Biomechanical Analysis in Rowing: Determining Pace with Autocorrelation

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Abstract. STEM approach encourages interdisciplinary thinking while also emphasizing connections between the fields of science, technology, engineering, art, mathematics and sport. Biomechanical analysis in rowing examines athletes' movements, muscle activity, movement of joints and energy transfer in detail, providing key insights to optimize their performance. In this study, we performed a biomechanical analysis of rowing using Phyphox for data collection and Python on Google Colab for processing. By analyzing tempo and performance with various paddles, we determined how paddle type affects rowing boat speed. The findings offer insights into optimizing rowing performance through data-driven analysis.

Introduction

STEM (Science, Technology, Engineering, Mathematics) studies is an educational approach that aims to provide students with versatile skills. This approach encourages interdisciplinary thinking while also emphasizing connections between the fields of science, technology, engineering, art and mathematics [1]. Sports activities can also be seen as an important component in STEM studies because sports activities require the application of STEM disciplines accompanied by scientific principles. For example, subjects related to science such as the effects of physical activity, biomechanics and physiology are included in sports. Students can gain skills in this field by understanding and applying STEM disciplines, from sports equipment to material selection, aerodynamic properties, and durability. Biomechanics is a branch of science that examines the basic principles of sports and the movement mechanisms of the body Biomechanical analysis in rowing examines athletes' movements, muscle activity, movement of joints and energy transfer in detail, providing key insights to optimize their performance [2].
Phyphox is an application developed by Aachen University that allows teachers and students to conduct physics experiments using sensors on smartphones [3]. Phyphox, a free application, makes physics experiments more accessible and is one of the tools that students can easily use and collect data in any environment they want [4].

Method

High school students who both rowed and improved their physics and programming skills carried out this study. We think that such activities are especially important as they will give students different perspectives and improve their STEM skills. In this study, we focused on the athlete's tempo to determine the rowing athlete's performance by using a new method. Students attached one mobile phone to the boat and thus obtained the acceleration time graph simultaneously via the Phyphox application. To determine the athlete's performance in rowing through biomechanical analysis, stroke period calculations were made for three different paddles based on acceleration-time graphs. The data collected with the Phyphox application was transferred to Excel. Since the data for 20 strokes were collected, the necessary calculations were made with Python programming via Colab to calculate the average acceleration of a stroke. Autocorrelation was examined to determine the athlete's tempo. After determining the tempo during the period, we obtained the average acceleration-time graphs by averaging the athlete over many periods. They repeated the same data collection process for three different paddles.

Findings

As seen in Figure 1, when the Aluminum paddle is used, the maximum acceleration is 1.5 m/s², when the aluminum macon paddle is used, the maximum acceleration is 1 m/s², and when the carbon Fiber paddle is used, the maximum acceleration is close to 2 m/s². These values show us the importance of material quality in shovels. Based on this evaluation, the best quality shovel can be determined.

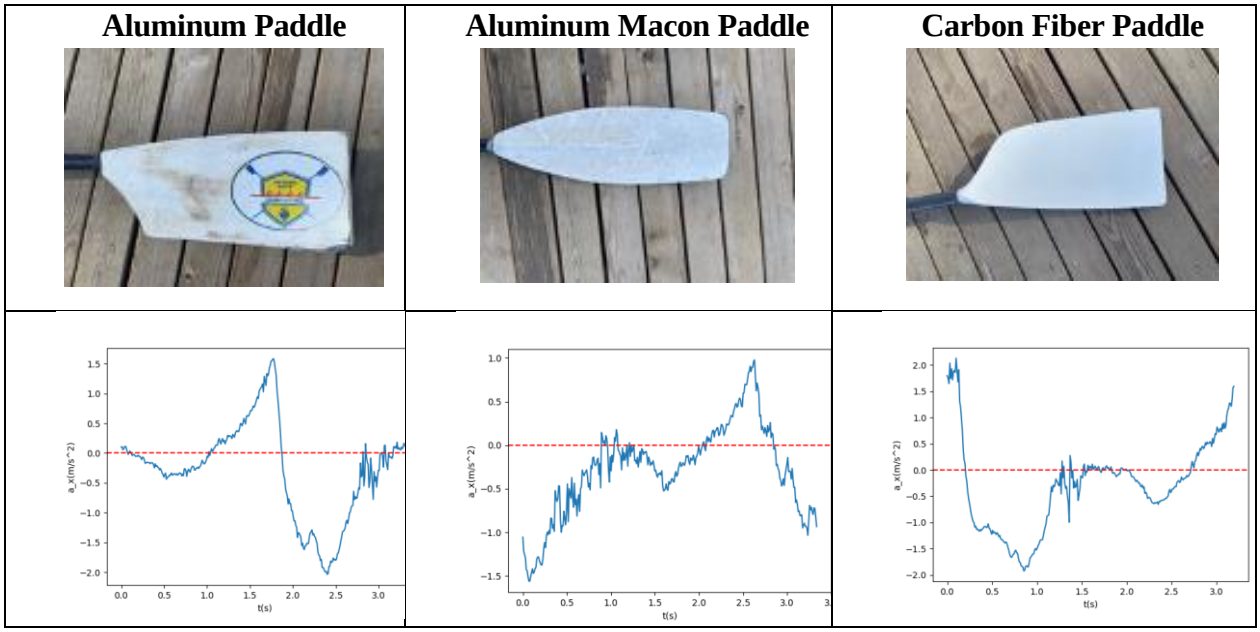

Fig. 1. Average Acceleration-Time Graph Taken with Related Paddles

(Other findings will be shared in the presentation)

Results and Discussion

In this study, the athlete's tempo was determined to determine the performance of a rowing athlete. The athlete's tempo was obtained through data processing from the data (acceleration-time graphs) collected via the mobile phone application using three different paddles. After determining the tempo over the period, we obtained the athlete's average acceleration-time graphs by averaging over many periods. We repeated these graphs with three different types of paddles: upstream and downstream. When we compared the tempos, we observed that the carbon fiber paddle had the shortest time, while the aluminum macon paddle had the longest time. When we compared the average acceleration time graphs, we determined that the highest acceleration value was in the carbon fiber paddle. Based on this, we can say that the choice or quality of material can affect the performance of rowing athletes.

References

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