Statement: "So much of the work done in science now requires input from multiple disciplines, that the separation of the disciplines is irrelevant and unnecessary."

Interdisciplinary research as the future of scientific progress

The Latin translation of the word 'science' is simply knowledge[1]. The shared resolve of all research and education is to attain and spread knowledge; and yet scientific disciplines remain segregated. Interdisciplinary collaboration is increasingly vital for scientific advancement: from the structure of DNA, to the 2019 Chemistry Nobel Prize on lithium-ion batteries.[2] The fundamental separation of these sciences, even in the case of Nobel Laureate Classifications undermines the value of sharing knowledge, but these may be necessary to educate and maintain the high-levels of subject expertise worthwhile to share. This essay aims to explore the value and nature of such disciplines and evaluate future scope for a science without disciplines.

Historically, the Middle Ages first introduced these unit divisions of knowledge 'disciplina' for more pedagogical methods of teaching, compared to 'doctorina' as more intellectual learning.[3] The specialisation of these disciplines to define intellectual fields gained profile towards the end of the eighteenth century[3]. The emergence of discipline specific journals in 1780, in contrast to the wide broad-subject area previous journals was well received, as they brought together communities of authors[3]. In the early nineteenth century, this was followed by specific roles in higher education, initially in reformed universities in Germany and gradually spread[3], such that specialised disciplines were taught to the next generation of scientists. Stichweh argues that in order for there to be a recognition of the value of specialised scientific acumen, a scientific community must evolve, where individuals are able to share knowledge and expertise.[3] Increasing knowledge gives rise to sub-specialities within specialities and hence further disciplines – and so it can be argued that it is the segregation of these disciplines which has given rise to the need for scientific communication and an appreciation of the expertise of other groups and individuals.

The current divisions within the sciences tend to be broadly grouped into three broad categories: the physical, biological sciences and psychological sciences.[4] These sub-disciplines can be further divided into specialised fields, however these fields themselves may cross disciplines. For example, electrophysiology, a branch of physiology requires knowledge of the nervous system biologically, but also the electrical cable properties of neurones. At the sub-speciality level, there is crossover between disciplines, highlighting all disciplines have some form of interdisciplinary learning. Disciplines allow individuals to explore areas of their own specific interest and educate in detail, but do not limit exploration of cross-disciplinary areas; yet provide individuals with a purpose and scientific community to align themselves to. In this way a community of individuals committed to a specific discipline, can develop their own opinions based on their empirical evidence and perspectives.[5] In this way, all the sciences adheres to values of rigorous, reproducible data to obtain empirical evidence to add to and advance the wealth of scientific knowledge.

However, modern research even into seemingly single-disciplinary such as the structure of DNA highlights science truly is a shared field. From the initial outlook, the nucleotide structure of deoxyribonucleic acid is biochemical in nature, and hence in the realm of biological science research. Though, recent evidence suggests a role of quantum entanglement in maintaining the structure of nucleotides as clouds of coupled harmonic oscillators.[6] Established mechanisms such as photosynthesis are now associated with quantum coherence, giving rise to the emerging field of 'quantum biology'.[7] Without the drive for physicists to explore biological concepts, and for biologists to consider the suggests of physicists and remain open to suggestion, the pairing of seemingly different sciences to advance science would be impossible. In this way, physics underlies all

biological sciences[8] from the macroscopic view a life comes a microscopic view to protein-protein interactions governed by the laws of physics.[8] Traditionally, biologists worked at larger scales of life and physicists concerned themselves with interactions of matter and field yet given their intrinsic connection from a top-down approach[8], it is necessary to acknowledge the convergence of disciplines and the need to encourage both interdisciplinary research and interdisciplinary education.

The field of the psychological sciences concerns itself with the social sciences and behavioural sciences. Increasingly, a biological basis or contribution is being attributed to much of psychology. For example, the research into the intrinsic endocannabinoid system in the brain has brought insight into conditions such as depression alongside behavioural impacts of recreational cannabis use.[9] Howell et al argues that the diverse opinions within the psychological sciences may make it difficult to come to a common consensus, and therefore is in opposition to a more 'canonical' science such as physics.[10] Perhaps, this fails to appreciate the diversity is what 'canonical' sciences [10] are learning to appreciate; theoretical physicists for example are divided upon the many variations of string theory[11]. The disciplines therefore have much to gain and learn from each other, and in interdisciplinary research can encourage different schools of thought.

Eliminating the traditional disciplines would allow for such expression and encourage wider awareness of all the sciences. This would reduce misguided stereotypes such as of psychology as a 'pseudoscience' by encouraging learning into its scientific basis and the value of subjective experience.[12] Such arbitrary traditional boundaries fail to account for advances combining the various disciplines and lead to some scientific disciplines treated as inferior in this way or promotes specific field development. Higher education is beginning to encourage crossing these boundaries, such as cross-disciplinary courses designed to increase the breadth of knowledge.[13] In educating students in this way, future academia increasingly becomes working towards the shared goal of increasing scientific knowledge and interest in various disciplines. It does however pose the significant risk of compromising the depth of understanding and high-skill attainment in specific areas[14], potentially slowing down the advancement of science overall, and so contradicts the common goal of science. Eliminating disciplines is therefore not the solution but collaboration between disciplines provides scope for greater research and communication.

This statement therefore is flawed in the concept that disciplines are 'irrelevant' or 'unnecessary.' Such disciplines provide a purpose, a common community and a shared specific goal for academics and students alike. The rise in interdisciplinary research is equally as important and should be encouraged in academia and education. COVID-19 research has highlighted the need for several disciplines to work together, such as in the Scientific Advisory Group for Emergencies (SAGE)[15] to increase productivity and share expertise to guide government advice. To quote Carl Seger, it is only through interdisciplinary communication in this way that "truly great ideas [can] emerge."[16]

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