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Research Notes

# Biomechanics Olympic Games: did it improve learning or just the final grades in the past 9 years?

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**HIGHLIGHTS**
- BOG plays a role of teaching-learning facilitator in biomechanics.
- BOG activities increase the average scores in the classroom by ~7%.
- BOG reduces classroom grade variability by ~3%.
- BOG promotes a more homogeneous learning development of the classroom.

**ABBREVIATIONS**
BOG Biomechanics Olympic Games

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**BACKGROUND:** The Biomechanics Olympic Games (BOG) is a teaching method (see Carpes et al., Adv Physiol Educ. 2017;41(3):436-440) to facilitate biomechanics education. It has been conducted over the past 9 years and replicated in other universities, successfully reducing failing grades.
**AIM:** Therefore, a recurrent question is whether the BOG reduces failing grades by raising the physical education and physiotherapy students' final scores or favors improving education.
**METHOD:** To address this question, we considered retrospective data from two biomechanics courses for 9 years and analyzed their final grades considering or not including BOG scores in calculating final grades.
**RESULTS:** The score attributed to BOG did not determine the success rate because most class grades were enough to approve, regardless of BOG scores. In this sense, the BOG played the role of facilitator in the teaching-learning processes in biomechanics. We found that enrollment with BOG activities increased the average scores in the classroom by ~7% and reduced variability by ~3% compared to final grades without considering the BOG participation.
**CONCLUSION:** The BOG promotes biomechanics education, not by determining the classroom success rate but by promoting a more homogeneous learning development of the classroom.

**KEYWORDS**: Education | Teaching | Biomechanics | Kinesiology | Pedagogical

## INTRODUCTION

Biomechanics courses are part of the curriculum from different professions and have a special participation in those studying the human movement [1]. Due to its connections with physics and mathematics, students frequently report difficulties during biomechanics courses, often justified by a weak educational background before starting undergraduate studies [2]. Also, life science students' difficulties in managing calculations are a concern for biomechanics learning [3]. Learning difficulties are not exclusive to biomechanics contents and may also rely on the teaching methods. In areas like human physiology, many successful initiatives effectively improve the teaching and learning processes [4-6].

A common goal of these initiatives is to promote innovation in the classroom [7-11]. Innovation in the classroom can not be considered just by adding an activity different from the usual lectures, as the case of including interactive video testing does not improve students' performance [12]. A primary strategy to improve teaching and learning is

to review the way university lectures are delivered.

There is a large variability in the configuration of the classes in universities worldwide, but there are strategies that can be widely applied. The use of questionnaires using clicker quizzes during the course resulted in moderate improvement of learning among physiology students [13]. Other techniques involve including educational games in classroom [8], and team-based learning approaches [14] to dedicate more hours to the laboratory activities [7]. It can also be performed by including more class activities related to research [3], establishing a collaborative environment, and helping students learn how to manage large volumes of information [9]. In general, these initiatives promote classes more centered on the student being active in the process rather than just relying passively on receiving information from the teacher. The student's active involvement is a very effective way to support learning outcomes [11] and increase the interest in different types of activities [15], which goes beyond knowledge acquisition [14].

The motivation to write this article comes from our experience of nine years of teaching biomechanics in a public university from an economically developing country where biomechanics is part of the regular curriculum of physical education and physiotherapy students [16]. The higher percentage of students' failures to achieve the necessary grade to complete the course motivated a change of strategy in the classroom and the establishment of different ways to teach and assess student's progress over the academic semester [16]. When we started with this initiative, we were not aiming to publish papers about it. Therefore, our article has inherent limitations that we mention in the following sections. We were experiencing a high failure rate in the biomechanics courses, which motivated us to change how the course was conducted and how lectures were delivered. Nine years ago, the biomechanics course was remodeled. The teaching approach was changed to include those regular theoretical and laboratory classes and parallel activities, including but not limited to small teamwork, flipped classroom, activities for science popularization, and participation in academic events [16]. The students should develop these activities by working in small teams, exploring and interacting with other students, professionals, and the community external to the university. This group of activities and methods was called The Biomechanics Olympic Games (BOG) and was fully described in a previous publication four years after its establishment [16]. The methodology was shared, and some initial results were described to demonstrate that the BOG was helping to reduce the redo rate in the biomechanics courses and describe the possibility of applying the method to other classes [16]. After nine years of developing BOG activities as part of the biomechanics courses for physical education and physiotherapy students, a recurrent question regards the impact of the BOG on individual scores obtained by the students.

