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Short communication

Can research align with service? Lessons learned from the Big Experiment and National Biomechanics Day

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ABSTRACT

Public engagement is an important role for the university academic, but is often neglected due to perceived lack of time and prioritized commitments in research and teaching. Yet, public engagement events offer an untapped opportunity for researchers to collect data from members of the general public who arrive on site at university labs. These engagement events could allow for data collection as part of didactic and demonstrative outreach events to be used in research and science. In this proof of concept study, a collaborative group of international researchers investigated the feasibility of embedding research quality assessment into events surrounding National Biomechanics Day. The Big Experiment collected data on 501 secondary school students (age range: 13 to 18 years) across 9 university sites within a 24-hour period. Data included maximal vertical jump height and self-reported physical activity levels. Vertical jump height was positively correlated to participant height, but not age or body mass. Very physically active students had significantly higher vertical jump heights than individuals who reported being somewhat or not physically active. This feasibility project demonstrates that with substantial preparation and a simple research design, focused research questions can be incorporated into educational outreach initiatives and ultimately provide a rich data source.

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1. Introduction

A main barrier to public engagement is a perceived lack of time, and the low priority of public engagement when compared to teaching and research responsibilities (Ecklund et al., 2012). Despite these perceptions, research has shown that academics who are involved in public engagement have a higher bibliographic index than non-engaged colleagues (Jensen et al., 2008). Devonshire and Hathway (2014) proposed a model for scientific engagement that provided more efficient and effective ways to incorporate teaching and research into this service component. One of the approaches suggested that researchers incorporate experimental science into classroom-based activities, so that

engagement also includes research quality outcomes that can better serve the academic community.

National Biomechanics Day seeks to expand awareness of biomechanics among youth through coordinated worldwide events (DeVita, 2018). As part of National Biomechanics Day, nine university sites in New Zealand and the United States collaborated to develop The Big Experiment (TBE). Using a similar approach to engagement proposed by Devonshire and Hathway (2014), the collaborators sought to understand the feasibility of incorporating a multi-site testing protocol within an established outreach program. TBE focused on outcome measures of physical activity levels and physical fitness; specifically, the use of questionnaires and a counter-movement jump provided simple parameters for assessing physical fitness and function. The project had a two-fold purpose: (1) to gather research quality data across multiple sites to increase sample size and more robustly answer research questions, and (2) to engage students in science through practical experience.

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2. Methods

2.1. Participant recruitment

Six university laboratories in New Zealand and three in the United States participated in TBE, as a component of National Biomechanics Day. National Biomechanics Day was promoted primarily through social media platforms and word-of-mouth. Secondary (high) schools that registered for the day were invited to take part in TBE activities. Participating schools received information sheets and consent forms prior to the event. Students were required to be free of injury at the time of National Biomechanics Day. All students provided informed written consent, and informed parental consent was ascertained where it was age appropriate. Experimental procedures conformed with the *Declaration of Helsinki* and were approved by the ethics committees and institutional review boards of all participating New Zealand and US universities, respectively.

2.2. Standardization of experimental protocol

Equipment setup and jump protocols were standardized across sites via video-based instructions, web conferencing, and practice trials to ensure quality assurance. Within a cross-sectional study design, each participant (i.e., student) attended a single session. Upon arrival, participants were allocated a unique identification wristband to anonymize data while allowing participants to identify their individual results. Stature, mass, and counter-movement jump (CMJ) performance were recorded as per standardized protocols, and physical activity levels and sport participation rates were surveyed (see Supplemental Data).

Supplementary data associated with this article can be found, in the online version, at <https://doi.org/10.1016/j.jbiomech.2019.03.006>.

IMeasureU Blue Thunder inertial measurement units (IMU) (IMeasureU-Vicon Ltd, Oxford, UK), which sampled at 100 Hz, were mounted firmly into the external pocket of a rigid support belt (Fig. 1; Pro-tec Athletics, Redmond, WA) or using double sided tape directly to the skin. Independent of the attachment method, the IMU sensor was affixed to participants at the level of the L5 vertebrae. The IMU was aligned such that the positive direction

of the y axis was orientated superiorly, and the positive z axis orientated posteriorly.

CMJ is a simple measure of lower extremity physical performance, which can be used in large-scale testing. While CMJs are commonly measured using force plates or jump mat technology, IMUs have been shown to provide valid measurements of jump height (Picerno et al., 2011). The standardized CMJ protocol involved participants standing with feet shoulder-width apart and hands firmly on their hips. Participants were instructed to bend their knees and immediately jump as high as possible, landing in the same spot (Fig. 2). Each participant completed three jumps on the command of the tester; four seconds separated each jump. Raw IMU data were transmitted in real-time to an iPad tablet (Apple Inc. CA, USA) and captured via a proprietary application (IMUReady, IMeasureU-Vicon Ltd, Oxford, UK). Individual data files were then coded with participants' unique identifiers, and uploaded to a Google Drive online repository (Google, CA, USA).

