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ORIGINAL

EFFECTS OF IMPLICIT AND EXPLICIT GOLF MOTOR LEARNING IN SCHOLARS

EFECTOS DEL APRENDIZAJE MOTOR IMPLÍCITO Y EXPLÍCITO DEL GOLF EN ESCOLARES

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ABSTRACT

The aim of this study is to examine, using an ecological approach, whether implicit motor learning methods enable improved learning of the full swing and the half swing (chip) in golf for beginners of the sport compared to the traditional explicit motor learning methods. The subjects comprised 56 second-year high school students (M=13.6±1.05 years) with no previous golf experience. Three measurements were taken: a) prior to the didactic intervention, b) a pre-test of motor learning performance at the school and c) a post-test of the transfer (two weeks after the pre-test) carried out on a golf course. Based on the results, learning complex technical movements such as the full swing and the chip in golf can be viewed as a continuum between implicit and explicit learning for adolescents in the initiation phase and integrating the positive aspects of both methods.

KEYWORDS: implicit motor learning, explicit motor learning, golf, physical education, scholars.

RESUMEN

El objetivo de este estudio es investigar mediante una aproximación ecológica, si los métodos de aprendizaje motor implícitos permiten un mejor aprendizaje del swing completo y del swing medio (chipeo) de golf en la iniciación deportiva respecto a los tradicionales métodos de aprendizaje motor explícitos. Han participado 56 estudiantes (M=13.6±1.05 años) de segundo curso de enseñanza secundaria (ESO), sin ninguna experiencia previa en este deporte. Se han tomado tres mediciones: a) antes de la intervención didáctica, b) el pre-test de rendimiento motor en el centro escolar y c) el post-test de transferencia dos semanas después del pre-test) realizado en el campo de golf. En base a los resultados, el aprendizaje de un gesto técnico tan complejo como el swing completo y el swing medio (chipeo) en golf pueden plantearse como un contínuum entre el aprendizaje implícito y el explícito en estas edades en la fase de iniciación e integrando los aspectos positivos de uno y otro método.

PALABRAS CLAVE: aprendizaje motor implícito, aprendizaje motor explicito, golf, Educación Física, escolares.

PURPOSE

The inclusion of golf in the 2016 Olympic Games is an indicator of the increasing globalization of this sport. It is estimated that worldwide between 55 and 80 million licensed individuals officially play golf in at least 136 countries (Evans and Tuttle 2015), although the number of amateur players is countless. Despite the tremendous number of golfers, scientific publications barely exceed 4000, and in the field of social sciences these drop to just 1700. Of these, only 10 are specific to the area of physical education (PE). Therefore, there is a need to understand the most efficient teaching-learning processes for the millions of future golfers.

Within the resources and diversity of students in a PE class (Chow, Renshaw and Button 2013), learning a movement as complex as the golf swing (Evans and Tuttle 2015; Stancin and Tomazin 2013) involves reflecting and considering which theoretical model supports the application of methods or teaching-learning situations that achieve the most effective learning of the golf swing in a safe practice setting that also fosters a peaceful coexistence within the group, increasing motivation and promoting practices for adherence to sports at these ages. It also implies educational knowledge of the golf content as the backbone of the proposed educational intervention (Del Valle, De la Vega and Rodriguez, 2015), but without forgetting the promotion of an atmosphere of coexistence in the group, achieving adequate motivation and encouraging sports adherence practices.

In recent years, a great deal of empirical research has been conducted in the field of learning and motor performance to determine the best approach in training or teaching and to maximize the acquisition of skills in PE and sports (Chow 2013), which has generated several guidelines to be implemented in various contexts proposing and developing new methods for teaching motor skills. Raiola (2017) explains that we have moved from a cognitive and behavioral theoretical framework of motor behavior to an ecological dynamics approach to the learning process. The first theories focused learning on the memory capacity of the learner to remember and try to reproduce the performance of the ideal model (technique) through linear repetition. Subsequently, the theory of ecological dynamic processes was developed from Bernstein’s theory of degrees of freedom (1967) and the theory of motor imagery (Lotze and Halsband 2006), which focus the entire learning process on the adaptation of the subject to the variability of the environment and to his or her own motor specificity to solve problems autonomously and spontaneously, based on relaxed communication from the teaching staff and an increase in student confidence (Webster 2010). This approach has been associated with non-linear pedagogy (Lee et al. 2014), in which satisfying the psychological needs of the individual is essential to achieve intrinsic motivation (Moy, Renshaw and Davids 2015).

