Trampoline bouncing – the experience of the body meets mathematics, visual observations, electronic data collection and analysis.

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Abstract. Trampolines are found in gardens, large playgrounds, sports grounds, as well as in the summer olympics. In earlier work we presented the mathematical analysis, as well as a comparison between theoretical results and electronic data. In later work, the 2012 olympic gold medal series of jumps by Rosannagh McLennan was used for student assignments, that were found to be challenging, exhibiting many well-known difficulties in relating displacement, velocity and acceleration. To get a better understanding of how students can overcome these difficulties, group discussions of this problem among groups of first-year university physics students were video-recorded and analysed, with respect to the use of various semiotic resources. In addition, we analysed how groups of first-year university physics students explain force and motion, when asked to create a short movie of themselves bouncing.

The motion on a trampoline can be described by a combination of free fall and harmonic motion: While in the air, the trampolinist is only affected by the force of gravity, and during the contact time the trampolinist also experiences an upward force from the trampoline bed. The stronger the push from the trampoline, the larger the acceleration and the higher the jump. In earlier work [1, 2], the motion on a trampoline was analysed in detail, showing the relation between the maximum force on the rider and the ratio between 'flight time' and contact time. The mathematical description was found to be in good agreement with measurement.

In this paper, we present an investigation that includes an assignment based on Rosannagh MacLennan's gold medal trampoline routine from the London olympics in 2012. She used 19 s (as extracted from the video [3]) to complete the routine of 10 jumps. The score board shows that 16 of these seconds were 'flight time'. Several groups of students were video-recorded as they worked to discern the different types of motion involved. They were asked to draw approximate graphs of elevation, velocity and acceleration during two full jumps of the routine (with the approximation that all jumps are similar). To support their discussions, an empty graph with suitable axes was provided. An analysis of these discussions will be presented.

In earlier work, individual student responses to a similar exam question were presented [4], we found that students rarely made use of earlier kinaesthetic experiences of trampoline bouncing. To encourage that connection, another cohort first-year university physics students were asked to work in small groups to create short movies of themselves bouncing and also explain the forces involved during the motion, as well as draw graphs of elevation, velocity and acceleration during the jumps. They were also invited to use their smartphones for data collection [5,6]. All these video-recordings were being analysed using a naturalistic methodology for extraction of students understanding and conception concering disciplinary knowledge, kinaesthetic experience and (pre-/alternative-) conceptions in relation to these.

Data analysis is ongoing and preliminary results suggest that many of the students have difficulties connecting the kinaesthetic experience with the physical description and mathematical analysis of the motion. These preliminary results indicate that traditional physics teaching often fail to establish the connection between kinaesthetic experiences and the disciplinary knowledge. Exercises that include embodied experiences seem to be an underused opportunity in secondary and university physics teaching.

References

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