The BOG has the primary goal of helping reduce failure rates in the biomechanics courses but avoiding failures and reducing redo rates is not enough to ensure that the methodology improves teaching. It is crucial to identify if BOG is not serving to approve students that did not achieve the minimal learning requirements to move on their studies. Here we set out to answer this question. In this article, we report the result of a retrospective analysis of students' grades obtained in the biomechanics courses over nine years to identify the impact of the Biomechanics Olympic Games on the final scores obtained by physiotherapy and physical education students. We hypothesized that the BOG would contribute to learning, but its design and implementation would not determine

higher grades for the students enrolled.

## METHODS

### The Biomechanics course

The syllabus for the biomechanics course includes 45 hours of lectures distributed over 17 weeks with weekly theoretical classes (120 min) followed by a practical class (60 min) delivered to first-year physiotherapy students and second-year physical education students. Students complete four written exams and three laboratory assignments as part of the evaluation program. Over the nine years, a similar program was always considered including fundamental concepts of torque and stability, kinematics, and kinetics of human movement. Written exams compose 60% of the final grade, the laboratory assignments compose the other 20%, and the last 20% comes from the BOG activities. This paper reports data from 16 classes resulting in a sample of 500 students over the 9 years.

### The Biomechanics Olympic Games

The BOG methodology is fully described in a previous publication [16] and will be just briefly mentioned here. Figure 1 depicts the organization of the biomechanics course in which BOG is included, and the full description of the activities, which are all related to biomechanics topics, is available in the BOG paper from 2017 [16]. To promote gamification, the teams are called by self-selected names. An online live scoreboard shows the classification based on the points obtained with the activities during the course time. The BOG result is considered in the computation of the final individual score of the students together with the regular classes, lab activities, and written exams, and it will compose 20% of the individual final grade.

### Data collection

The institutional records of the individual scores from the last 9 years in which BOG was developed were used for data analysis without identification of students' names. In this institution, the student should achieve a final score equal to or higher than 6.00 out of 10.0 to be approved. Considering that BOG is an educational project approved by the local institution to be part of the Biomechanics course, there are no comparative biomechanics classes not developing BOG for a control comparison. Therefore, we considered the final grades obtained considering the BOG participation and estimated the scores excluding the BOG participation. In this case, we normalized the grades to the maximal score, excluding the 20% participation of BOG in the final grade. Ethical review and approval were not required for this report following the local legislation and institutional requirements.

