Winter's Principles of Sport and Exercise Science

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Dr Alan Ruddock FBASES and Profs Rob Copeland, David Broom FBASES and Jon Wheat provide insights into the lessons learned from Prof Edward Winter FBASES.

Introduction

Edward Winter was Professor of the Physiology of Exercise at Sheffield Hallam University for more than 20 years, a founder member of BASES and made a sustained and substantial contribution to the Association for more than 35 years; he sadly passed away on 18 July 2020. In this article we share some of the lessons Edward taught us, as an inspirational teacher, nurturing colleague and mentor, co-author, supportive friend, and bastion of science.

Edward's approach to teaching

"Science appears to us with a very different aspect after we have found that it is not in lecture rooms only, but that we may find illustrations of the highest doctrines of science in games and gymnastics, in travelling by land and water, in storms of the air and of the sea, and wherever there is matter in motion." - James Clerk Maxwell (1831-1879) - Introductory lecture on elementary physics (Cambridge, 1871)

Edward would start each academic year with the above quote, which exemplifies his approach to teaching. Traditional lectures and laboratory practicals were a mainstay, but he supplemented theory with seemingly innumerable examples of the applications of science to occupation, combat and aviation, which underpinned the first principle.

Edward's principles

1. Science is simply a way of working, consisting of: 1) observations; 2) research questions; 3) hypotheses; 4) experimentation; 5) analyses; 6) outcomes; and 7) broadcasting (not dissemination as only males can do this, from Latin dis-semen). The term "bad science" is, therefore, a misnomer, because if principles and practices of science are relinquished, work is not science. This simple seven-step process provides a framework for conducting science and importantly evaluating what is, and is not, science - which in the information age, is a handy tool (Winter, 2010).

Sport and exercise science is, therefore…

2. The scientific study of factors that influence the ability to perform exercise.

Exercise defined as "planned, structured and repetitive bodily movement" on the surface appears to be an innocuous term, often used interchangeably with physical activity. However, the lesson here is in taking care to identify key terms; here, movement.

INSERT IMAGE OF Gymnastics CRUCIFIX…

There are many examples in sports where movement is disadvantageous, such as in a crucifix, not discounting the benefits of fixator and stabilising muscles in dynamic activities such as running, cycling and swimming. Winter and Fowler (2009a) proposed a new definition of exercise that accounted for dynamic and static activity:

3. Exercise is "a potential disruption to homeostasis by muscle activity that is either exclusively or in combination, concentric, isometric or eccentric" (Winter & Fowler, 2009a; Winter et al. 2016).

Definitions are important because they enable common understanding, form an essential basis for science, and are at the heart of critical thinking. It is tempting to accept popular terms and nomenclature as scientific. However,…

4. Scientists are bound by the principles of the Système International d'unités (SI). They should pay due diligence to the mechanical constructs of force, work, power, energy, velocity, impulse, momentum, efficiency, economy, effectiveness, mass and weight and use correct terms and nomenclature (Winter & Fowler, 2009a; Winter & Knudson, 2011; Winter et al., 2016).

We should take care to understand the mechanical origins of metrics. For example, power, denoted as the eponymous Watt, has a specific definition and there are many activities, such as jumping, where the calculation of power alone cannot fully explain the outcome of movement.

The importance of understanding mechanical constructs and origins is exemplified in principle five.

5. The function of muscle is "to exert force, and it does so by attempting to shorten" (Winter & Fowler, 2009a; Winter et al. 2016).

Galen (c. 150 AD) proposed that muscle expands, consistent with the acute increase in girth that accompanies muscle activity. In 1663, Swammerdam isolated and suspended muscle in a sealed glass tube, with a single water droplet in a capillary to the top. The muscle was stimulated and twitched, but the water droplet did not move as would have been the case in Galen's function-by-expansion theory. Importantly, this simple experiment also demonstrated that muscle does not contract. Despite this finding almost 400 years ago, the use of the term "contraction" to describe muscle activity perpetuates. Indeed, misuse of "contraction" is not alone in sport and exercise science.

