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What is Exercise Science?

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Abstract

The purpose of the paper is to define Exercise Science. The following definition is offered and justified: Exercise Science is a theory-based, research-led discipline that seeks applied solutions to health problems related to physical inactivity, and which aims to understand and promote individual and public health and wellbeing through evidence-based physical activity interventions.
Keywords: exercise science, sport science, health enhancing physical activity

Purpose of the paper

Although Sport Science is perceived by some as a new discipline, it is relatively mature in comparison with Exercise Science. Whilst many readers of this journal will have an experience-based definition of Sport Science, they may have a less refined answer to the question, what is Exercise Science? Since Exercise Science is referred to in both the benchmarking statements for Hospitality, Leisure, Sport and Tourism, and Healthcare programmes (Physiotherapy), and is used in some degree titles, this fundamental conceptual question is worth asking. How can lecturers discuss the best way to promote student learning and assessment in Exercise Science unless they have a shared understanding of what it is?

If there is no definition of Exercise Science there is a danger when designing a degree in Sport and Exercise Science that the exercise strand is submerged in a sea of sport-related learning outcomes. As a longstanding member of the British Association of Sport and Exercise Sciences (BASES) and former leader of a large Sport and Exercise Science degree said when I discussed this paper with him, 'the whole area of 'what is what' is a mess which means we are often talking at cross purposes'. This paper attempts to throw some light on the area and generate heat by promoting a debate on 'what is Exercise Science?' Whilst this paper proposes a definition of Exercise Science, it does so in the hope that it will be contested and that other scholars and practitioners will offer alternatives. It should be noted that whilst this work is about Exercise Science, it is not a scientific paper, but a scholarly reflection on the nature of the area. It is a study of Exercise Science that challenges the reader to consider what exercise scientists do by asking the fundamental question, 'what is Exercise Science?' The paper addresses this question by looking at the common usage of key terms in Exercise and Sport Science and goes on to make the case that Exercise Science is not the same as Sport or Health

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Science. The paper then presents a new definition of Exercise Science that has four key elements, each of which are justified in turn. Finally research, professional practice and learning and teaching in Exercise Science are briefly discussed, before a short conclusion is reached.

Common usage?

Imagine a group of sport and exercise scientists talking about the three main areas that form the foundation of their subject. My guess is that you will imagine hearing them talk about Exercise Physiology, Sports Psychology and Biomechanics. Why in common usage is physiology normally preceded by exercise and psychology by sports? One answer may lie in the early development of Sport Science. In the past, when it was not possible to simulate the stresses of an actual sports competition (e.g. kicking, jumping, running with a ball whilst twisting and turning) in a physiology laboratory, treadmills and ergometers enabled the pioneers of Sport Science to impose an exercise stimuli instead. Therefore at this time, the term Exercise Physiology or 'Work Physiology' was the most accurate description of this pioneering research (see for example, Astrand and Rodhal, 1986). However, whilst the term Exercise Physiology may have been used for many years, this should not mislead us into thinking that it primarily dealt with research questions or learning outcomes linked to health-enhancing exercise. A look at the contents pages of many exercise physiology textbooks published in the 1970s, 1980s and 1990s shows the emphasis was (and arguably still is) very much on performance sport, not health-related issues.

In contrast with the difficulties faced by physiologists in recreating realistic sport stimuli in the laboratory, the psychological research in education and the workplace of the 1950s and 1960s were relatively easy to transfer into another performance orientated environment i.e. sport. This, along with the relatively limited technological demands created by collecting data on, for example pre-competition anxiety, meant that the term Sports Psychology was appropriate from the inception of the area. Recently, new insights from notational analysis and the miniaturising of data collection technologies, have allowed physiologists to achieve the same ecological validity in their laboratories or in the field, as psychologists have enjoyed for some time. Therefore, what could arguably be termed a 'real' Sports Physiology has emerged.

Clearly, this analysis is only one possible explanation for the adoption of the terms Exercise Physiology and Sports Psychology in common usage. Sport scientists themselves may tell their own story in other ways and should be encouraged to do so. Nor is it to suggest that physiologists perceive as much difference between sport and exercise as psychologists appear to. However the argument can be made that the term 'exercise' has been used differently over time and in their own way by physiologists and psychologists respectively.