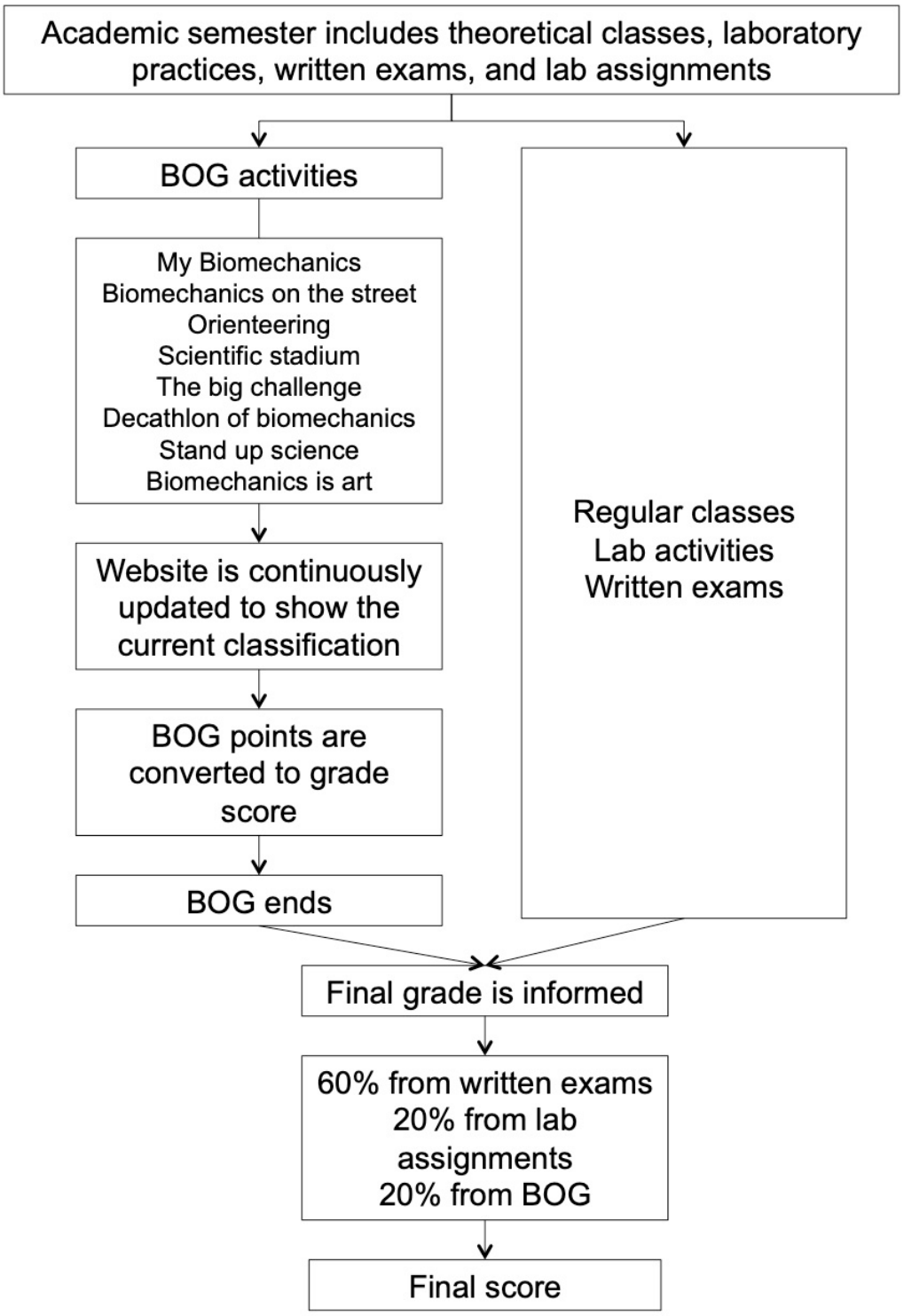


**Figure 1.** Schematic representation of the BOG methodology considered as part of a regular Biomechanics course.

### Statistical analysis

The Shapiro-Wilk test confirmed the normal distribution of the data. Scores are described as mean and standard deviation. We also quantified the data variability considering the coefficient of variation (standard deviation to mean ratio). The comparison of scores including or not BOG was performed with paired t-tests, and the intraclass correlation between scores including or not BOG was also determined. All statistical analyses considered a significant level set at 0.05.

## RESULTS

The average scores over the nine years of the BOG development did not differ ($p = 0.76$, Figure 2) when we compared the grades including (6.65 ± 0.62) or not the BOG scores (6.55 ± 0.84). Only for three classes (classes 5, 7, and 8, Figure 3) among the sixteen considered, the exclusion of BOG scores in the final grade resulted in a change of the student's condition from approved (final grade above 6.00) to reproved (final grade bellow 6), and in one class (class 3, Figure 3) BOG scores changed the condition from reproved to approved. For all the other cases, despite the BOG generating an increase in the final score (average increase of 7.74 ± 3.83%), it did not determine the approbation of the students. No difference was found between scores including or not BOG outcomes.

