Sports Science

TGfU in the teaching of handball at school: impacts on the motor coordination and technique in the game

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Abstract - Aim: This study investigated the impact of a handball-teaching program through the understanding of the TGfU on motor coordination (MC) and technical skills of students. **Methods:** The sample consisted of 43 students of both genders, with a mean age of 14.3 years (± 0.46), divided into two groups, G1 - Teaching Games of Understanding (TGfU) and G2 - TGfU + MC, and both received 20 classes. We used the Körperkoordinationstest für Kinder (KTK) for the assessment of MC and the Game Performance Assessment Instrument (GPAI) for technical skills in handball. **Results:** The categorization confirmed the reliability of the application of teaching programs and the results showed that, after the intervention, both groups presented meaningful improvements in MC, considering time and gender effect. The female students presented a larger impact on MC in both teaching programs, while the male students obtained a larger impact in the technical skill execution index when received the TGfU + MC model. Still, the relative frequency for the classification of a good MC increased in both groups after the intervention, and the normal MC was the one with the highest frequency in both groups and genders after the proposed program. **Conclusion:** We concluded that the teaching program was able to provide meaningful improvements in MC considering both groups and that the proposal of the inclusion of specific MC elevated the impact of technical skills for male students.

Keywords: sports, learning, motor coordination and TGfU.

Introduction

The human movement is determined and influenced by different factors; one of them is motor coordination (MC)[1]. Considering this, studies intend to enlighten how motor skills are processed, executed, and regulated at different levels. From this, they identify the development and/or motor disorders in different types of natural or specialized skills, which are called, in this study, technical skills of children and adolescents[2]. It is by the execution of these skills that we assess the MC, intrinsic to the physical and sports activities, as well as everyday life[1].

Evidence postulates associations between the level of MC and the health of individuals considering both genders, which include the level of physical activity, private and public schools, body mass index (BMI), and others[3]. In the scope of sports, studies concerning MC showed a positive correlation between MC and the participation in sports practice, which infers that this is a predictor of sports development for young athletes[4-7] in different sports.

It becomes necessary to develop MC from an early age once this is directly linked to learning specific technical skills in sports[1]. Within this context, team sports become an assisting tool in the general development of athletes, because they integrate different components (cooperation and competition, MC and technique, and tactic), through motivational and challenging activities for children, teenagers, and adults[8].

Since the late 20th century there is a debate on curricular structure and types of instructions concerning teaching sports, which brings to mind that the conceptions of teaching sports stimulate and promote meaning and reflection in the learning process and tears the idea of teaching sports in an isolated/segmented way when technique precedes tactical application[9,10]. Despite this effort, the transformation when teaching sports is more evident in published literature than in a practical reality[11]. Aburachid et al.[12] complements that the teaching of the technique is still a foremost content during Physical Education classes, and not often, there is the application of teaching methods that urge tactical learning in students' games, nor stimu-

late the development of MC, a capacity that supports tactical and technical leaning when teaching sports[13].

The Teaching Games for Understanding (TGfU) have been the first model to undertake the level of this new teaching conception[14], which prioritizes aspects of tactical mastery and its interaction with technique, comprehension, and information processing regarding decision-making, that aims the construction of knowledge and the capacity of action during a game[15]. The model suggests tactical-technical development through a didactic-pedagogical cycle, one that recommends tactical knowledge, and the teaching of technique is according to the needs of the game[16]. However, the TGfU does not contemplate the development of MC in this cycle, a content that will serve as a basis for sustaining the development of specific sports skills, necessary techniques for sports practice success[17].

Studies of intervention that aim for the development of MC become relevant in the sense of filling gaps of pedagogical praxis, in order to reach and provide teachers knowledge concerning the development of this capacity and its contribution when compared to others. Thus far, few studies of intervention have assessed tactical-technical knowledge in handball[18-22] and none has presented a study that highlights the analysis of MC after a teaching program through comprehension. Studies with the TGfU model appear in other sports such as soccer[23], futsal[24], basketball[16,25,26], and volleyball[27], though they have not applied motor coordination as teaching content.

Based on the investigations, we worked with the hypothesis that the application of specific MC contents for handball combined with the TGfU model might provide improvements in the MC levels and technical skills of students. Therefore, this study aimed to determine the impact of a handball-teaching program through the TGfU model on MC and students' technical skills.