Whilst the term Exercise Physiology has a long lineage, arguably the term Exercise Science only became part of the UK academic lexicon when the British Association of Sport Sciences (BASS) changed its name in 1993 to the British Association of Sport and Exercise Sciences (BASES). Since that point, the area has grown so quickly that Professor Jerry Morris could write in his 2003 foreword to Hardman and Stensil (2003) that:

> The text meets the needs of *countless* students of Physical Activity and Health now to be found in Universities, Sports Science, Clinical Medicine, Epidemiology. (Page XIX. Emphasis added by the author).

Exercise Science is not the same thing as Sport Science

Some years ago, many British universities were forced to distinguish Sport Science from Physical Education by establishing distinctive learning outcomes. So too in some institutions, Exercise Science is now distinguishing itself from Sport Science. This is not to say that the two areas do not share things in common, for example, subject matter related to cardiovascular function or human motivation. Nor is it to deny that many scientists interested in Sport are also interested in Exercise. However, as the following six points show, Exercise Science is not the same as Sport Science:

1. Sport Science is focused on talent identification, performance enhancement and player support. Alternatively, Exercise Science is focused on health, wellbeing and happiness. Although a case can be made that holistic approaches to player support have an element of wellbeing, such support is targeted at performers not the public.
2. Sport and Exercise are different behaviours. The motivation that precedes these behaviours and the outcomes that follow are also different.
3. Sport scientists often find themselves working in an environment that has been determined by the policies of the Department of Culture, Media and Sport, national governing bodies and the National Lottery. Alternatively, exercise scientists work within frameworks set by the National Health Service, hospitals and primary care trusts.
4. There appears to be an implicit recognition by a number of journals that the subject matter of Exercise Science is so different from that of sport science that it warrants reflection in their title. For example, in 1988 the *Journal of Sports Psychology* became the *Journal of Sport and Exercise Psychology*.
5. Physical training for professional sport is not the same as exercise. Even though the mode of human movement may be the same, the behaviour is different. For example, compare a rugby player running three miles as part of her training programme with an exerciser also running three miles for health-related fitness reasons. For the rugby player, this cardio-vascular training may form part of a periodisied training programme that combines work across a range of fitness variables, designed by the sport scientist to lead to a peak performance. The run is part of a process designed to enable the athlete to meet a performance outcome. However, for the exerciser the run may be an end in itself (e.g. because it is fun to run in the sun) or be part of a health-enhancing programme. For the professional rugby player the run may be seen as part fulfilment of their contract of employment and therefore extrinsically motivated, whilst for the exerciser the motivation may be intrinsic. In this example note that health is not the same type of outcome as peak sports performance. Firstly health is more important than sport. Secondly health is a lifelong goal, unlike training for a specific game or season.
6. Interdisciplinary Sport Science is characterised by collaboration with coaches and performance directors. Interdisciplinary Exercise Science is characterised by collaboration with general practitioners and professionals allied to medicine.

Casti (2000) suggests that the public perceive scientists as ‘evil alchemists’, ‘noble scientists’, ‘stupid obsessives’, ‘inhuman rationalists’, ‘adventurer heroes’ or ‘out of control’. Whilst it is doubtful that the public has given much thought to how to stereotype sport or exercise scientists one can speculate that if they had, Casti would have to add ‘Mickey Mouse’ to his list. After all, it is arguably a small step from Goddard’s (2004) observation that ‘a course in golf studies, one of the most persistently derided of so called Mickey Mouse degrees, has been given the seal of approval by funding chiefs’ to a more general observation about sport and exercise science degrees. Arguably the best response to anecdotal accounts of sport and exercise scientists being labelled Mickey Mouse are the excellent Research Assessment Exercise ratings achieved by Sport and Exercise Science (Smith, 2002).

Exercise Science is not the same thing as Health Science

Just as Exercise Science is not Sport Science, nor is it Health Science. Exercise Science is focused on only one determinant of health, i.e. health-enhancing physical activity and does not concern itself with, for example, alcohol and tobacco usage (except when investigated in the context of physical activity, see for example Ussher et al., 2003a). Exercise Science has not made extensive use of the methodological approaches found in Health Science including health impact studies and randomised controlled trials (an exception being Ussher et al., 2003b). The National Health Service (NHS) does not systematically employ exercise scientists who remain unregistered and unchartered. Though it should be recognised that the NHS does use exercise as both a therapy (delivered in the main by physiotherapists) and as a public health intervention (delivered largely by health promotion specialists).