2.3. Data processing

Vertical jump height was calculated automatically within the online repository using customized Matlab code (Mathworks, Natick, MA). Each participant's three jumps were detected where the vertical acceleration exceeded a 3 m/s^2 threshold and ended when 100 consecutive data points dropped below the 3 m/s^2 threshold. Peak vertical jump height was calculated using a modified version of the Picerno et al. (2011) using linear and rotational acceleration to track vertical position of the body's center of mass (see Supplemental Data). After calculating the three jump heights for each participant, data were written to a master data file including their identification code, collection site, and age.

To fully engage students in the scientific process, a real-time graphical representation of results was created. A customized continuously running code using Matlab and Plotly (Plotly, Montreal, Canada) provided a graphical representation of the multisite vertical jump height data hosted on the Virginia Tech Granata Lab website (Fig. 3). This online graphic displayed vertical jump height (Y-axis) plotted against age (X-axis). The data points were color-coded by collection site and presented the unique identifier via a mouse roll-over function.

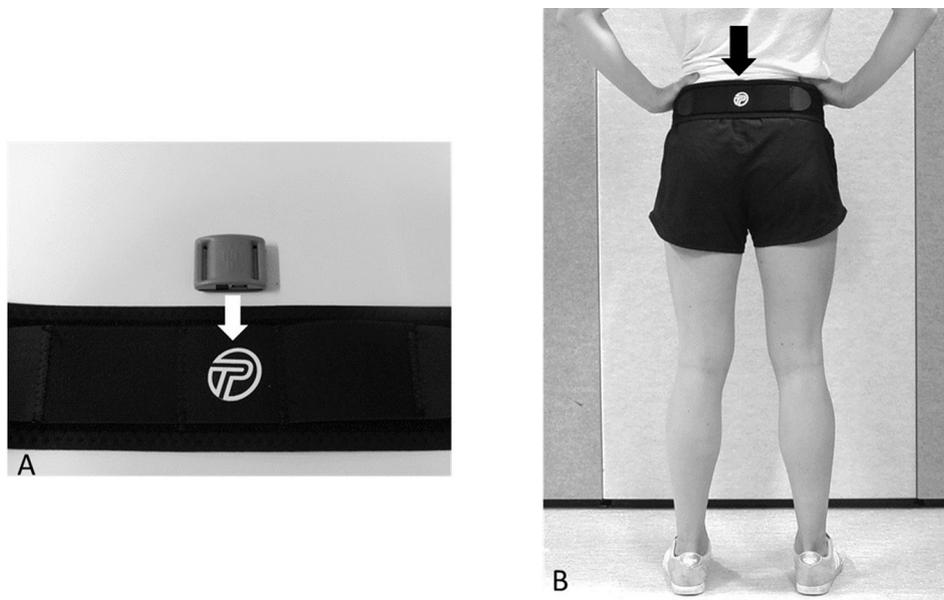


Fig. 1. Inertial sensor set-up. The inertial sensor was mounted firmly in a pre-defined direction into the external pocket of the belt (A) and the belt was secured to the participant's waist so that the sensor was positioned over the L5 vertebrae (B).