Based on these learning theories, explicit motor learning aims to develop a precise awareness of the execution of the technical movement through the acquisition of declarative knowledge about the way in which the skill to be learned should be performed (Kleynen et al. 2015; Verburgh et al. 2016), which implies an adequate working memory to remember, manipulate and apply the instructions for performance (Van Abswoude et al. 2018). For this, accurate information must be provided (the objective of the task and rules/standards to be followed), various types of feedback (on the performance, improvement strategies; on the outcome and on the immediate administration after performance) and an approach to the movement in parts (actions to be carried out and manual guidance).

In contrast, the objective of implicit motor learning is to seek functional solutions to motor problems, avoiding the excessive contribution of verbal information (the conscious awareness of performance is not developed), the overall execution of the movement and external attentional focus are considered and autonomy is fostered through the decision-making of the participants on certain playing conditions (Wulf, Chiviacowsky, and Drews 2015), which enables the learning of motor skills without the concomitant accumulation of declarative knowledge.

Faced with this conceptual dichotomy and with *a priori* contradictory objectives regarding adolescents learning the golf swing, there are very few studies conducted in PE on the benefits of implicit and explicit motor learning. Of note is that of Capio et el. (2013), who directly addressed the viability of implicit motor learning in PE in the primary school stage, concluding that learning to throw in schoolchildren (8-12 years) by reducing performance error in one group allowed greater learning than in the other group without error restrictions. Similarly, Buszard et al. (2017) indicate that in children up to the age of 10, explicit instructions have a negative influence on basketball shooting performance due to their low working memory capacity.

In direct relation to the learning of golf in children only two recent and contradictory studies have been published on the focus of attention. Brocken, Kal, and Van der Kamp (2016) state that attention directed towards the external focus achieves better results in learning to putt in golf in children between 8-12 years of age, but that working memory is not predictive of motor learning, in either the internal or external attention group. However, Van Abswoude, Nuijen, and Kamp (2018) found no differences in learning golf putting in children related to the focus of attention and indicate that individual preferences towards the specific task are the main factor determining performance.

In addition and within the context of this study, we highlight the research contributions of Kleynen et al. (2015), who analyzed the consensus of 40 experts on several strategies to promote explicit or implicit learning: analogy learning, errorless learning, observational learning, dual task learning, trial and error learning, observational learning (model) and imaginative learning. They also emphasize the importance of practicing the entire skill, the focus of attention, practice session organization (blocked or random practice), feedback and type of instructions.

Of all these strategies, Kamp G. Van der et al. (2015) indicate that errorless learning or minimizing error is the only method for implicit motor learning that has been validated in groups, in which practice or setting conditions are altered to induce implicit motor learning in precision activities, such as golf putting and ball throwing, initially practicing at a short distance from the hole or target and slowly increasing the distance to improve learning (Maxwell et al. 2001; Capio et al. 2013). They also consider that in PE the most viable implicit learning methods to be applied in individual sports should be directed towards the overall aspects of movement (*analogy*) and towards the results of the action in the environment (*external focus*: head of the club), in which the student's attention is directed towards the effect or result of the action in the environment, rather than on the movements of the body or how the action is executed (i.e. internal focus of attention).

Capio et al. (2015) conclude that through analogy students learn the extent of technical rules that explicit learning normally provides. Consequently, students who acquire skills by analogy appear to have less access to declarative knowledge about the movement than those who learn explicitly, indicating that learning by analogy may use mechanisms of action or behavior that are similar to each other or related to implicit processes.

Additionally, the study by Keogh and Hume (2012) asserts that there are relatively few motor learning studies in the literature to determine the most ideal strategy for learning the golf swing at different levels and ages, as most research has been done on performance of the putt in adults.

With the knowledge of the current situation concerning implicit and explicit motor learning in golf, the literature focuses mainly on studies in adults, which is why we raise the question, as teachers, to what extent and when implicit learning can be incorporated into PE classes, where motor skill learning is usually carried out in mixed, diverse groups (Kamp G. Van der et al. 2015), with a maximum ratio of 30 students. Given the difficulty of teaching complex motor skills in the recreational space of a school, and considering that the literature does not take a position on the possible application of implicit motor learning in adolescents for the acquisition of complex motor skills such as the golf swing, we proposed this study with the aim of determining whether or not implicit motor learning is effective in comparison with explicit motor learning. It is expected that: 1) The explicit motor learning (CG) group will achieve better results in short-term performance, 2) The implicit motor learning (EG) group will produce better learning outcomes, 3) Both groups will improve, although the EG will manifest greater learning in the longer term than the CG.

