

## Effects of using an assessment instrument on procedural knowledge in team sports

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### Abstract

The aim of this study was to analyse the effects of applying an observation tool used by elementary pupils to assess their procedural knowledge (PK) in volleyball. This investigation has a quantitative methodology which involved a quasi-experimental design with a control group. Elementary pupils (N=16) from sixth grade (age  $11.23 \pm 0.88$ ) at a state school in Seville (Spain) participated in this study. The pupils were distributed into a control group (n = 8) and an experimental group (n = 8). The dependent variable was the PK, which was measured using a validated questionnaire. Between the pre-test and post-test of PK, the pupils belonging to the experimental group observed the game through the Games Performance Assessment Instrument (GPAI) tool. The results proved that that the experimental group showed statistically significant differences with the control group in the total score of the questionnaire on PK ( $p = 0.001$ ). In the interviews, the pupils attributed their improvements to the learning generated by the observation instrument used. This work demonstrates that tactical training in elementary pupils helps to improve procedural knowledge.

**Keywords:** decision making, GPAI, net games, evaluation

### Introduction

It seems that there is a relationship between tactical knowledge and decision-making in sport. Different studies suggest that cognitive processes train tactical knowledge could contribute to decision-making in real situations in sports. (Figueiredo, Lago, & Fernández, 2008; French & Thomas, 2009; García-González, Araújo, Carvalho, & del Villar, 2011; McPherson & Kernodle, 2007; A. Moreno, Moreno, García-González, & Del Villar, 2010; Serra-Olivares & García-López, 2011).

In this sense, the training of cognitive processes of tactical knowledge (e.g. anticipation) is a good method to improve decision making in real situations. If an athlete anticipates and observed the movements of his adversary will be able to adjust their decision-making during the competition (García-González et al., 2011; Mann, Williams, Ward, & Janelle, 2007). However, the key to training of perceptual-cognitive skills is how to transfer them during the decision making in real game situations (Broadbent, Causer, Williams, & Ford, 2014). Different studies indicate that age alone does not influence the level of tactical knowledge, sport expertise is more important (Mann et al., 2007; Marasso, Laborde, Bardaglio, & Raab, 2014; McPherson & Kernodle, 2007)

Researches have inquired about training methods and evaluation of tactical knowledge and decision-making in sport. At the tactical knowledge there are tools like analysis verbal protocols, questionnaires and training programme based on video-feedback. Observational analysis are tools for decision-making (García-González et al., 2011; McPherson & Kernodle, 2007; Oslin, Mitchell, & Griffin, 1998).

From the relationship between tactical knowledge and decision-making, As a consequence of these indications, Anderson (1982) established two types of knowledge: declarative and procedural. In the first case, the "know what" is used to describe declarative knowledge, while the "know how" is used to describe procedural knowledge. The first is understood as a set of theoretical knowledge of a sport, whereas procedural knowledge is conceived as the knowledge based on the tactical solution in the environments played (Otero, González, & Calvo, 2012a). According to French and Thomas (2009), the development of a declarative knowledge base in a specific sport is essential for the development of good decision-making skills.

Declarative knowledge comprises all the theoretical knowledge of a sport, from the technical-tactical fundamentals to the regulatory aspects. Therefore, when a player shows a reduced declarative knowledge he or she yields low quality decisions in real game situations (French & Thomas, 2009) "If the volleyball player knows, for example, what the dimensions of the field are or the position of the players, we could say that this player has certain level of declarative knowledge (Moreno et al., 2010). On the other hand, besides knowing the theoretical knowledge of the sport, the capability of knowing how to solve a tactical problem posed in theory is

defined as procedural knowledge. In the same way García-González (2009) determined in a study that declarative knowledge and procedural knowledge, as measured by questionnaires, have a positive influence on decision-making and implementation variables, thus confirming the importance of the use of questionnaires as measuring instruments. Del Villar et al. (2013) developed and validated a questionnaire to assess the influence of procedural knowledge on decision making in volleyball, which was used in this investigation.

Numerous studies state that the knowledge acquired determines the quality of decisions and actions made by the player, causing an increased performance in competition. Therefore, the improvement of declarative and procedural knowledge in sport is of great importance for the achievement of sporting prowess (Iglesias, Moreno, Santos-Rosa, Cervelló, & Del Villar, 2005).