Methods

This is a descriptive study with a quasi-experimental design of a non-probability convenience sample[28]. In order to obtain a wider internal validity, we considered, for the sample, subjects that had not had a systematized training in handball and then, based on previous studies[12,29] the researchers gave two Physical Education classes before the intervention, so there was some familiarization with handball. In these two introductory classes, the students played in a reduced game and court, without a lot of rules and with little intervention by the researchers, with the intention to promote initial support of mastery and ball handling for both experimental groups.

The classes through TGfU followed the structure recommended by Mazzardo et al.[22] and were given by the responsible researchers, based on previous studies of similar nature[22,30]. They intended to avoid methodological distortions in the application of the teaching proposal and the teaching style of the guided discovery, crucial conditions during students' learning process.

We previously provided the structure of the classes for the Physical Education teachers, containing their goals, contents, and the activity progression planning, so they could have access to the used content. Both groups received two 55-min classes each, one during school time - P.E. class -, and an after-school one. A collaborator assisted the researcher during the classes, and this one oversaw its filming to avoid setbacks. We determined the number of 20 classes based on other intervention studies that identified meaningful values in analyzed variables starting from 15 classes[31].

Sample

The sample consists of students from two classes from state public ninth graders, in Brazil, which is equivalent to junior high school. First, we contacted a school representative who allowed us to conduct the research. Subsequently, we had two meetings with the school Physical Education teacher, in order to explain the procedure that would happen along the process. The sample included 43 male and female students, split into Group 1 (G1: 21 students - 14.4 ± 0.5) and Group 2 (G2: 22 students - 14.4 ± 0.46), aged between 14 and 15 years old (14.3 ± 0.46).

As a criterion of inclusion in the sample, these students had to submit a signed consent form, as well as the free and informed consent form given by their responsible ones, in which we described the goals and procedures to be achieved during the period of intervention. The participants should also be beginners in handball (without previously knowing the sport), not take part in other sports training during the period of intervention, and not turn 16 years old within this period. We followed the rules and regulations established by the National Health Council, and the Research Ethics Committee of the Federal University of Mato Grosso approved this study, which obtained protocol number CAAE: 57863616.4.0000.5541 and number of the report: 1.928.736.

Class content

After the pre-test application, G1 received handball pedagogical intervention, during Physical Education classes under the TGfU model and G2 received handball pedagogical intervention through TGfU combined with contents of specific MC (TGfU + MC). To G2 - TGfU + MC, we added contents of specific MC to the classes, considering handball-specific activities of MC with the ball, and according to the objectives of each class (verify Mazzardo et al.[22]), totaling 20 classes given to both groups.

We determined the progressions of task complexity during classes considering vertical and horizontal articulations[32] that allowed the development of tactical knowledge in the game context. Furthermore, we used for the formulation of sessions, the tactical principles of attack

and defense defined by Bayer[33], and the structuring of classes with the North American version of the TGfU, the Teaching Sports Concepts, and Skill[34].

It is worth mentioning that major particularizations of the organization and distribution of class contents are in Mazzardo et al[22]. By looking at Figure 1, it is possible to realize that similar time creates opportunities for each segment of the didactic pedagogical cycle of TGfU, except MC contents that were given only to G2, which we could confirm using the chi-square test that did not show differences for each segment of the class.

Instruments

We selected the Körperkoordinationstest für Kinder (KTK), the battery of MC tests for children[35], to which we divided into four tasks: (1) keeping balance walking backward; (2) one-legged hopping; (3) jumping from side to side; and (4) moving sideways. With the assessment, we were able to obtain the score of each task and we verified in the scoring table, the corresponding score according to the age of the participant, which resulted in the total motor quotient and the one per task[36].

To analyze the technical skills of handball, we chose the Game Performance Assessment Instrument (GPAI)[37], which consists of the assessment of its efficacy in operation during the game. Based on recorded videos of students playing in a 10-min 3v3 + goalkeeper game, we determined seven components of the performance. As the instrument allows researchers the freedom of choice regarding the analysis of components, we decided to assess the skill execution index (SEI) to verify the technical-coordinative assessment of students, the focus of this study. The scoring was individual, and the number of effective answers was divided by the number of ineffective answers. Thus, any scoring over one (1) indicated that efficient answers were superior to inefficient answers.

The verification of data reliability concerning the categorization of classes and the validation of the performance in the game attended 10% of sample[38], once we analyzed and reanalyzed two videos of each experimental group and two classes. Experienced teachers carried out the analysis of the videos and the researchers of this study gave classes, in both groups, to avoid inconsistency in the application of the model.