METHOD

Participants

Fifty-six second-year high school students (28 men, M=13.5±1.2 years; 28 women, M=13.8±1.9 years) participated in the study, with a CG of 16 women and 12 men, and an EG of 12 women and 16 men. This distribution was maintained as it was an ecological study carried out in the regular PE classes (60 minutes x 2 days per week). No student had practiced this sport or had observed anyone playing golf.

This study was performed in compliance with the 1964 Declaration of Helsinki, revised in 2013, which defines the ethical guidelines for research involving human subjects. Prior to the study, written informed consent was obtained from the participants and their legal guardians. Throughout the entire research process and afterwards, the provisions of the Organic Law 15/1999 of 13 December of Spain, on the protection of personal data were applied. All the participants were treated following the ethical guidelines of respect, confidentiality and anonymity in data processing. Additionally, the parents of each student in the CG signed the consent to use the App: Coach's Eye on the student's mobile phone.

The participating teachers were the PE teacher with 20 years of experience (10 of them teaching golf in schools), two trainee teachers who were instructed in the application of the variables to be analyzed (distance in the full swing and the chip), and five qualified golf professionals.

Materials

The golf swing tasks at the school were performed on a 1x0.60 m section of artificial turf. The full swing was performed with a 9 iron and the half swing, hereafter referred to as the chip, with a sand wedge or pitching wedge. In both cases, different colored plastic balls with holes were used (lighter weight to facilitate stopping for accident prevention).

The golf swing tasks on the natural grass course of the Granada Golf Club (Spain) were carried out on natural grass with the 9 iron and the sand wedge or pitching wedge, for the full swing and the chip, respectively, and using official golf balls belonging to the same practice course.

Procedure

Participants were randomly assigned to either the CG (explicit learning) or the EG (implicit learning). In both cases, during the practice phase they performed a total of 54 shots, distributed in blocks of nine strokes each day (three chipping rounds with the sand wedge or pitching wedge, three full swing rounds with a 9 iron and three rounds of putting with the putter) following the indications of Glazier and Glazier (2011).

The provision of the initial information and the demonstration of the technical movement were conducted on a section of artificial turf 1x0.60 m using a 9 iron golf club and a plastic practice ball with holes. Both the complete movement and its different parts were demonstrated in slow motion, finishing once again with the complete movement.

In the CG (explicit learning) a student golfer (14 handicap) served as a model and corrected the execution depending on the result of the shot made by his peers (on body actions to be performed during the following shot: use a firmer grip, straighten your arms, put more weight on your right foot, don’t turn your head, rotate your upper body as a unit) during the school sessions within the PE schedule and always assisted by the subject teacher.

At the beginning of each session, the demonstration was repeated and the technical points to be addressed were reviewed throughout the classes at the request of the students or when the teacher deemed it appropriate. Through the Eye's Coach application, the students could record the student-teacher as the ideal model of execution and compare this technical movement with their own performance whenever each student considered it appropriate, thus encouraging self-applied feedback.

With regard to the EG (implicit learning), the main objective was to encourage the dynamic adaptation of movement patterns to achieve the goal of hitting the ball to the right place in each practice situation, rather than trying to reproduce a recommended movement modification provided by the teacher.

In the EG, the instructor corrected the participant when asked or when the instructor saw the need to intervene in order to maintain motivation towards training. The instructor's actions were directed not towards body movements but towards certain aspects of the task (raise the club more vertically, touch the ground, equal timing of the backswing and downswing, eyes on the ball, etc.).

Barnett et al. (2015) indicate that only three golf tests are considered to have documented reliability and/or validity measures, but none of them have been tested in children. These authors provide a new tool to use in the primary stage (up to 10 years of age), focused on the observation of body actions in the execution of the swing (explicit learning) during practice on a golf course and using plastic balls.

Among the validated tests, we find the 'Nine-ball skills test' and the 'Approach-iron skills test,' administered in elite and high-level amateur adult male golfers (Robertson, Burnett, and Gupta 2014). There is another indoor test, also implemented in men, on the score of the results in the pitch and putt (Porter at al. 2009).