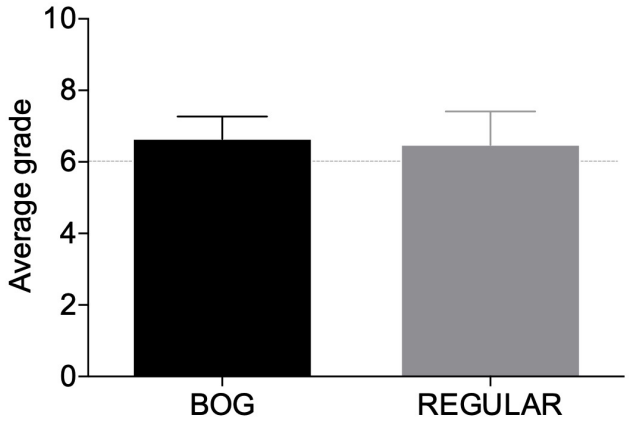


**Figure 2.** Mean and standard deviation of the final grades obtained for classes of 2011 to 2019 considering (BOG) or not (REGULAR) the inclusion of the BOG project scores in the final grade.

The relative difference between the scores for the final grade, including or not the BOG scores, was 7.74 ± 3.83 %, and the coefficient of variation in the classes over the years was slightly higher when BOG was not considered in the final grade (9.35 % for BOG and 12.90 % for regular score). Intraclass correlation between scores, including or not the BOG scores, was 0.70.

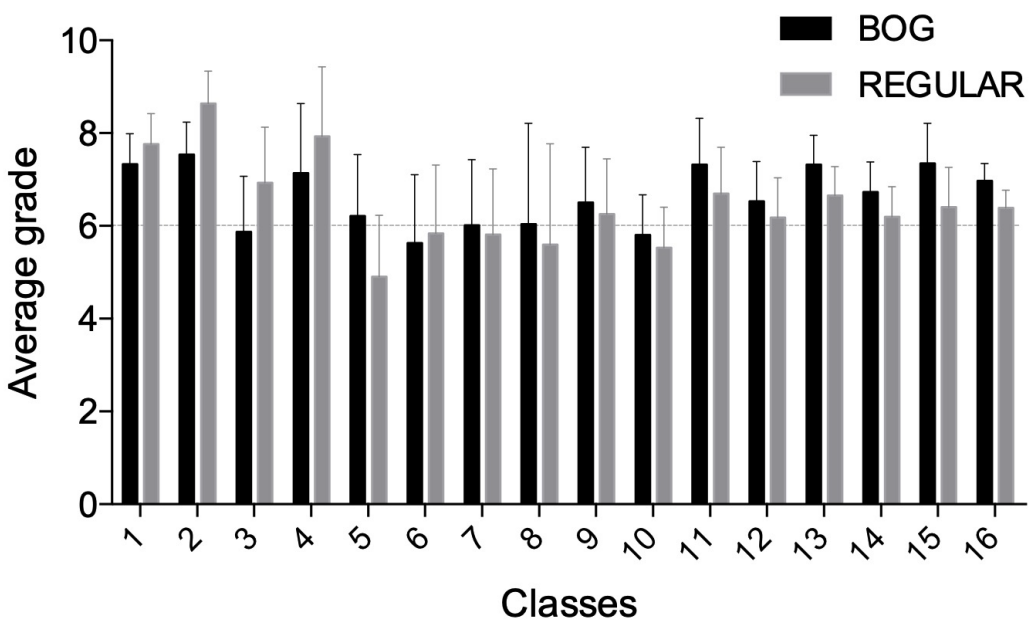


**Figure 3.** Average scores for final grades determined including BOG or not (REGULAR) in all classes.

It is difficult to capture the opinion of the students regarding the project because if the professor or teaching assistants ask them, there is a potential bias on how questions are presented and interpreted. Furthermore, we are reporting data from the past 9 years. Even though many resources are available to develop questionnaires to evaluate classroom instruction, our attention was not directed to this during the courses. To capture students' opinions, we required students to anonymously state, by the end of the academic semester, if they liked the activities and if they consider that other courses being conducted with similar methodology would generate more interest, especially for the extra-class studies. At the end of the course, all students affirmed they liked the BOG methodology and considered that courses with a higher load of theoretical classes and few laboratory activities could benefit from the BOG approach.