The use of the Game Performance Assessment Instrument (GPAI) of Oslin et al. (1998) is one of the procedures for analysing decision making (Otero et al., 2012a; Otero-Saborido, Lluch, & González-Jurado, 2015; Otero-Saborido & Silva, 2015). This tool qualitatively discriminates the game and allows analysing the quality of the actions of the game. Its application can be used in all team sports, although some categories have to be adapted to the specific characteristics of each form. The use of GPAI helps athletes and / or students to focus on tactical problems specific to procedural knowledge that have been targeted for this study. GPAI is one of the two most used performance instruments in the field of co-evaluation of team (Memmert & Harvey, 2008). According to the review of Arias and Castejón (2012) GPAI is used in 43.7% of studies about net sports.

Within volleyball, several technical-tactical actions have gained special attention, among which attacking, serving and blocking are considered the most important of all (Coleman, 2002; Palao, Santos, & Ureña, 2004). Drikos, et al., (2009) point out that, during a game, ending actions are the ones that exert greatest influence on the performance of a team. Of all the ending actions, attacking is the game action from which more points are awarded in competition, showing a strong connection with victory and becoming the biggest indicator of success in volleyball, followed by serving and blocking (Drikos et al., 2009; Rui Marcelino, Mesquita, & Sampaio, 2011; Palao et al., 2004; Quiroga et al., 2010; E. A. Ureña, León, & González, 2013).

Moreover, in recent decades, serving has become the first offensive weapon for players and teams of different levels (A. Ureña, Vavassori, León, & González, 2011). In addition, it is the first action of the game in which there is an opportunity to score a point (García-Tormo, Jiménez, & Rábago, 2015; R. Marcelino, Mesquita, Castro, & Sampaio, 2008; Quiroga et al., 2010; Rodríguez-Ruiz et al., 2011). On the other hand, blocking is the first action performed by the defending team to try neutralizing the incoming attack (Hileno & Buscà, 2012; Laporta L Nikolaidis P, Thomas L, 2015). This technical action has increased its importance during the development of the game, especially in women's volleyball (Mosher, 1993).

Now that the influence of procedural knowledge on making-decisions has been clarified, the present work aims to test the effects of using an observation instrument (GPAI) in live situations on the procedural knowledge of some of the most determining actions in volleyball such as attacking, serving and blocking.

## Material and Methods

The present research has quantitative methodologies. The quantitative part is a quasi-experimental design, since there is no randomization in the selection of participants, with a transversal approach and a nonequivalent control group design with pre post measurements.

## Participants

Elementary pupils (N=16) from sixth grade (age  $11.23 \pm 0.88$ ) at a state school in Seville (Spain) participated in this study. The pupils were distributed into a control group (n = 8) and an experimental group (n = 8).

## Instruments

Two instruments were used in this research. The procedural knowledge questionnaire validated by (Moreno et al., 2013) was used to measure the dependent variable. This instrument was validated with 486 volleyball players and had high validity values from the perspective of internal consistency. 15 items were selected for the present research. The questions referred to decision-making during serving, blocking (four questions each) and attacking (eight questions). These technical actions were the ones observed by the pupils from the experimental groups.

The other instrument, used for the independent variable in the experimental group, was an observation tool based on the Games Performance Assessment Instrument (GPAI) developed by Oslin, et al. (1998). In the present investigation, the GPAI was used during decision-making at serving, attacking and blocking. Moreno's design (2011) adapted by Oslin, et al. (1998) was used for the attacking action. For the blocking action, the criteria applied was the one designed by Moreno, et al. (2011), and the criteria selected by the FIVB tool were applied to the serving action (Table 1)

*Table 1. GPAI used: Moreno et al. (2011a; 2011b) adapted from Oslin et al. (1998)*

DIMENSIÓN: making decisión	Criteria
GPAI for attacking	1. Attack directed to an open area of the opposite half.
	2. Attack directed toward an area which is uncovered or poorly covered by the blocking players.
	3. Attack on the block with the aim of achieving block-out.
GPAI for blocking	1. The blocked ball returns to the field of the attacking team, scoring a point.
	2. The blocked ball returns to the defending team, allowing all attacking options.
	3. The blocked ball returns to the attacking team, preventing all attacking options. The attacking team then sends the ball from low hand or fingers to the team that performed the block.
GPAI for serving	1. The player sends the ball to areas of interference between players, near field lines, or areas involving displacement and contact at movement by the players.
	2. The player sends the ball to the attacking players making it difficult for them to attack.
	3. The player sends the ball to the setter or to areas where the performance of the different placement options are difficult.

With regard to the influence of extraneous variables it should be noted that both teams were in the same competition. The physical education teacher was informed of the investigation procedure. Game situations used by both teams during training sessions were identical.