From the categorization of classes, we determined that the total length of the class created an opportunity of similar time for the execution of the TGfU methodological cycle for both groups. As well as the other items of the categorization, like participation of students in classes, delimitation of spaces, structural complexity of the task, training conditions organization, and types of technique organization. They showed that learning happened by the resolution of tactical problems, with the use of the technique during the game, which confirmed the teaching by the applied model[22].

Data processing

After the verification of data normality by the Shapiro-Wilk test, we applied descriptive statistics (median and interquartile range and absolute and relative frequencies) and inferential statistics (Wilcoxon test, to provide comparisons in the group and Mann-Whitney for comparisons between experimental groups). In order to complement the hypothesis testing, we used effect size (ES) ($r = z - score/\sqrt{n}$), which measures the real effect of an intervention (Cohen's Classification). The intra-observer analysis, regarding categorization, reached a level of agreement of 100% for both groups and the inter-observer one reached 98.05% and 98.3% (G1 and G2, respectively). As to the GPAI, the intra-observer analysis reached a level of agreement of 94.5% and 88.9% from the inter-observer. We adopted a hypothesis value of $p \leq 0.05$.

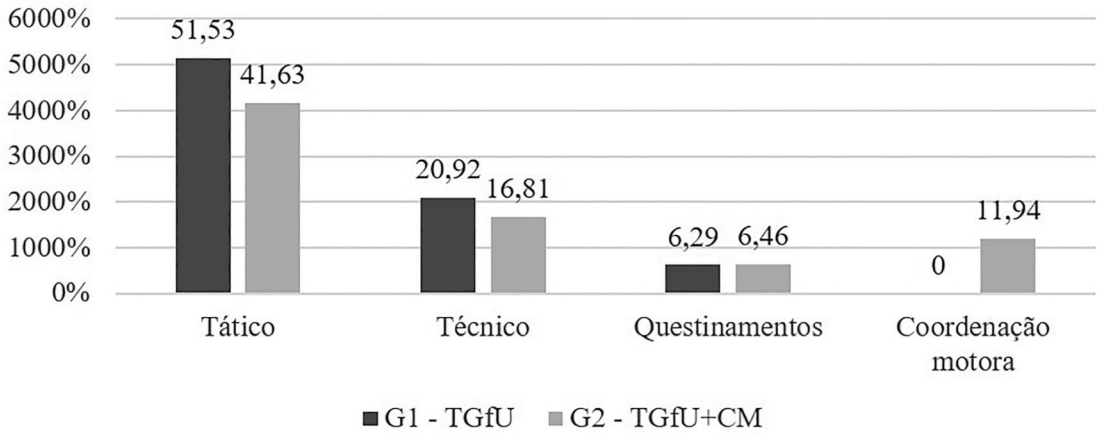

Figure 1 - Pedagogical characteristics of the TGfU model applied in this study for both groups, according to the stimulated capacities. TGfU: Teaching Games for Understanding; MC: motor coordination.

Results

According to the study hypothesis, the data analysis presented that there were meaningful improvements for both groups (G1 and G2) concerning the level of MC, given the time of intervention and gender (Table 1). For G1, male students presented meaningful improvements in the balance beam and sideways move tasks, as well as in the motor quotient. Female students presented meaningful improvements in most tasks, except the balance beam one. For G2, which received the content of MC in classes, male students expressed meaningful improvements in three out of four tasks, except the one-legged hopping. Female students presented meaningful improvements in all tasks and motor quotients.

When we analyzed absolute and relative frequencies of the groups (Table 2), we noted that, during the pre-test, the classification "normal motor coordination" comprised most of the students from G1 and G2 for both genders. The classification "motor coordination disorders" recorded 11% of the female sample.

Besides the fact that the value of "normal motor coordination" remains with a high frequency for both groups and genders, after the intervention, we highlighted that the frequency values for "good motor coordination" increased for both groups regarding male students (Table 2). It was possible to note that we classified no student with "motor coordination insufficiencies" after the intervention, and we noticed improvements in the classification of MC, mainly, concerning male students from G2, that received this content during classes.

At post-test, in both groups, male students presented meaningful differences for technical skills, when assessed by SEI, while the female students did not present meaningful differences for this variable (Table 3). In the analysis between groups, we found meaningful differences for male students ($p = 0.019$), but not for female students using SEI. After the intervention, considering both genders, we did not find statistically meaningful differences for technical skills between groups.