## DISCUSSION

Our nine-year follow-up showed that for the vast majority of the classes, our hypothesis was confirmed. BOG did not determine the approval of the students in the biomechanics course. Still, it helped students to achieve a higher final grade. Furthermore, the average scores in the classroom had lower variability when BOG was considered in the determination of final scores. There were slight fluctuations in the average scores over the years. It happened despite the BOG methodology. We hypothesize these fluctuations may depend on the students' characteristics regarding their interest in biomechanics.

The previous experience of the students with specific topics and concepts from science may influence their learning [17]. In the institution where we develop BOG activities, the biomechanics course is presented for first-year physiotherapy students and second-year physical education students. Most of them come from public high schools that can be a good indicator of higher access of lower-income students to the university [2] but also very heterogeneous regarding learning opportunities, leading to difficulties in topics related to

physics and mathematics as those included in biomechanics courses [19]. We do not know the influence of the BOG methodology if applied for courses happening later, in the third or last year of university, when students would have a larger background from the classes and the experiences provided by the university activities. Furthermore, as BOG is a regular activity, we unofficially heard that students going to start the biomechanics course often ask for information from former biomechanics students about the BOG. Although we did quantify its influence on BOG outcomes, it may help students better understand the activities' dynamics. It may help to explain the evolution of the grades in the more recent classes evaluated. It may suggest that it would be valuable to remodel all the activities for future courses.

BOG considers different activities to promote the students' involvement with the contents of the classes. An educational project cannot play a simple role in promoting grades. It has to have a goal, and as described before, BOG activities are based on science development, science popularization, and interaction of students with a broad range of topics and experiences always related to biomechanics [16]. As part of BOG activities, the undergraduate students are early introduced to scientific method concepts, which was previously suggested to accelerate learning [18]. The search for scientific support to the activities developed is continuously stimulated, for instance, when going out to the community to promote biomechanics awareness, the topics selected for the activity must have an evidence-based approach. The involvement of the students with the literature is essential to motivate them to foster technical knowledge and may result in better learning considering lifelong skills [11].

As we mentioned in the original paper describing the method, BOG started after we promoted a single innovative activity in a class. But adding one activity different from the traditional lecture may not be enough to enhance learning [12], and better results are found when strategies involve a combination of different types of activities [15]. Therefore, the BOG method considers at least 7 different activities over the academic semester.

The experience with the teaching project may also impact the development of the students in future courses. A past investigation suggested that learning complex topics, as biomechanics concepts, through strategies that promote student interest can also improve their general academic ability [19]. We consider that a teaching approach valuing science is important and includes activities related to research that benefit learning [3]. It facilitates the students to embrace a vision of applied sciences when developing professional activities guided by scientific research and spreading this way of thinking in the community.

Furthermore, BOG involves team-based activities. Proposing blended learning, including different strategies to be performed individually, may limit the benefits because some students cannot be sufficiently autonomous to perform the activities independently [15]. Therefore, BOG may also promote interactive and collaborative work, and it may have impacted the variability of the average classroom grades. It is important to mention that BOG activities are not centered on preparing for the written exams. Activities are planned to promote further interest in the topics despite their relevance to the exams and the degree of difficulty that studies may report considering the different topics covered by the course.

## CONCLUSION

The success rate in the classroom was not determined by the inclusion of the BOG scores in the final grades. Still, the enrollment with BOG activities improved by ~7% of the average scores in the classroom and reduced variability in the final grades by ~3%. We consider that BOG promotes the improvement of biomechanics learning. The score attributed to the BOG activities in the final grade was not a determinant for the classroom success rate.

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