The end users of exercise science research are not always from the health sector but can be from the fitness industry (see for example, Smith, 1989) or the leisure sector (see for example, Burton and Smith, 1997). Whilst there is a synergy between the health and fitness sectors in terms of the types of evidence they require, there is also room for potential conflict as demonstrated by the following quote from a letter to *The Times*:

> This could include refusing to allocate car parking spaces to gyms through the planning application process to avoid the somewhat puzzling scenario of people driving to health clubs only to 'ride' on a stationary exercise bike when they could have achieved a similar health benefit by walking or cycling to the facility. (Smith, 2004)

If Exercise Science is not Health or Sports Science, what is it?

Brown (2001) offered the following definition:

> …the term exercise science refers to the application of science to the phenomenon of exercise. (2001:6)

This definition lacks clarity on three grounds. Firstly, as Brown makes clear in the first section of his book, he sees no differentiation between Sport Science and Exercise Science, and therefore in this definition the term Exercise is used to include in his words 'sports, and leisure activities of all sort' (2001:6). Secondly, it is a circular definition that tells us that exercise science is the scientific study of exercise. Thirdly, one could replace the word 'exercise' in Brown's definition with any other term e.g. 'space' and the definition would, in grammatical terms, still make sense, suggesting that the definition has not captured the distinctive features of Exercise Science.

To address the weaknesses of Brown's definition and building on the earlier discussions in this paper, the following new definition is offered which stresses the use of a scientific approach to resolve applied issues:

> Exercise Science is a theory-based, research-led discipline that seeks applied solutions to health problems related to physical inactivity and which aims to understand and promote individual and public health and wellbeing through evidence-based physical activity interventions.

This definition is presented in part to stimulate a rigorous debate on what is Exercise Science? The definition given above has four key elements. The first element is that Exercise Science is theory-based; the second that it is research-led; the third that it seeks applied solutions and the fourth that it is evidence-based. The following sub-sections justify these key elements.

Justification that Exercise Science is theory-based

In 1988, Sonstroem called for a more theoretical perspective from those conducting research into exercise adherence. It can be argued that in the 1980s exercise adherence research dominated Exercise Science (see for example, Dishman, 1988). Since 1988, a number of theoretical perspectives have been applied to Exercise Science including the Theory of Reasoned Action (see for example, Smith and Biddle, 1999); the Theory of Planned Behaviour (see for example, Jackson et al., 2003); self concept (see for example Marsh, 2002) and Physical Self Perception (see for example, Fox and Corbin, 1989). In addition, there has been an increase in the use of theory-driven qualitative methodologies (see for example, Sparkes, 2002). The use of these theoretical perspectives and others demonstrate that researchers have responded to Sonstroem's challenge and that Exercise Science is now theory-driven. Further evidence of the theory-driven nature of Exercise Science comes from Dishman (1994) which includes a part entitled 'Theory and Determinants of Physical Activity'.

Justification that Exercise Science is a research-led discipline

One way to justify that Exercise Science is research-led is to demonstrate that the research output of exercise scientists is significant. One way to achieve this is to look at the work published from recent peer-reviewed scientific conferences. For example, the book of abstracts (Mester et al., 2001) from the

sixth annual congress of the European College of Sport Science (ECSS) shows that the conference included two thematic sessions on physical activity, health and fitness. More recently, the eighth annual ECSS congress (Muller et al., 2003) had seven health and fitness sessions and a plenary debate entitled 'physical activity and health – what is the evidence?' These observations are indicative of a growth in exercise science research over this two year period and the research focus of the discipline.