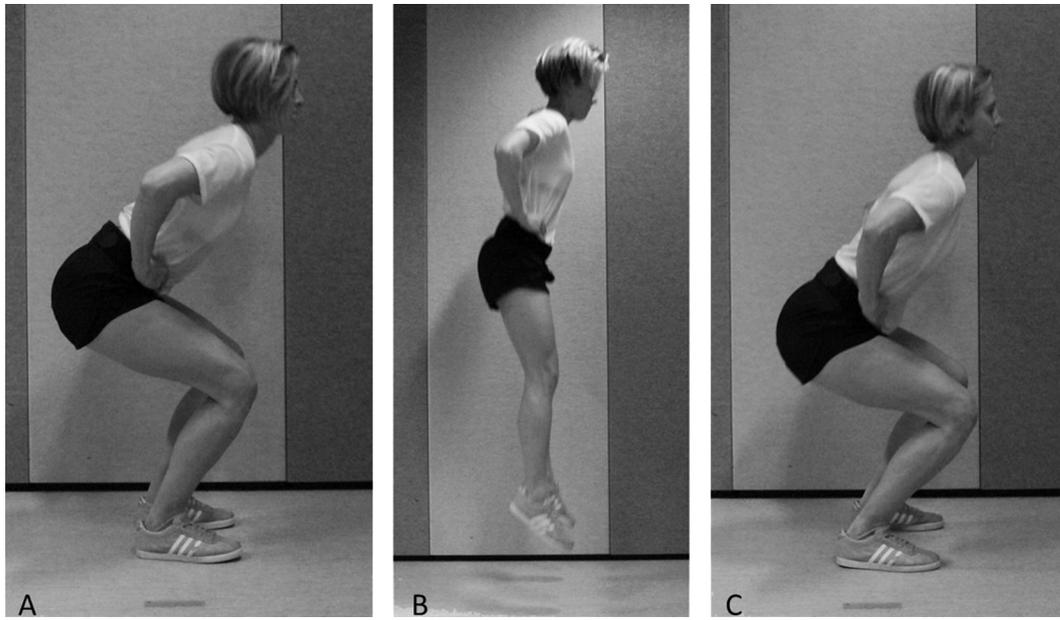


Fig. 2. Standardization of the counter movement jump. The participant stood with hands on hips, shoulder width apart (A) then immediately jumped with maximal effort (B) to ultimately land in the same location (C).

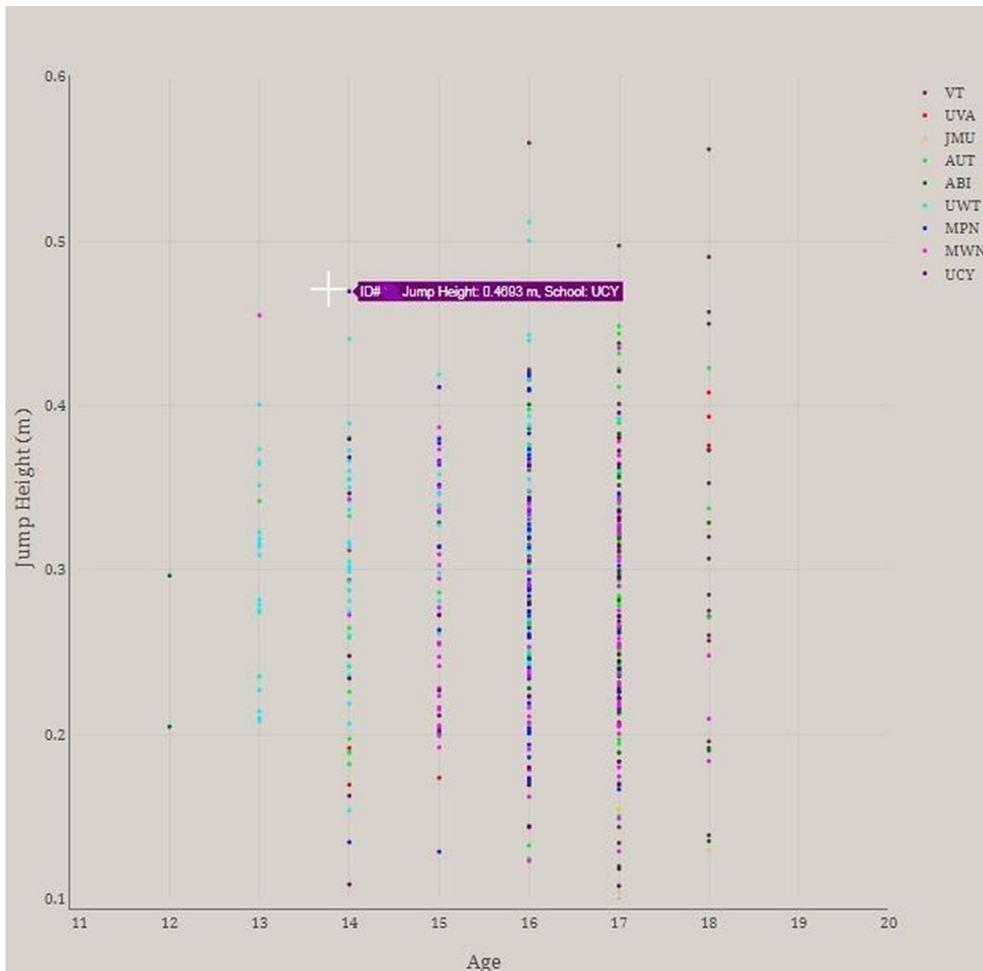


Fig. 3. Example of the scatterplot graph viewed in real-time on the Virginia Tech Granata Lab website.

Table 1
Descriptive characteristics (mean \pm SD) for each university testing site.