6. Terms such as "workload" and "work rate" (which are mechanically imprecise and colloquial) should be abandoned and the terms "intensity of exercise" and "domains of exercise" should be adopted because of their clarity and universal applicability (Winter & Fowler, 2009a; Winter et al., 2016).

Similarly, because of their clarity and universal applicability…

7. Scalar quantities such as time (s), distance (m) and speed ($m \cdot s^{-1}$) might be all that is needed, and preferable over, for example, power, to assess performance (Winter& Fowler, 2009a; Winter et al., 2016).

Indeed, "Power" and derivatives of metrics in principle 7 should only be used if they adhere to strict definitions that enable scientists to describe and explain outcomes better than first principles. If they do not, work risks becoming the antithesis of principle eight.

8. Use a writing style that upholds the scientific requirements for precision, clarity and conciseness (Winter, 2005).

As section editor for the *Journal of Sports Sciences*, Edward often observed misapplied vernacular, tautology and superfluity. Common examples included:

- "This study looked at." Studies do not look; they "investigate, examine or explore".
- "There are many different types." "Different" is not required.
- "In order" used as a prefix but its omission makes no difference to the meaning of a sentence.

This principle also extends to the presentation and interpretation of findings.

9. Do not confuse significance with precision of measurement. Consider whether "a significant finding" refers to "significance" in a statistical or practical sense. Relating to the latter, "is the finding meaningful?" (Winter, 2008a).

On meaningfulness, which is arguably more important than statistical significance…

10. Does the intervention work? If yes, how well? Does it exceed the minimum important difference? How precise is the estimate of how well the intervention works? Is the intervention cost-effective? (Winter et al., 2014).

Authors can *a priori* state an important difference, use confidence intervals to assess precision of estimates, and importantly appraise the time and financial costs of an intervention to judge practical application. The latter is important because if sport and exercise science is to have a continued positive impact, it must be accessible in some form to all corners of society.

In this manner…

11. Outcomes from research should be stated clearly, simply and unequivocally and answer the "so-what?" question (Winter & Nevill, 2014).

Dr Ruddock remembers a conversation with Edward. "I asked him for advice on reviewing a manuscript. Edward asked me to recall the practical application of the study, then repeatedly asked, 'So what?' until I found the real importance of the work. It took five 'So what?' questions to find this

base. I passed the findings of Edward's interrogation, along with principle 12, to the authors who were grateful for the insights."

12. Two simple questions define good work: First, does the work advance knowledge and understanding. Second, will the work change practice? (Winter & Nevill, 2014; Winter et al., 2014).

Principle 12 was always at the heart of PhD programmes, doctoral training workshops he provided for students in the faculty and vivas. However, ostentatious statements associated with novel findings were tempered by historical references.

13. Just how new is new? Consider the works of Hippocrates and Galen who attended to the surgical and medical needs of gladiators, the formalisation of science in the Renaissance, notably Santorio and Galilei (1600s), and the formulation of the laws of Thermodynamics forged by the industrial revolution (1700s) (Winter, 2008b).

Important lessons can and should be learned from history. Some might consider aspects of the above semantics. However, principle 14 should be unequivocally and universally accepted by all scientists.

14. Humans are *participants* in research, not *subjects*. The latter is associated with crimes against humanity during the Second World War (Winter & Maughan 2009). Freezing, infection and treatment of typhus, transplantation of limbs and making seawater drinkable were just some of the appalling ways humans were *subjected* to experiments, in which death was considered a necessary outcome to improve the chances of Nazi survival in war (Winter, 2008c). Participants provide informed consent, volunteer for, and can withdraw from studies at any time per the Declaration of Helsinki, the internationally recognised ethical standard.

Remember…

15. "Everything's already been said before, but since nobody was listening, we have to start again." (Andre Gide (1869-1951) (Winter et al., 2016).

We encourage all readers to apply Winter's principles of sport and exercise science. They are a distillation perhaps, but certainly a continuation of Edward's attempts to uphold science in sport and exercise.

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Prof Edward Winter FBASES

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