### Procedure

The investigation lasted six sessions in both groups (including pre-test and post-test). The pre-test and post-test was applied using the procedural knowledge questionnaire validated by Moreno, et al. (2013). The control and experimental groups performed four weekly training sessions. The length of each session was about 45 minutes. Whole-games situations similar were used in each session of both groups. The physical education teacher and pupils of the experimental group were informed of the objectives of the investigation and they were given an informed consent.

The implementation of the GPAI observation instruments (Oslin et al., 1998) in the experimental groups had four sessions. The first one was used to explain the tool and to answer questions about observation. During the following sessions, the groups were observed through GPAI tool.

The pupils of the experimental group used the observation instrument to evaluate their teammates in 3 different sessions of 45 minutes each. Once this training process was over, both the control and experimental groups undertook the post-test that involved a procedural knowledge questionnaire. Finally, those pupils who used the GPAI were interviewed in order to know their thoughts and opinions about the procedure and what they might have learned from it.

The interviews were semi-structured and the questions were designed and formulated by the study investigators. Before the questionnaires were carried out, the pupils were informed of the aim of the study. Each interview lasted about half an hour. The interviews were recorded and later transcribed for analysis.

Considering the previously quoted scientific literature, which states that good procedural knowledge in sport improves tactical decisions in practise, we formulate the following hypothesis:

- A mutual evaluation of tactical decisions by pupils improves procedural knowledge.

### Statistical analysis

SPSS V.18 software was used to analyse the collected data. The Shapiro-Wilk test was performed to establish the normality of each variable and the Levene's test for homogeneity of variance in intergroup comparison. To compare the differences between pretest and posttest, a paired sample T-test was conducted. For intergroup comparisons, an independent sample T-test was conducted. Two strategies were used to assess the effects of using GPAI on procedural knowledge. Firstly, the "change" value was obtained as the difference between the scores from the post-test and pre-test. Secondly, analyses of covariance (ANCOVA) with the same independent variable were performed, although using the post-test scores as the dependent variable and the pre-test scores as a covariate. The effect size (ES) was calculated for comparisons made, according to the procedure proposed by Cohen (1988), considering the following criteria: >0.2 (small), >0.5 (medium), and >0.8 (large). The significance level was set to a value of  $p \leq 0.05$ , and the confidence limits of 95% were calculated for all measures.

**Results**

To check whether the procedural knowledge of the pupils had improved along the study, the scores of the pre-test and post-test were compared using a T-test for related samples. The experimental group showed a statistically significant improvement in the total score of the questionnaire on procedural knowledge in two of the three dimensions of questions. The T-test for related samples in the control group showed that there were no improvements in the total score or in any of its dimensions. The pre-test of both groups shows no statistically significant differences in neither the total score (Table 2).

**Table 2**  
*Comparison intragroups and differences between groups in pretest*

Variables	Control Group		Experimental Group			Comparison Groups					
	Pre	Post	Pre-post	Pre	Post	Pre-post	Pre				
	M	SD	M	SD	P-value	M	SD	M	SD	P-value	P-value
Total	10.65	1.76	10.25	2.18	p=0.351	9.25	2.91	12.00	1.92	p=0.004*	p=0.334
PK											
PK	2.37	0.91	3.00	0.92	p=0.140	1.50	1.06	2.75	1.03	p=0.019*	p=0.101
SV											
PK	5.75	0.70	4.42	1.76	p=0.051	5.00	1.41	6.25	0.70	p=0.028*	p=0.201
AT											
PK	2.50	0.92	2.62	0.91	p=0.598	2.75	1.03	3.00	0.75	P=0.351	p =0.6191
BL											

PK: Procedural Knowledge; SV: Serving; AT: Attacking; BL:Blocking; M: Mean; SD: Standard Deviation  
\*p < 0.05; \*\* p < 0.001 (Student's T test).

However, the main objective of this study was to determine whether there were differences in the development of procedural knowledge between the experimental group and the control group that might be attributable to the intervention. For this, the "difference" variables were compared between the scores from the post-test and pre-test (Table 3) of both groups using t-tests for independent samples.

**Table 3**  
*Comparison of the variable 'Pre-post difference' between control and experimental group*

Variables	Control Group		Experimental Group		Comparison Groups P-value	Covariance P-value	Effect Size (d)	Magnitude
	M	SD	M	SD				
Total	0.37	1.06	2.75	1.83	p =0.001**	p =0.002*	2.08	Large
PK								
PK	0.62	1.06	1.25	1.16	p =0.281	p =0.131	0.56	Medium
SV								
PK	1.12	1.35	1.25	1.28	p =0.003*	p =0.010*	1.80	Large
AT								
PK	0.12	0.64	0.25	0.79	p =0.717	p =0.478	0.10	Small
BL								

PK: Procedural Knowledge; SV: Serving; AT: Attacking; BL:Blocking; M: Mean; SD: Standard Deviation  
\*p < 0.05; \*\* p < 0.001 (Student's T test).