Site	Age (years)	Sex	Height (cm)	Mass (kg)	Jump Height (cm)
1 (N = 7)	17.43 \pm 0.53	2 M; 5 U	N/A	N/A	22.34 \pm 12.93
2 (N = 22)	15.45 \pm 1.47	8 M; 14 F	172.36 \pm 11.59	69.86 \pm 27.13	28.29 \pm 9.09
3 (N = 60)	17.00 \pm 0.74	27 M; 33 F	174.50 \pm 10.92	73.82 \pm 19.39	27.62 \pm 9.82
4 (N = 36)	16.58 \pm 1.30	18 M; 18 F	168.25 \pm 10.73	63.78 \pm 12.46	27.30 \pm 7.15
5 (N = 79)	16.27 \pm 1.18	51 M; 27 F; 1 U	174.81 \pm 13.56	81.12 \pm 23.24	28.81 \pm 8.20
6 (N = 66)	15.89 \pm 0.61	24 M; 41 F; 1 U	173.19 \pm 7.71	69.69 \pm 12.17	29.03 \pm 7.49
7 (N = 83)	16.13 \pm 1.02	41 M; 35 F; 7 U	173.11 \pm 8.18	75.26 \pm 73.90	28.36 \pm 7.44
8 (N = 42)	16.10 \pm 1.19	24 M; 17 F; 1 U	173.50 \pm 10.09	69.87 \pm 17.23	25.37 \pm 9.31
9 (N = 106)	14.86 \pm 1.29	55 M; 32 F; 19 U	173.12 \pm 9.16	64.70 \pm 11.00	32.10 \pm 6.85

Note. M: male, F: female, U: unidentified.

3. Results

Over 500 secondary school students ($n = 501$; age: 16.0 ± 1.3 y; height: 173.3 ± 10.3 cm; mass: 70.0 ± 16.5 kg) participated in TBE held across nine university sites. One site provided age, but not anthropometric data, for its participants; all other sites gathered age, stature, mass, and jump height (Table 1). Jump height ranged from 4.61 cm to 55.96 cm, with an average of 28.84 ± 8.43 cm. Pearson's correlations revealed a weak, significant relationship between participant height and average jump height ($r = 0.321$; $p < 0.001$), but no relationship was found between average jump height and age or mass.

Self-reported physical activity levels were collected from 306 of the 501 participants. The majority ($n = 175$) reported being very physically active, while 120 participants were somewhat active. Only 10 participants did not consider themselves to be physically active. A one-way ANOVA compared self-reported physical activity levels and recorded jump heights. Very physically active participants performed significantly higher jumps (29.37 ± 7.02 cm) than the somewhat active (27.21 ± 7.42 cm, $p = 0.05$) and not physically active (24.87 ± 7.82 cm, $p = 0.04$) groups.

4. Discussion

The purpose of this study was to understand the feasibility of incorporating a multi-site testing protocol for collecting research-quality data within an established outreach program (in this case, National Biomechanics Day). Specifically, the sample size collected at each site demonstrated a willingness of students to engage in the scientific process. The overall volume of data collected across multiple sites in a single 24-hour period confirmed an ability to collect and share data and increase sample size to better answer research questions in a way that would be difficult to achieve at a single site.

Although not dissimilar to more traditional approaches, the preparation for embedding research quality assessments into outreach events cannot be overemphasized. Ethical approval was required from each university, and was a limiting factor for participation by some US universities. Additional steps for quality assurance were necessary to standardize the approach across all testing sites, but did require more preparation and planning. Throughout the project, lessons were learned that will improve the capacity to align research output with educational outreach. As with all high quality research, specific questions must be established from the outset, and directed assessments used to answer the planned research questions. While cutting edge technology can be more awe-inspiring to younger students and also has the potential to improve the accuracy and fidelity of collected data, it can increase

user burden before, during, and after the event. Conversely, a basic assessment can be easier to incorporate across multiple sites with varying technological resources. There is a constant desire to collect as much data as possible from willing cohorts, particularly in more difficult populations. However, it must be remembered that the research is one piece of a collective engagement opportunity, and that the priority of engagement events is to engage and teach students; collection of data should exist as a complement to the primary goal.

In summary, when a simple yet directed research design is established with ample preparation time, it is feasible to leverage community engagement for research purposes, subsequently increasing the effectiveness of both. Care must be given to allow sufficient time for the organization of such a large operation, which is further magnified by including multiple (international) sites. Most importantly, the success of such a project relies on identifying and executing a simple, focused project that will enrich the learning experience of student participants.

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Conflict of interest

The authors have no conflicts of interest to declare.

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