Another opportunity to evaluate the extent to which Exercise Science is a research-led discipline was presented by the first joint BASES-BASEM (British Association of Sport and Exercise Medicine) conference that was held 3rd-6th September, 2003. This conference was particularly appropriate for an analysis to determine if Exercise Science is a research-led discipline for two reasons. Firstly, the conference had a joint 'excellence' in sport and exercise theme. Secondly, as BASES and BASEM ran the conference in cooperation, it was open to exercise scientists from both associations. In their published review of the conference, Bartlett and Nevill (2004:235) stated, 'the conference provided the intended integration of knowledge from the various science and medical disciplines', confirming that this conference was particularly suited to an analysis of both exercise and sports science research outputs by both the medical and scientific communities. The peer-reviewed abstracts from the conference were published in the March 2004 edition of the *Journal of Sports Sciences* (Vol. 22 No. 3). Based on this edition of the journal, the author categorised the published research as either Sports Science or Exercise Science based on his definition of Exercise Science, operationalised using the following criteria:

1. All abstracts that specifically stated a sport-related research question or application were classified as Sport Science and vice-versa.
2. Abstracts focused on talent identification, performance enhancement and player support were classified as Sport Science, whilst abstracts focused on health, wellbeing and happiness were classified as Exercise Science.
3. Abstracts set in the context of policies determined by the policies of the Department of Culture, Media and Sport, national governing bodies and the National Lottery were classified as Sport Science. Alternatively, abstracts referring to frameworks set by the National Health Service, hospitals and primary care trusts were classified as Exercise Science.
4. Abstracts that used sports performers as subjects were classified as Sport Science.
5. A preliminary reading of the abstracts revealed that a number of studies focused on running. Therefore a decision had to be taken on whether to classify running as a sport or as exercise. For the purpose of this study, running was classified as a sport on the grounds that it is a vigorous activity and therefore related to performance and fitness rather than to health. In contrast, studies looking at mild to moderate activity such as brisk walking were classified as Exercise Science. To be consistent with the classification of studies on running, all abstracts including maximal exercise were classified as Sport Science.
6. Abstracts reporting data on calibration trials; validity studies and the development of new techniques were classified as methodological.

The only abstract that defied classification using these criteria was McCorry et al. (2004) which looked at occupational fitness in the emergency services, within the physiology section. Therefore, this abstract was excluded from the analysis. The results from this work are shown in Table 1. It is recognised by the author that despite the establishment of criteria, this was a subjective process and others may have reached different classifications. It was the author's experience that biomechanics abstracts were the hardest to classify. Despite these limitations, it is hoped that this attempted classification will encourage others to either replicate the procedure or to track changes over time, or look for other possible classifications. For example, Sport Science related to Physical Education as compared to Coaching. Other useful analysis could include looking at the gender and age distributions of subjects used in Sport and Exercise Science.

Table 1 suggests that Exercise Science is a research-led discipline because despite the recent development of the area, 29 per cent of all conference abstracts can be classified as Exercise Science

rather then Sport Science. Furthermore, Exercise Science papers are present in all five areas including the relatively small ones of kinanthropometry and biomechanics.

Areas	Sport	Exercise	Methodological	Totals
Biomechanics	10 (67%)	4 (27%)	1 (7%)	**15 (13%)**
Kinanthropometry	7 (54%)	3 (23%)	3 (23%)	**13 (11%)**
Interdisciplinary	13 (59%)	9 (41%)	0 (0%)	**22 (19%)**
Physiology	21 (54%)	13 (33%)	5 (13%)	**39 (34%)**
Psychology	20 (77%)	5 (19%)	1 (4%)	**26 (23%)**
Totals	**71 (62%)**	**34 (29%)**	**10 (9%)**	**115**

Table 1: Classification of published research abstracts from the joint BASES-BASEM conference (2003)

Justification that Exercise Science seeks applied solutions to health problems related to physical inactivity

Exercise scientists have worked with the government in the UK over a number of years to seek applied solutions to address public health problems caused by sedentary living. Evidence of this work came in 2001 with the publication by the NHS of 'Exercise Referral Systems: National Quality Assurance Framework' and more recently with the publication of the Chief Medical Officer's Report on physical activity in 2004.

Justification that Exercise Science uses evidence-based practice

BASES is the professional body that offers accreditation to those exercise scientists in professional practice. The primary accreditation criterion is evidence-based practice which the applicant has to demonstrate, in part through the submission of a case study. The need to ensure evidence-based practice in Exercise Science is important if exercise is not to be portrayed as a panacea for all ills or a magic medical bullet. This is important in a society like the UK where arguably, exercise has become a commodity to be bought and sold and one often marketed by celebrities.

