Using the Olympic spirit to improve teaching and learning process: the biomechanics Olympic Games

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THE OLYMPIC GAMES started in Athens, on April 6, 1896, inspired by the ancient games held in Olympia (5). After many years, the Olympic Games remain as one of the biggest events in the world. The “Olympic spirit” regards unity among people and nations, mutual respect, and the determinant role of cooperation to achieve success toward a common goal. Some of these qualities are also important in the academic process.

Biomechanics is an academic course with important links to the Olympics. It helps in the understanding of how sports gestures are performed, along with its mechanical characteristics, body adaptations, design of equipment, determination of performance indicators, and strategies for injury prevention (10). Biomechanics courses address contents of physiology, anatomy, mathematics, and physics (7). It is common to observe that many students fail biomechanics due to difficulties in following the topics of the course. In this regard, the Olympic spirit could be used to motivate and increase student participation, promoting a more productive course and decreasing failure rate.

High failure rate was faced in our institution in the last few years, where biomechanics is part of the curriculum of Physical Therapy and Physical Education. These students take Biomechanics in their first year of undergraduate. The weak educational background is evident among students entering public universities in Brazil (1), and many of them are unable to follow the courses satisfactorily. As a result, the percentage of students who had to retake Biomechanics reached up to 65%. At that moment, we felt that some action was needed. The regular classes, including theoretical (120 min) and practical classes (60 min) plus laboratories, reports, and written exams (4 exams), were not enough to ensure students’ understanding or even to motivate them to go through the contents of the course.

Our first action trying to reduce the failure rate was to include a quiz game as part of evaluation process to motivate the students before the final exam (4). We observed positive effects of this activity on failure rate, which dropped from 65% to 45% in 2011. We then included student participation in research projects as part of the course, in an attempt to involve students in laboratory activities, which are known to contribute to the learning experience (3). However, student enrollment in laboratory activities was weak. Our next step, the most successful to the date, was to incorporate some ideals from the Olympic Games, which at that time (2012) were happening in London, to the Biomechanics course. The project was named “Biomechanics Olympic Games” (BOG). BOG was approved by the institutional education board (Institutional Review Board no. 1002316) and established as part of the course content in 2013, representing up to 20% of the students’ final grade. BOG was designed to motivate collaborative work, to increase interest in course topics, and reduce failure rate. Previous research showed that using teaching approaches that focus on collaboration can facilitate students to efficiently receive large amounts of information, which is helpful for completing learning tasks (9).

The main purpose of this paper is to describe the Biomechanics Olympic Games and to share with the readers our methods, main results, and experience after inserting this educational project as part of the regular undergraduate Biomechanics course. Our article describes how the BOG had been developed in the previous 4 yr.

METHODS

Synopsis

On the first day of the semester, the professor and teacher assistants (Masters and PhD students) proposed the activities that composed the BOG. Students were free to join the project; otherwise they take the course and complete the regular written assignments, laboratory practices, and reports. The BOG is developed throughout the whole academic semester (17 wk), and students have to complete the seven tasks. Four tasks were developed in class, and the other three as homework. Students worked in teams, and follow BOG updates online (website in Portuguese: https://sites.google.com/site/olimpiadadebiomecanicagnap). At the end of the semester, points obtained in BOG composed up to 20% of their final grade. The other 80% were completed by the combination of three written exams and an individual research proposal (60%) and three research-driven experiments performed in the laboratory and presented orally in class (20%). The BOG activities performed by each team were shared with other teams in a dedicated Facebook community (https://www.facebook.com/groups/alunosfelipecarpes), which is also a good strategy to increase the interest of undergraduate students (2).
Participants

BOG has happened every semester since 2013, and this report considers the participation of first-year students of Physiotherapy enrolled in the Biomechanics course. Each course included 25–35 students, from both sexes, and a total of 45 h, distributed in two theoretical classes and one laboratory practice per week.