Discussion

Considering the objectives of this study, when analyzing the intervention program impact through TGfU on students' MC, we observed relevant improvements for both groups. The female students presented higher scores considering MC in comparison to male students, reaching large ES for all tasks in G2 - TGfU + MC, and G1 - TGfU presented medium ES for the balance beam task and large ES for other tasks. These results partially corroborate with the study conducted by Aburachid et al.[5], which observed

Table 1 - Median and interquartile ranges of the coordination test considering the effect time and gender in both groups.

Group	Gender	Tasks	Pre-test Md (I-III IQR)	Post-test Md (I-III IQR)	p	ES	
G1 - TGfU	Male	Balance Beam	87(79.5-100.5)	106(92-108.5)	0.014*	0.480	M
		One-legged Hopping	77(73-79)	77(74-79)	0.622	-	-
		Side to side Jump	101(78.5-112)	107(94.5-114)	0.074	-	-
		Sideways Move	84(77-95.5)	98(91-106.5)	0.043*	0.398	M
		Motor Quotient	101(95-112.5)	115(110-118)	0.002*	0.611	L
	Female	Balance Beam	79(65.75-82.75)	90(77-109.5)	0.080	-	-
		One-legged Hopping	54.5(46-60)	59.5(51-70)	0.042*	0.508	L
		Side to side Jump	82(76.25-87.5)	88(82.5-103.75)	0.012*	0.630	L
		Sideways Move	62(58-76.75)	79(74-91.5)	0.018*	0.594	L
		Motor Quotient	85(83.25-97.25)	96.5(90.25-112)	0.012*	0.630	L
G2 - TGfU+MC	Male	Balance Beam	92(69.5-101.5)	106(93-109)	0.016*	0.473	M
		One-legged Hopping	76(73-77)	76(70-79)	0.400	-	-
		Side to side Jump	104(89-109)	110(96-117.5)	0.042*	0.398	M
		Sideways Move	87(74-96.5)	93(84.5-104)	0.012*	0.493	M
		Motor Quotient	106(101.5-112)	116(105-121)	0.001*	0.624	L
	Female	Balance Beam	83(79-102)	96(78.5-113.5)	0.030*	0.512	L
		One-legged Hopping	56(50.5-60)	60(56.5-71)	0.028*	0.518	L
		Side to side Jump	79(75-82)	85(76.5-90)	0.027*	0.520	L
		Sideways Move	70(48.5-74.5)	89(63.5-96.5)	0.008*	0.629	L
		Motor Quotient	92(85-93.5)	102(88.5-108)	0.008*	0.629	L

Legend: TGfU: Teaching Games for Understanding; MC: motor coordination; Md: median; IQR: interquartile range; ES: effect size; M: medium; L: large; *$p \leq 0.05$.

Table 2 - Absolute and relative frequency of the motor coordination classification, pre and post pedagogical intervention for both groups and genders.

Motor Quotient (Coordination - KTK)		G1 - TGfU				G2 – TGfU + MC			
		Pre-test		Post-test		Pre-test		Post-test	
		F	%	*F*	%	*F*	%	*F*	%
Very good motor coordination	Male	0	0	0	0	0	0	0	0
Good motor coordination		2	15,4	5	38.5	1	7.7	7	53.8
Normal motor coordination		1	84.6	8	61.5	11	84.6	6	46.2
Motor coordination disorders		0	0	0	0	1	7.7	0	0
Motor coordination insufficiency		0	0	0	0	0	0	0	0
Very good motor coordination	Female	0	0	0	0	0	0	0	0
Good motor coordination		0	0	1	12.5	0	0	0	0
Normal motor coordination		4	50	7	87.5	7	77.8	7	77.8
Motor coordination disorders		4	50	0	0	1	11.1	2	22.2
Motor coordination insufficiency		0	0	0	0	1	11.1	0	0

Legend: KTK: Körperkoordinationstest für Kinder; TGfU: Teaching Games for Understanding; MC: motor coordination.

Table 3 - The technical skills considering time and gender effect for both groups.