Research in Exercise Science

A paradox has resulted from the research conducted by exercise scientists in that the more they have found out about the relationship between physical activity and health, the more they have had cause to question their own nomenclature. For as research progressed in the 1990s on the exercise-disease/dose-response relationship, the more it became clear that the question is not 'how much exercise' must one do to obtain a health benefit, but 'how little'. Therefore, most research in the third millennium talks about physical activity or health-enhancing physical activity (HEPA), not exercise. This distinction is in line with Casperson et al. (1985); the word 'exercise' is used to describe structured and goal-orientated movement (e.g. attending an aerobic class to improve fitness) whilst HEPA refers to any human movement that improves health (e.g. brisk walking). Despite this work, there is as yet, no sign of a rush to lobby BASES to become the British Association of Physical Activity and Sport Sciences. Such a gesture may not be needed if there is a consensus amongst the exercise science community that the term accurately describes them and explains to others what they do.

Current research in Exercise Science also demonstrates that the meaning of the term 'science' is contested. For whilst much research in Sport and Exercise Science is positivist, research by scholars such as Jim McKenna, Diane Crone and others is challenging Exercise Science to embrace approaches

such as Hermeneutic Phenomenology and Grounded Theory. Indeed, building on the observation of Steven Blair who, in the forward to Biddle and Mutrie (2001:XV), noted that 'until quite recently exercise scientists have focused little attention on the principles, concepts and methods from the behavioural and social sciences', I would add that some British exercise scientists appear to be becoming sociologists. This is not to dispute that another group of exercise scientists are building on its advanced knowledge of statistics to begin to handle large population level data sets, and to track complex changes over time in the lifestyles and health of communities. Again as Steven Blair has noted:

> In the late half of the 20th century the epidemiology of physical activity and health achieved attention, and physical inactivity has been identified as an important health problem in many countries. (In Biddle and Mutrie, 2001:XV)

One possible future for the 'statistical group' of exercise scientists is to follow the lead of Blair and evolve into epidemiologists. With this complementary and natural division between the social science and epidemiology approach to Exercise Science the area has heeded Gleick's (1998:5) warning that **'**fifteen years ago, science was heading for a crisis of increasing specialisation'.

European and North American research perspectives currently dominate Exercise Science. Therefore, there is a challenge for the area to become an international discipline that reaches beyond English language journals and recognises the contributions and needs of developing countries.

Professional practice in Exercise Science

Just as Sport Science should attempt to answer the question what is the difference between an applied sport scientist and a coach, similarly, Exercise Science should ask what is the difference between an exercise leader and an exercise scientist? If one accepts the definition of exercise science given in this paper, this question can be answered by stating that exercise scientists do research, construct theories and postulate interventions based on evidence, whilst exercise leaders are practitioners who run classes and work with individuals. Of course, the two sets of competencies (i.e. exercise science and leadership) are complementary and may be found in one individual. However, this observation should not lead us to equate exercise science with exercise leadership, nor to assume that because an individual is good at one, they will be good at the other.

Learning, teaching and assessment in Exercise Science

What are the implications of the definition of Exercise Science given in this paper for student learning and assessment?

Student learning

Based on the definition given in this paper, can Exercise Science be classified as an academic discipline? Also, is there enough depth of material in Exercise Science for it to be taught progressively from Level 1 to Masters, or should it be viewed as a vocational area of study? Henry's (1964) definition of an academic discipline is helpful when considering this:

> An academic discipline is an organized body of knowledge collectively embraced in a formal course of learning. The acquisition of such knowledge is assumed to be an adequate and worthy objective as such, without any demonstration or requirement of practical implication. The content is scholarly as distinguished from technical and professional

Henry's definition is significant as it highlights the importance of scholarly enquiry in its own right, independent of any extrinsic reward or end user. Tested against this definition I believe that exercise science can be classified as an academic discipline because it is theory-driven and research-led. However, Henry's work also serves to highlight the constructive tension within Exercise Science between the scholarly and the need for application as reflected in the following statement by Dr John Buckley, the current and progressive Chair of BASES's Exercise Science committee:

> Fantastic research has been done and continues to grow on all fronts, epidemiological, physiologically and psycho-socially. The greatest need for development is applying this on the frontline. This frontline application requires two key facets:
>
> 1. an ability to synthesise the scientific information into something that is meaningful for health promoter/ rehabilitation practitioner and client/patient alike, and
> 2. actually delivering exercise plans/sessions/programmes that are safe, effective and enjoyable
>
> (Taken from the BASES website www.bases.ac.uk on 20/04/04).