BOG Activities

Opening Ceremony. This activity happens in class, and it takes just a few minutes; it is the day in which the game starts. In this activity, the professor presented the structure of the Biomechanics course, such as the topics addressed every week, the regular activities that will compose the final grade, and the BOG project. Each BOG activity is detailed, including the criteria for evaluation, the online availability of all of the information in the BOG website, and some examples of activities that may serve as reference for teamwork organization. After the initial introduction, the professor delivers a lecture on the history of biomechanics and the interaction of biomechanics with other fields of knowledge, such as physiology, anatomy, physics, and mathematics. After this first meeting, students spend the first week of the course setting up teams and choosing a team name, which is expected to be related to biomechanics and/or science. Most common team names are “Newton,” “Galileo,” “Eureka,” and “Enoka,” which is understandable because, in the first class, the professor shows a time lapse of the history of biomechanics, including names of past and present scientists. Each self-selected team has five to six students. In general, each BOG edition includes seven activities performed according to specific deadlines and guidelines. The most common activities developed in the previous BOG editions are described in Fig. 1, which shows the flowchart of the BOG along the academic semester.

BOG activities successful completed by the end of the semester are computed in a ranking. This ranking has different grades, from 0.25 to 2.0 points, that will be added to their final grade, ranging from 0 to 10, and those students achieving final grade 6.0 or higher are approved. Table 1 shows the point conversion system into a score to be added to the final grade of each student.

My Biomechanics. You may remember how the Olympic Games start. BOG wants to promote something similar. Up until the third class in the semester, BOG teams will perform an in-class presentation and answer the question, “Where can I see biomechanics in my future professional activity?” They will answer this question to the whole class during a 10-min activity. The main purpose of this activity is to motivate the students to look for additional details of the course content, to talk to senior students in the faculty, and to talk with professionals in the community. The only rule for this activity is presentation time. It became common in the last editions for students to bring online content from websites like YouTube and social media (Facebook, Twitter) for discussion, different from past presentations, when most of teams presented slides, including concepts from books. All teams that completed the task could achieve up to 100 points; this is the first moment they receive a reward for joining the game. Points will depend on their performance and may differ between the teams based on the judgment made by the professor and based on specific criteria that are previously explained to the classroom and made available on the BOG website.

Biomechanics on the Streets. Inspired by the Olympic Marathon activities, this out-of-class activity, students will run across the campus, promoting activities for popularization of biomechanics. They can perform this task during the whole academic semester, each time considering a different topic. Most common activities include talks in schools (topics related to the posture, backpack weight, and general healthcare); biomechanics concepts (i.e., resultant forces, impact, torque, balance) during physical education classes in schools (mostly with kids); visits to gyms, hospitals, and rehabilitation clinics; science communication on the streets; and activities with older adults. To avoid misunderstandings when communicating science in the community, the professor must first approve the proposed activity. In some cases, a senior student member of the Neuromechanics laboratory will support the team during the activity. Teams can achieve up to 200 points, depending on the proposal of activity and the number of people attending the activity. The grade rubric involves the number of team members who were present during the development of the activity, a proper justification of the population selected to participate and the topic that will be presented, the number of people participating in the activity, the presence or not of time for questions from the public, and the general quality of the promotional material. The activity that involved the highest number of participants receives an additional 50 points. This activity can be performed as many times as the students want throughout the semester.

Orienteering Challenge. Olympic village is often in the news during the Olympic Games, with nice landscapes and athletes walking around. We bring this spirit to our BOG during the Orienteering Challenge, which is performed as an out-of-class activity. Teams have to follow some clues, strictly prepared as biomechanics charades that are hidden in different places across the university campus, to find seven envelopes with questions that must be solved as quickly as possible. An example of a charade is to use the Pythagoras Theorem to identify the location of one envelope in the campus, or calculating average walking speed to get to the place where the charade is. They will find envelopes in these hidden places, and each envelope will have a biomechanics question to be solved and the next charade indicating the next location. The time spent to find the seven envelopes and the number of questions correctly answered is used to calculate the final score. The fastest team completing the task receives
150 points, and the additional teams that complete the task receive 50 points each. This activity is performed once in the semester. The time that will take to complete the Orienteering Challenge may vary according to the duration of the class, the size of the campus, and weather conditions. In our case, the fastest team usually completes the challenge in 12–15 min; the last team to complete usually does not take more than 20 min. Accommodations should be made for students who require special attention, such as for students with reduced mobility (e.g., wheelchair users).