The results of the variable 'difference' between pre-test and post-test showed a more positive improvement for the group in which the GPAI tool was applied during the training compared to the control group. Specifically, there was a significant difference in the total score of the questionnaire on procedural knowledge and in the 'attacking' dimension.

In order to provide additional analytical evidence, a second strategy based on the use of analysis of covariance (ANCOVA) was applied, with the post-test scores as the dependent variable, the pre-test scores as covariates and the intervention as an independent variable. The aim was to compare whether there were significant differences between groups considering the previous level of the subjects. The results are completely consistent with the analysis of the 'pre-post Difference' scores, since significant differences are obtained in the total score and in attacking dimension. Finally, the effect size estimates show large efficiency for the intervention group in total score, and attacking dimension.

## Discussion

The hypothesis formulated in this study suggests that mutual evaluation of tactical decisions performed by the players themselves improves their procedural knowledge. The results of the present study confirm this hypothesis, since the players in the experimental group showed greater differences in the post-test than the players from the control group. The not obtaining of statistically significant results in two of the variables (serve and block) is attributed to the low number of questions of both dimensions (4 questions each). Descriptively, both dimensions get greater difference.

Moreover, the views of the interviewed players suggest two ideas. First, their empathy with the GPAI; that is, the players, who are sometimes reluctant to interfere with external investigations they do not know, have shown such great willingness and interest in the study that some of them even requested help from the researchers for the design of other observation tools to incorporate them into their daily training routine. And second, their improvement after the procedural questionnaire was unanimously attributed in the interviews to the use of the observation instrument.

With respect to the process of research and intervention in the experimental group, the researchers suggested that a greater number of sessions would yield better results. In similar study Figueiredo, et al. (2008) obtained values slightly greater than the ones from the present investigation, although this may be related to the number of sessions, which were 25 and 15, respectively, compared to the 4 sessions of this work. However, greater numbers of sessions also corresponded to a large load of contents, which was included in both studies (technical execution, decision making, declarative knowledge...). Therefore, including more sessions in the present investigation would have required the inclusion of other actions besides the three used (serving, attacking and blocking.)

The importance of procedural knowledge, understood as tactical decisions in the game set out to the player in a theoretical environment, is being widely used in other team sports such as football and basketball (Del Villar, Iglesias, Moreno, Fuentes, & Cervelló, 2004; Iglesias et al., 2005; Otero, González, & Calvo, 2012b). However, it is in volleyball where more research is proliferating (Figueiredo et al., 2008; Gil et al., 2012; Alberto Moreno et al., 2013). The measurement of the general procedural knowledge of the game through questionnaires can be used as an indirect indicator of the tactical ability of the athlete (García-Gonzalez et al., 2009). For the improvement of tactical skills, it has been demonstrated that showing video sequences of different attacking actions facilitates the recognition of similar patterns in other team sports (Vaeyens, Lenoir, Williams, Mazyn, & Philippaerts, 2007; Williams, Heron, Ward, & Smeeton, 2004)

In that line of research, the literature has already confirmed that the acquisition of good procedural knowledge influences the improvement of decision-making in the game. Considering the need for giving importance to decision making, the present research had as a priority the observation and analysis of three specific actions: serving, attacking and blocking. Supporting this selection of actions, Palao and Ortega (2015) analysed and compared the frequency and effectiveness of technical and tactical actions between winning and losing teams. Their results showed that winning teams differ from losing teams by ending actions such as the serves that do not allow attacking options, blocking points or counterattacks. This paper uses a reduced sample. For this reason, as prospective future research, the research could be replicated in larger samples and measuring as an independent variable 'making-decisions 'in real game situations'.

## Conclusions

In the present study, we have concluded that procedural knowledge (determining factor in making decisions during the game) improves after the application of an intervention program in elementary pupils from sixth grade. Likewise, in the interviews, the participants attributed their improvements to the learning generated by the observation instrument used. As a limitation, the use of a natural sample, and therefore a quasi-experimental design, was controlled with the pre-tests (no significant differences between the two groups) and the covariance. However, in future investigations, it will be interesting to randomise the selection of participants.

Likewise, it would be necessary, as a continuation of the present study, to carry out a subsequent investigation to assess whether an intervention program with an observation instrument influences the improvement of decision-making in the game field.

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