Group	Gender	Pre-test SEI Md (I-III IQR)	Post-test SEI Md (I-III IQR)	p	ES	
G1 - TGfU	Male	5.33(4.33-6.75)	14(6-17.5)	0.011*	0.500	M
	Female	3.5(1.5-5)	7.5(2.87-10)	0.093	-	-
G2 - TGfU+MC	Male	3.4(2.79-4.62)	7(5.41-11,5)	0.004*	0.539	L
	Female	3.5(2-4.58)	3(1.84-8.25)	0.859	-	-

Legend: SEI: skill execution index; Md (IQR): median and interquartile range; ES: effect size; M: medium; L: large; *p < 0.05.

meaningful improvements of boys' MC after 15 futsal classes considering all talks for the age range of 12 and 13 years old. Furthermore, the results of this very study resemble the results obtained by Soares et al.[39], proceeding the analysis of MC of 73 participants, both genders, futsal students, aged between 9 and 14 years old, verified, after 18 classes, meaningful differences and concluded that training provoked alterations in MC with a ball.

In the study conducted by Chagas, Ozmun, and Batista[40], with participants aged 13 and 14 years old, volleyball students in Physical Education classes, they observed a meaningful moderate correlation between MC score and the development of technical skills, showing that gross MC seems to develop a relevant role in the execution of specific skills of that discipline. These results partially corroborate with this study since only male students presented meaningful improvements in the execution of the specific skill in handball after school time. Práxedes et al.[11], upon giving 9 futsal classes, for 21 teenage students aged 12 to 14 years old, divided into two groups (with and without experience in the discipline), showed that only the inexperienced group presented a meaningful improvement in the analyzed skill (the pass). Moreover, reiterated the need for intervention programs to establish adaptations to students' skill levels so that results become more representative the tasks applied to the group with certain experience were not able to promote modification in the skill-related to the pass.

The inclusion of specific MC contents in the TGfU model might have assisted the range of the large effect size, which enabled improvement on the level of handball technical skills concerning male students, and medium effect size for the group of students who only received the TGfU as the teaching program. Inversely, the female students did not obtain improvements upon the intervention in their technical skills, a fact that we consider being directly related to lower stimuli of motor opportunities when compared to young ones, during the childhood and teenage life. Another possible explanation might be in the large effect sizes reached by the students in the MC task. The practices of specific MC exercises seem to be easier to be achieved by female students to the detriment of technical skills. Still, MC was stimulated and measured out of the game context, differently from the technical skills, which we stimulated and measured during the game. According to Práxedes et al.[11], the activities proposed for the development of technical skills were considered easy for young ones, with experience in the sport, presenting the opposite in this very study for female students.

Due to the sparsity of studies on intervention using teaching programs allied to the MC stimulation applied in sports, it becomes complex to compare the results with other investigations. We understand that there are two ways of ascending elevated coordinative levels. The first would be through a long period of the intervention program, once short-length stimuli favor the basic development of simple technical skills and not the complex ones to apply during game [12]. The second one would be that intervention programs could teach a minor number of technical skills, once the time of practice with students is short, and concentrate on a less technical execution for a longer time, so it becomes more useful, as observed by Práxedes et al.[11].

As a limitation, there is a small sample size, which hinders data generalization, and there is the low MC of students, which generated adaptations related to simplifications and task complexity in this interventional program. We recommend, for future investigations, the use of validated instruments that assess MC with balls once this is the observed specificity in team sports games, as well as the verification of the learning of the skills through activities of lower and higher complexity.

Conclusion and future perspectives

Considering the results obtained after the application of the handball-teaching program, we concluded that the teaching model we used promoted improvements in MC of both groups and genders. Furthermore, the inclusion of MC contents in the TGfU model promoted high levels of technical skills amongst male students in both groups. The female students did not have an improvement for the SEI, a fact that might be directly related to fewer motor opportunities during childhood and teenage life and the high complexity of learning technical skills in a situational demand.

We emphasize the importance of planning content to be worked with, both Physical Education classes, and sports training clubs, so the teacher will provide the student the possibility to develop his/her capacities, aside from warning for the need of sports practice, which is struggling for its place against new technologies. The teachers must seek new teaching ways to awaken in their students the motivation and reachable challenges regarding the training, in addition to adapting contents according to the level of experience and skill, elevating the classes to a mastery environment favorable to learning.

In summary, this investigation presents guiding results for Physical Education teachers, besides reinforcing the importance of a motor evaluation in order to orient the planning in the teaching, learning, and training process adequate to MC level and students' technical skills, as well as it provides discoveries in the practical-scientific field. An important fact to highlight, by subjective field observations, was the perception about the students' motivation during the intervention, who mentioned they liked the training and the questions for the promotion of the guided discovery that belonged to this model.

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