but would not be able to execute it, and vice-versa. In the present case, it is suggested that the players would have understood the directives but could not adequately react to the environment and apply the directives in the different affordances of the game. Oppositely, the rates of the second game show that the players believed they both understood and executed the given directives. Their perceptions demonstrate they were conscious of and unanimous on a better performance and ap-

preciated improvements although the rates of their understanding do not reflect significant differences. Since the assessment provided by the coach also reports an improvement in the second game, it is verified that the players improved their global individual performance.

The main limitations of the study comprise the lack of statistical measurement of the sample and the precision of the assessment. In fact, the experiment was conducted with a single competitive team, which left the sample with a limited number of participants and a limited control of variables. However, it was suggested by the coach that the tactical content he was working on was relatively new to all the members, putting all players at a similar starting point in terms of learning. Therefore, it is likely that detailed information about age and weight did not have an important impact. Moreover, the game principles that were assessed could be observed as a whole with a general degree of appreciation. Nevertheless, a detailed, objective assessment of the execution of the core principles corresponding to each directive could have been a huge asset and should definitely be included in the protocols of further similar studies.

Such advancements imply that a team can employ different tools to enhance the process of learning the tactics. However, the pedagogic methods must be defined to: (i) keep interest as well as challenge in the team, (ii) ensure the balance between theory and practice, and (iii) adapt the content to the cognitive capabilities of the players. Such development consists in sustaining an athlete-centred model for the teaching-learning-training process, which features adapted tools to support an information flow and communication between coaches and athletes in both ways, including quality instructions as the key element to structure and learning in situations of play [7, 28]. Accordingly, the contribution of visual tools to support the communication and teaching tasks in coaching finds its relevancy when such knowledge is complex and can increase working time or difficulties. Nevertheless, the tactical knowledge to be analysed in future studies in these areas should refer to validated tactical principles such as the general, operational, and core principles of the game [27]. For instance, a similar investigation could be conducted to establish more detailed links between the declarative knowledge of these principles and the ability of the same players to apply them [29]. This way, in conjunction with a well-defined curriculum, teaching, and assessing through such principles with instruments like Sphero™, could produce better players.

## Conclusions

The aim of the study was to compare the players' and coach's individual perception of tactical competence before and after an intervention based on imagery techniques and a multimedia resource (Sphero™). The assessment of understanding and execution shows that the new tactical knowledge was proceduralized through the training programme, comprising tailored situations of a play and their analysis. The results reflect a significant improvement in the execution of the directives given by the coach and in the perception of the execution by the players themselves.

Throughout the learning process, imagery activity with Sphero™ engaged the players in explicit learning activities and enhanced the acquisition of relevant information that guided the perceptual-cognitive skills and the processes involved in decision-making, which had an impact on the assimilation [30]. In brief, imagery activities with the interactive instrument made complex things to learn clearer and facilitated their representation throughout a rich program made of exercises and analysis. However, actual training was still necessary to assimilate the movements and become performing in the competition. In conclusion, Sphero™, like other solutions, is an interesting addition to the teaching-learning-training process in youth soccer owing to the nature of tactical knowledge but cannot replace training or eliminate the time for assimilation.

## Disclosure statement

No author has any financial interest or received any financial benefit from this research.

## Conflict of interest

The authors state no conflict of interest.

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