The 2-hour marathon: what do students think?

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Overview

This educational activity is designed to enhance teaching and learning of physiology by connecting the limits of human physiology to one of the most coveted barriers in athletic performance: the 2-h marathon. Moreover, investigation into the possibility of achieving this athletic feat promotes critical thinking and an understanding of how science works.

2-h Marathon

For over 100 yr, athletes, coaches, and scientists have endeavored to improve running performance. For example, former Olympian and academic physician, Sir Roger Bannister, broke the 4-min barrier in the mile, while at the same time publishing a series of experiments in the Journal of Physiology (2–5) investigating the limits to athletic performance. Bannister would later write (1) that “Athletic performance depends upon the understanding of the physiological limiting factors when man runs at different speeds.” One of today’s running barriers is the 2-h marathon. The current official men’s marathon world record is 2:02:57 (Berlin Marathon; Berlin, Germany, 2014), requiring a 2.4% improvement to achieve the first sub-2-h marathon. Joyner (16) originally modeled marathon running performance using maximal oxygen consumption (V\text{O}_{2}\text{max}), lactate threshold, and running economy that might influence marathon performance. After completing this discussion, students were challenged to develop their own commentary focused on the follow-up commentary (22). At the end of class, students met outside of class with their colleagues’ viewpoint (18) to read before an in-class discussion (day 1), students met in small groups and were instructed to identify additional factors beyond V\text{O}_{2}\text{max}, lactate threshold, and running economy that might influence marathon performance. After completing this discussion and sharing ideas through a guided report-out, all students were provided the extensive commentaries (22) that were published in response to the viewpoint from Joyner and colleagues (18). Student predictions were validated as they found that several factors that they had tentatively identified (e.g., age, genetics, geographical location, etc.) were indeed raised in the follow-up commentary (22). 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groups to develop a short (~2–3 min) presentation focused on their “additional” marathon factor to present before their classmates. At the conclusion of the group presentations (day 2), all students were asked to select the top three group presentations (excluding their own). The top three groups were provided extra credit and an opportunity to present their ideas to world-renowned marathon expert and original author (16, 18), Dr. Michael Joyner, through a scheduled Skype video conference. During the video conference presentations (day 3), Dr. Joyner prompted the student presenters with questions and afterwards fielded questions from the presenters as well as the rest of the class.

Graduate course. Lecture content describing the determinants of endurance performance (\(V_{\text{O}_2\text{max}}\), lactate threshold, economy/efficiency) was off-loaded to video lectures to provide more class time for an extended project. Similar to the process described for undergraduate students, graduate students reviewed Joyner’s work (16, 18), along with the follow-up commentary (22). Additionally, students discussed several review papers covering endurance exercise performance (17), running economy (6), and elite endurance athlete training (20). They also explored books, websites, and popular press articles surrounding the recent sub-2-h marathon initiatives. Using this information, they worked together to identify the optimal runner physiology needed for the sub-2-h marathon. To appreciate the importance of running economy (oxygen cost required to run at a given speed, units of \(\text{ml} \text{O}_2 \cdot \text{kg}^{-1} \cdot \text{km}^{-1}\)), students carried out an experiment to measure oxygen consumption during treadmill running, determined their own running economy, and compared their values to the literature (6, 15). Students also worked together to prepare a conference presentation (oral and poster format) highlighting their predictions and presented their poster at a department research seminar. During the seminar, students received feedback from other undergraduate and graduate students and faculty in the Departments of Kinesiology and Integrative Physiology, Biological Sciences, and Physical Therapy. Some of the concepts presented included a theoretical runner who could run a sub-2-h marathon, importance of the 80–80–180 rule (i.e., \(V_{\text{O}_2\text{max}}\) of 80 ml·kg\(^{-1}\)·min\(^{-1}\), lactate threshold of 80% of \(V_{\text{O}_2\text{max}}\), running economy of 180 ml·kg\(^{-1}\)·km\(^{-1}\)), effects of drafting, alterations in running economy with training, and psychological considerations (Fig. 2). Based on feedback received at the seminar, students modified their presentations and sent an electronic copy (i.e., PowerPoint poster with audio voiceover) to Dr. Joyner for review. Students then participated in a 1-h discussion and answer session with Dr. Joyner through Skype and learned more about the physiology and history of running. Graduate student predictions were also validated, as they found that several points that they had identified were raised in the follow-up commentary, recent publications, popular press, and by Dr. Joyner.

Assessment. For undergraduate students, a short quiz was administered before and after the activity to check their understanding of exercise physiology and marathon performance-related concepts. For graduate students, a survey was administered after the activity to obtain their perceptions about the activity and perceived learning. Based on the results of the pre-post activity quiz, undergraduate students improved their understanding of exercise physiology and marathon performance. Similarly, graduate students reported that they enjoyed...
the activity, and that it enhanced their learning of exercise physiology. Furthermore, all of the graduate students recommended that the activity be performed again. Taken together, these results demonstrate that the 2-h marathon activity offered an authentic academic experience that facilitated learning.

**Future Directions**

Now that the 2-h marathon is within striking distance (2:00:25), the activity could be adapted by having students identify specific strategies (12) to shave off the remaining 25 s (~1 s/mile, 0.3% improvement). A discussion about limitations to female marathon performance would also be timely (8, 13, 14) and facilitate investigation into sex differences in athlete performance. Finally, comparison of how human marathon runners measure up to other animals suited for long distance running/walking (e.g., horse, sled dog) would prompt an even broader discussion of animal physiology and performance (21).

**Summary**

For this activity, undergraduate and graduate exercise physiology students explored what it would take to achieve the first sub-2-h marathon for men. Specifically, students reviewed the literature, made predictions, conducted experiments, and analyzed data. They also communicated their findings to peers, faculty, and a world-renowned expert in the field. The 2-h marathon activity was well received by students and enhanced their learning of exercise physiology. The activity may be useful for educators who teach physiology and could be adapted to emphasize additional concepts. Finally, we envision that, by engaging and challenging our students to participate in the 2-h marathon discussion, they will be able to help us continue to search for the answers needed to push the limits of human performance further.

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**DISCLOSURES**

No conflicts of interest, financial or otherwise, are declared by the authors.

**AUTHOR CONTRIBUTIONS**


**REFERENCES**