To our knowledge, no test exists in the literature on scores for the full swing and the chip in novice adolescent golfers conducted in an adapted space with the limitations of an outdoor sports court of a school. Based on the contributions of the test by Porter et al. (2009), we used a three-point scale, the chip in non-professional golfers, the distance for the chip of 10 m, and sets of 10 repetitions, as well as the contributions of Barnett et al. (2015) on the use of plastic practice balls.

The motor learning pretest took place after six practice sessions at the school, by two trainee teachers who calculated the mean of the three attempts for each of the shots (full swing and chip) was calculated after two practice trials without a ball. For the full swing, the target (hole) was located 15 m from the tee and the following scale was assigned: 3 points (if the ball passed that distance in flight), 2 points (if it passed after a previous bounce on the ground) and 1 point (if it did not achieve the distance). For the chip, the target (hole) was located 7 m from the tee and the following scale was used: 3 points (if the ball entered the hole in flight), 2 points (if it entered after a previous bounce) and 1 point (if it did not enter the hole).

The posttest transfer took place two weeks later, on the natural grass practice tee of the Granada Golf Club (Spain), with official golf clubs and balls belonging to the Club, which involved kinematic realignments in relation to the acquisition phase (D'Innocenzo et al. 2016). The same scale was used but the distance of the target (hole) for the full swing was 50 m from the tee and in the chip the target (hole) was 10 m from the tee. Before practicing the same strokes as at the school, the students received information and correction on the technical movement from five golf professionals, supplementing the information they had received in their PE classes.

As in the study of golf putting performance in 10-year-old students using a 10-trial retention test (Bahmani et al. 2017), in our study each student performed a total of 10 swings, in two nonconsecutive series, before being evaluated by the same trainee teachers using the mean of the last three strokes, both in the chip and in the full swing.

Statistical analysis

A descriptive analysis of the data was carried out both overall and of each experimental group in each of the variables. Frequency and percentage tables were determined for the categorical variables. The mean and standard deviation were calculated for the continuous variables and/or the medians and interquartile ranges for the non-normal variables.
The Kolmogorov-Smirnov test and the Shapiro-Wilk test were used to study the normality of the data. Since all the variables analyzed showed significant results, the data were analyzed using non-parametric tests. Descriptive statistics of the median (M) and the interquartile range ($IQR=P_{75}-P_{25}$) were used. Likewise, the Wilcoxon test was applied for independent samples in the comparison of the two study groups, as well as in the paired samples in which the pretest and postest were compared. The significance threshold was set at $P<0.05$, and all data analyses were performed using the SPSS statistical package (version 23).

RESULTS

To conduct the study, and given that the experimental groups were formed using a randomized list of students, weight and height were studied to establish the baseline for the study groups. The descriptive statistics of the two groups are presented in Table 1. The comparative statistics (Height: W=765, P=0.589; Weight: W=754, P=0.471) indicated the homogeneity of the results, which allowed the CG and the EG to be compared.

Table 1. Descriptive statistics: median (M) and interquartile range (IQR), mean (Ẋ) and standard deviation (SD) of the height and weight in the CG (n=28) and the EG (n=28).

Variables	GROUPS	Descriptive statistics			
		M	**IQR**	**Ẋ**	**SD**
Height (cm)	CG	164. 80	12.40	164.80	8.55
	EG	166.75	32.00	165.17	8.14
Weight (kg)	CG	55.55	19.34	58.82	15.27
	EG	58.87	17.20	61.11	15.72

The following sections provide an analysis of the variables studied: full swing and the chip.

Full swing

The full swing involves the maximum range of motion execution of the backswing and the downswing. The median (M) and interquartile range (IQR) of the full swing in the pretest motor learning phase and in posttest transfer in the two groups are shown in Table 2.

The descriptive statistics of the CG in the pretest (M=2.00, IQR=0.55) and in the posttest transfer (M=2.00, IQR=0.33) compared to the EG in the pretest (M=1.67, RIQ=0.70) and in the posttest transfer (M=2.00, IQR=1.03), indicate that the CG demonstrated a superior performance than the EG in the pretest, but that this performance was the opposite in the posttest transfer.

Table 2. Mean (Ẋ**)** and standard deviation (SD) of the full swing in the CG (n=28) and EG (n=28) in the pretest (PR-T) and in the posttest transfer (PT-T).