Scientific Stadium. Olympic athletes deal with big stadiums and observation of fans and opponents. In this task, students are motivated to enter scientific stadiums, which are scientific congresses happening out of class. As the Olympic athletes, they will watch the performance of colleagues, but they also will perform themselves. To perform this task, students have to participate in academic congresses during the semester, either on campus or off campus. Each certificate of participation will be awarded with 20 points. Additional points will be awarded if, besides the participation, they perform an oral (60 points) or poster presentation (40 points), regardless of the topic of their presentation. This activity is performed during the whole semester and the main purpose is to motivate students to participate in scientific events promoted by our university or by other institutions.

The Big Challenge. Many Olympic sports require fast thinking and team strategies that will determine the winner. During The Big Challenge task, BOG teams are exposed to a number of questions that need to be answered in a short time (up to 1 min). This activity is performed in class, once per semester. Questions will come randomly in a multimedia presentation and consider different topics of the course. Each question has multiple choices, and the students should register the answer they judge to be correct. When they judge that the question is difficult to answer, they are allowed to request “help,” which allows them to check their material (e.g., books, articles, notes). Three “help” requests are allowed for each team. The game is played in the classroom, right before one of the written exams scheduled for the semester. The team with more correct answers receives the highest score. The higher score is 100 points, and then successively 80, 60, 40, and 20 points for the remaining teams. Afterwards, the professor recalls each question, shows the correct answer, and addresses any further questions that students may have.

Decathlon of Biomechanics. Similar to the Olympic decathlon, this task challenges the teams to complete 10 different activities in a circuit combining physical exercises and cognitive tasks. This activity is performed out of class at the university campus, once per semester. The circuit varies every edition, but, in general, it involves running sprints, jumping, hurdles, shadow boxing, soccer kicks, basketball shots and handball throws, abdominal workouts, jump rope workouts, shuttle run practice, and stair climbing. The time to complete the circuit is recorded, and, in the interval between exercises, the teams have to solve biomechanics questions that are placed in specific locations at the gymnasium. The teams completing the circuit faster will achieve more points. For each biomechanics question answered wrong, an additional 10 s are computed to the total time required to complete the circuit. The higher score is 100 points, and then successively 80, 60, 40, and 20 points for the remaining team.

Stand-up Science. Olympics Games are a high-level competition, which depends on state-of-the-art scientific advancements. In this task, teams are required to select scientific papers that address topics discussed in the classroom. They are oriented about the importance of the impact factor index, the processes of scientific publications, and the strategies to research for scientific papers. Students will select a paper within a topic of their interest, read it, and prepare an oral presentation during an out-of-class meeting with the professor. The presentation is performed in the laboratory (on a day and time scheduled previously) for an audience that includes not only the professor, but also graduate students from the laboratory and any other colleague from the class that wants to join the presentation. Presentation lasts up to 10 min, followed by 20 min of comments and questions from the audience. This activity aims to help students to select evidences from the literature and introduces them to more complex topics, such as data analysis, statistics, and scientific writing. Teams can score up to 100 points, which are attributed according to the quality of the paper, relevance of the topic addressed, posture during the presentation, ability to answer questions about the paper content, and ability to discuss concepts already discussed in the classroom. Students in general have many questions concerning data processing and statistics, which are fully explained and solved by the professor without affecting their score. This activity can be performed as many times as the students want during the semester.

Biomechanics Is Art. Art is part of the Olympic Games, since it started in Greece, an artistic epicenter of ancient civilizations. The biomechanics-is-art task does not have any specific orientation or rule to be followed: teams just have to present their artistic contribution. Teams will conceptualize and perform an artistic manifestation that explains concepts of biomechanics in an out-of-class activity. In the past editions, many different manifestations were developed: popular songs were adapted with lyrics talking about biomechanics, theater presentations, poems, video clips, handicrafts, and use of recyclable materials and art in iron and argil. In general, the concepts more often represented are as follows: force, balance, running, walking, athletics, and biomechanics instruments, such as a zoopraxiscope. The aim of this task is to challenge the teams to reflect about biomechanics concepts and to think about different ways to present the knowledge, especially when exposed to people who are not necessarily academics. This activity is performed once per semester, and teams can score 100 points. The arts produced are kept in the laboratory as a reference for future students taking the Biomechanics course.