Whilst agreeing that exercise scientists should conduct research to underpin professional practice, I am less convinced that it is they who should be doing the 'delivery'. The debate about the role of the exercise scientist in professional practice can be characterised as being between those who believe that they should be running exercise programmes and interventions (the 'deliverers') and those who believe that they should be producing the evidence, influencing policy and providing professional guidance (the 'experts'). This debate is important in relation to student learning, because it helps to determine which students should be studying Exercise Science. It seems logical to assume that the 'deliverers' would favour students to learn on a BSc degree in Exercise Science giving them the time both to read for academic award and acquire the vocational competencies required to deliver professional services. Alternatively the 'experts' could argue that Exercise Science should be delivered through modules to undergraduate students on medical and physiotherapy programmes. These approaches are not mutually exclusive and some lecturers in Exercise Science find themselves delivering modules to both specialist and non-specialist students. Not only is this challenging in terms of adapting to different learning styles on varied programmes, but it also raises questions about progression and level(ness). For example, how does one equate the anatomy and physiology taught to the average medical student with that taught to a sport and exercise science student? What implications does this have for the prerequisites for a Level 3 elective module on Exercise Science?

Given the dominance of the scientific model at the start of the third millennium, arguably the first responsibility of any science educator, the exercise science lecturer included, is to ensure that students understand the limitations of science. Pope John Paul II addressed this issue in 1998 when he stated:

> Another threat to be reckoned with is scientism. This is the philosophical notion which refuses to admit the validity of forms of knowledge other than those of the positive sciences; and it relegates religious, theological, ethical and aesthetic knowledge to the realm of mere fantasy. (1998:129)

Pope John Paul's comments are in contrast to those of Gribbin (1998:2) who stated the 'scientific world view is the greatest achievement of the human intellect'. One way to ensure students understand the limitations as well as the power of science is to expose them to a broad literature rather than to the narrow exercise science canon. This could include, for example, texts on the history and philosophy of science. A good Level 1 resource that could help to do this by tracing the development of science over the last 2000 years is Tallack (2001). This text also graphically challenges the art-science divide.

Student assessment

Given that exercise science is a broad discipline ranging from epidemiology to social science there is a risk that students are over-assessed. This may also result from lecturers believing that they must assess everything they teach. The implications of over-assessment include a diminishing of the student experience and a reduction in staff time available for research.

Exercise scientists practice their profession in a number of environments including public health and clinical settings. As demonstrated by the recent announcement that Dr Paul Bromley (the current Chair of BASES's Physiology Section) has been elected to serve a three-year term as a Member of

Council of the Sport and Exercise Medicine Section of the Royal Society of Medicine (BASES website, 20/04/04), the potential for exercise scientists to work in medical settings is growing. Therefore, should exercise science undergraduate students be assessed on clinical skills? Should assessment be equally divided between those aimed at measuring fitness for academic award and those designed to test professional skills? Curriculum and assessment designers from the professions allied to medicine may have insights to share with their colleagues in Exercise Science in this regard.

Conclusion

It would be foolhardy to believe that a community of scholars who are as passionate about their work as sport and exercise scientists would accept without question the definition of Exercise Science given in this paper. The definition can and should be contested on a number of grounds including its justification and the dichotomy it creates between Sport Science and Exercise Science. Future work could: (i) produce a critical history of European Sport and Exercise Science, contrasting it with that of North America; (ii) identify the current operational definitions of Sport and Exercise Science used in UK higher education, and (iii) include studies on how Sport and Exercise Science works, perhaps using methods from sociology.

Exercise Science has reached a level of maturity that requires those who work in the discipline to define it and reflect on it as well as do it. Hopefully, this paper will provide momentum to this endeavour.

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