Variable	Measurement		CG	EG
Full Swing	PR-T	Ẋ	2.0711	1.7379
		SD	0.4168	0.4007
	PT-T	Ẋ	1.9225	2.0857
		SD	0.4078	0.6234

The progress of each group was analyzed on an individual basis according to the test statistics. Comparison of the pretest and posttest transfer of the CG (Z=1.294, P=0.196) showed no significant improvements between the two measurements. There was even a drop in performance in the second measurement. However, in the EG (Z=3.108, P=0.002) a significant improvement was seen between both measurements, even surpassing the data for the CG in the second measurement. That is, there was an improvement in the performance of the EG in the posttest transfer, which surpassed that of the CG (not significant).

However, when comparing the CG and the EG, there were significant differences in favor of the CG in the pretest (W=629, P=0.004), i.e., the CG performed better in the first measurement than the EG. It is also noted that the EG performed better than the CG in the posttest transfer but without reaching significance (W=740, P=0.332).

Chip

The chip is medium amplitude a shot in the backswing and downswing range of motion. The M and IQR of the pretest and posttest transfer for the chip in both groups are shown in Table 3.

The descriptive statistics for the CG indicate that in the pretest (M=1.30, IQR=0.92) and in the posttest transfer (M=2.00, IQR=0.33) results were very similar to the data for the EG in the pretest (M=1.485, IQR=0.67) and in the posttest transfer (M=1.67, IQR=0.70).

Table 3. Mean (ẋ) and standard deviation (SD) of the chip in the CG (n=28) and EG (n=28) in the pretest (PR-T) and in the posttest transfer (PT-T).

Variable	Measurement		CG	EG
Chip	PR-T	ẋ	1.5257	1.4714
		SD	0.5499	0.5061
	PT-T	ẋ	1.8632	1.7104
		SD	0.4486	0.4592

The comparison of the pretest and posttest transfer (Z=2.685, P=0.007) in the CG indicated that there were significant improvements between both measurements in this group. Similar and significant results to those obtained in the EG (Z=2.325, P=0.020) were also found, which indicated that in both groups the results in the second measurement had improved, with slightly better results in the CG. However, there were no significant differences between the groups in either the pretest (P=0.733) or the posttest transfer. (P=0.239).

CONCLUSIONS

In the full swing, the explicit motor learning CG achieved significantly better pretest performance results than the implicit motor learning EG, and as D'Innocenzo et al. (2016) indicate, it seems that guiding the attention of novice subjects towards the relevant aspects of the model accelerates observational learning of the full golf swing. That is, self-awareness of the movement may have an advantage early on in the initial stages of practice. Better results are obtained due to the subjects being more capable of using exteroceptive (visual, auditory) and kinesthetic (tactile) information as feedback to evaluate and compare the differences between the actual and the desired result (Malhotra et al. 2015).

In our study, the visual aid provided through the administration of feedback by the student-teacher to the rest of the students on small errors appears to have resulted in more effective learning than providing feedback on larger trials (Palmer, Chiviacowsky, and Wulf 2016), in accordance with Kamp G. Van der et al. (2015) on the benefit of visual aids in a variety of other athletic activities (ballet, volleyball, football, cricket, long jump). In other words, directing conscious attention to the movement in the CG did not necessarily adversely affect or alter the performance of students with fewer skills (Beilock et al. 2002, Camacho-Lazarraga, 2019) rather precisely the opposite. The optimal result for the full swing by the CG is in agreement with D'Innocenzo et al. (2016) who state that using attention guidance together with observation in learning the full swing in golf enables the achievement of the correct movement in a shorter period of time and greater effectiveness of the observational learning strategy by optimizing the attentional process of the learner and the resulting information extraction. In addition, Malhotra et al. (2015) state that for those who direct conscious attention to body movements, this may not be so negative during the execution of new skills. Therefore, the results of the motor learning pretest for the full swing in the CG confirm that self-awareness and conscious motor processing of movement in the early stages of learning can benefit performance (Maurer and Munzert 2013) as the students were able to understand the idea of the movement (Oliveira et al. 2013) so that in later stages they could carry out an information shift towards an external focus of attention.

However, compared to the positive data from the motor learning pretest, the results indicate that there was a decline in performance by the CG (explicit learning) in the posttest transfer. Accumulation of knowledge as a result of self-consciousness or conscious processing may result in a decrease in performance due to an interruption of the automaticity of the movement resulting in inefficient muscle activation (Palmer et al. 2016; Tzetzis and Lola 2015).