### Table 1. Points achieved in BOG and the respective score in the final grade

<table>
<thead>
<tr>
<th>BOG Points Achieved</th>
<th>Score Added to the Final Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥700</td>
<td>2.00</td>
</tr>
<tr>
<td>601–700</td>
<td>1.75</td>
</tr>
<tr>
<td>501–600</td>
<td>1.50</td>
</tr>
<tr>
<td>401–500</td>
<td>1.25</td>
</tr>
<tr>
<td>301–400</td>
<td>1.00</td>
</tr>
<tr>
<td>201–300</td>
<td>0.75</td>
</tr>
<tr>
<td>151–200</td>
<td>0.50</td>
</tr>
<tr>
<td>100–149</td>
<td>0.25</td>
</tr>
</tbody>
</table>

RESULTS

Regarding the last 4 yr of the BOG project, our more important quantitative result is the change in course repeat percentage (Fig. 2). In the last edition, repeat percentage was around 8%, which was one of the best results we achieved. For each semester BOG includes from 25 to 40 students, depending on the number of students attending the Biomechanics course. All students opted for participating in the activities proposed as part of the BOG project. We understand that repeat rate can limit the analysis of BOG effectiveness in the teaching-learning process. However, we consider it important to mention these results, because the topics of the course did not change in the years of BOG development and the professor tried to develop the topics with similar approach along the years.

Regarding how much the BOG helps students’ grades, the highest average points obtained by a team during the semester of activities was 1,200, but the average points usually ranges from 400 (most of the teams) to 800 points (the team achieving the highest score in the semester).
Students enjoy activities such as visits to the community. In the beginning, they may be afraid of talking to other people. However, after the first experience, most of the teams want to repeat the task (Biomechanics on the Streets). Not many teams complete the task Stand-up Science. This is considered by the professor to be one of the main tasks because it helps to teach students research-related topics that will be important during the development of their undergraduate degree. These topics include research hypothesis, literature review, statistics, and data interpretation. These types of activities can accelerate the transition of novice-to-expert development in education (8). As a strategy to increase participation in this task, the professor regularly addresses the importance of scientific reading during the classes.

BOG currently accounts for 20% of the student’s final grade. This percentage was arbitrarily determined. Increasing the participation of BOG in the final grade would give a higher attention to the project, but, at this point, it could be a limitation, because a higher percentage would require more time dedicated by the professor and teacher assistants to follow the tasks. Finally, one could argue that BOG may determine whether the students will achieve the grade to be approved, and, therefore, as part of a team activity, students could be approved without achieving the individual standards necessary. We performed an analysis of the grades in the past 4 yr (eight editions) of BOG to determine whether BOG is contributing to approve students who otherwise would not be able to reach the minimal necessary grade. We found that BOG is not the only determinant of course passing. We observed that, as long as the students start to develop BOG activities, the scores in regular tests (written texts, experiments, and research projects describe earlier) progressively increase during the course of the semester. This suggests that BOG may help students also to progress during the entire course by promoting more engagement with the topics of study.

Finally, a limitation in the discussion of BOG influences on teaching and learning is the lack of a “control group,” which would be a class of students not participating in the BOG project, attending only the regular classes and evaluation procedures. However, we will keep this limitation, as we would not have clear criteria to establish which specific class would not join the BOG project. Classes from 2011 and 2012 can be considered as a control condition, because in those years BOG activities were not conducted (only the quiz and the extra class laboratory tasks described early).

Finally, BOG development does not mean much “extra” work for the students. Extra work could be considered only for the tasks Biomechanics on the Streets, Scientific Stadium, and Stand-up Science, because all of the other activities are developed in class. Students complete three exams as part of the regular course, and, for each of these days, a task was performed, because the test usually takes 60–90 min, while the whole class period is 120 min. Therefore, BOG also promotes a better use of class time in those days dedicated to exams.

Conclusion

The inclusion of innovative strategies to improve the teaching and learning processes in the academic environment is welcome by the students, since they are previously informed and can participate during the conception and development of
the project. In our case, BOG has been successful because it helped to drop the course repeat ratio and promoted higher engagement with activities related to the content of the course. Furthermore, BOG contributes to the dissemination of scientific knowledge inside and outside the university and increased the expectations of the students before starting the Biomechanics course.

Further steps in BOG development includes the addition of new tasks based on feedback from the students regarding the tasks already developed. It could be of interest to include more tasks related to scientific experimentation, which can be difficult due to cost and difficulties of the students to attend laboratory session during extra hours.

DISCLOSURES

No conflicts of interest, financial or otherwise, are declared by the author(s).

AUTHOR CONTRIBUTIONS


REFERENCES