It has been speculated that poor results by the CG on the posttest transfer is a consequence of working memory dependence (Maxwell, Masters, and Eves 2003) because if too many instructions are given on how to perform a skill, learners are likely to be preoccupied with thoughts on how to respond and adopt a more controlled mode of information processing, disrupting automatic response processes, since the accumulation of technical knowledge as a result of practice and conscious mechanisms seem to interrupt performance (Maxwell, Masters, and Eves 2010; Ste-Marie et al. 2013) or may negatively alter motor performance (van Ginneken et al. 2017) resulting in knowledge that is more likely to be forgotten over time (D'Innocenzo et al. 2016).

Nevertheless, performance in the EG (implicit learning) improved in the posttest transfer in the full swing even surpassing the CG (without significant differences), which indicates that the results of implicit learning become evident in the long term (Capio et al. 2015). They are also less dependent on working memory, which can be beneficial for specific learning, thus avoiding disruptions in movement control and with less performance deterioration in the long term (Rendell et al. 2010; Maxwell et al. 2001, 2003; D'Innocenzo et al. 2016).

These findings are consistent with theoretical predictions that implicit learning is particularly advantageous for children in the early stages as they can learn more and lasting motor skills over the long term, reflecting the general plasticity of neural circuits (Van der Kamp et al. 2015) and allowing the execution of more stable motor skills in terms of intra-individual variability than explicit learning, as well as less vulnerability to choking under pressure (Lam et al. 2009, basketball study).

Analysis of the results of the chip in our study, both the CG and the EG showed similar results in the pretest and both succeeded in improving these results in the posttest transfer (with no significant differences), with slightly better data in the CG, in line with the results of Bright and Freedman (1998) and Kavussanu, Morris, and Ring (2009), which indicate that the interaction of the restrictions under which a golf swing is performed differs from swing to swing and from person to person, and that the 'optimal' coordination pattern that emerges will show a marked variation between swings and individuals (Keogh and Hume 2012). In the execution of the chip, the general results show a poorer outcome than in the full swing, which allows us to indicate that both the CG and the EG did not have sufficient experience to have developed appropriate and automatic motor solutions (for example, the proper force and the average elevation in the backswing to strike the ball) and that the small difference in favor of the CG may be due to a greater awareness of the movement in these initial stages based on repetition.

Based on the results of our study, adolescent learning of the full swing and the chip during PE lessons should be viewed as a continuum between implicit and explicit learning and not as a dichotomy (Kleynen et al. 2015) There is growing acceptance that individual differences among students should be taken into account when considering teaching interventions in any learning context, in addition to the specific impact this has on improving student expectations (Palmer et al. 2016; Wulf et al. 2018).

Moreover, the results of this study can serve as a guide for PE teachers who are interested in introducing this sport, but who lack both technical and tactical experience, providing guidelines associated with the methodology of golf learning in adolescents, including such important aspects for large groups as the organization of the group and the material, the provision of initial information and feedback as well as the use of new technologies, all framed in a dynamic group structure that enables the achievement of adequate levels of intrinsic motivation, a perception of fun and adherence to future motor practices.

Future studies could include a retention test or longer-term transfer test or perhaps consider offline learning (sleep) to confirm the effectiveness and consolidation of these two learning methods (Verburgh et al. 2016), increase the sample (educational centers), the age range, the number of sessions (golf course) and vary the approach to the tasks or possibly explore the relationship between the degree of autonomy, the degree of difficulty of the task and motivation to practice. Additionally, the control of inter-subject variability (age, sex, anthropometric measurements) can provide optimal coordination parameters that involve greater individualization, even though this is complex to apply in PE.

What Does This Article Add?

The aim of this study was to determine the most effective method for learning the full swing and the chip in golf for adolescent beginners in PE classes. Implicit and explicit motor learning methods were applied and compared, each with its own characteristics.

This is a novel study within the field of learning the golf swing in adolescents during PE class. Previous research in this sport has been conducted in adults (beginner and advanced) mainly oriented towards putting with only a few studies addressing the half-swing movement. The small number of available studies in children has examined the association between the focus of attention and the golf putt.

This study affirms that within the area of PE for adolescents, both the full swing and the chip can be taught through a mixed approach using both implicit and explicit learning. While the content is of great technical/tactical difficulty and with a risk of accidents (being hit by the club or the ball), the implicit approach (autonomy, external focus of attention, practice by trial and error, less initial information and feedback, same-level communication) enables the acquisition and performance of the technical movement to the same extent as the explicit approach (control and direction of the class, internal focus of attention, modeling and repetition, hierarchical communication), which can improve levels of student involvement, motivation and enjoyment without undermining the level of learning and motor performance.

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