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Reforming a STEM Doctoral Curriculum to Promote Interdisciplinary Border-Crossing

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Abstract: To confront the major challenges of the 21st century, doctoral students need to be able to think and work across disciplinary boundaries. I have been inspired by metaphors for interdisciplinarity to develop new strategies to cultivate an interdisciplinary mindset amongst my students in Singapore. In particular, the border-crossing metaphor likens disciplines to countries with well-defined borders, and suggests that border-crossing necessitates the presence of guides to help students and travellers alike to complete their arduous journey. Since the publication of my Point-of Departure article, I have contributed to major curricular reforms at my institution to align our programme with evolving national educational and research policies. Thus, in my presentation, I will present the above strategies and outline the additional changes we are making to our curriculum, namely condensing our 2-year taught component into a single 13-week semester while prioritizing interdisciplinarity, the norms of good scientific practice, and effective communication.

Paper: Doctoral education today suffers from several challenges (Bosch & Casadevall, 2017; Leshner, 2015; Rashid, 2019). Firstly, the fragmentation of academia into traditionally bordered disciplines does not reflect the complexity of major global challenges that we currently face, e.g. climate change and the Covid-19 pandemic. What is needed is a holistic approach that integrates insights from different disciplines concerned with different aspects of a given problem. To address such challenges, our doctoral students need to leave the comfort of their own disciplines to conduct research that crosses and transcends one or more disciplinary borders (Rashid, 2021).

Secondly, overspecialization in a single discipline may underplay the critical thinking skills that are essential for working across disciplines. Furthermore, some have argued that serious problems with the scientific enterprise, e.g. poor reproducibility and a rise in the number of retracted publications, are due to doctoral students receiving inadequate training in critical thinking (Bosch & Casadevall, 2017).

Thirdly, exposition-centred instructional approaches in which instructors rely on “teaching by telling” fail to engage students. Such approaches, however, are still the norm in the Singapore context, a problem which is compounded by the tendency of our students to be reserved in the classroom. Thus, there is a strong need to promote active learning which, according to Freeman et al (2014), “engages students in the process of learning through activities and/or discussion in class, as opposed to passively listening to an expert. It emphasizes higher-order thinking and often involves group work”.

Furthermore, major developments in local postgraduate education mean that doctoral programmes within my university are to be administratively managed by a new umbrella graduate school whose mission is to promote broader interdisciplinarity across campus. One major consequence of this re-structuring is that our students have to complete our mandatory curriculum in one semester rather than two years, so as to ensure that all PhD students, regardless of their programmatic affiliations, will follow their supervisor's departmental requirements from the second semester onwards. It is more urgent now than ever before that students and academics alike understand what interdisciplinarity entails. Metaphors are quite useful when illustrating the concept of interdisciplinarity and contrasting interdisciplinary and disciplinary modes of learning (Repko et al., 2020). According to the boundary-crossing metaphor, disciplines are sources of expert insights into a particular problem, and crossing of disciplinary borders is the action needed to access such expertise. Disciplines are like countries with well-defined borders and interdisciplinarians are like travellers who need to cross these borders when moving from country to country (Repko et al., 2020, p. 76). I have extended this metaphor to portray academic educators wishing to engage students in interdisciplinarity as guides on an arduous journey (Rashid, 2021).

In order to meet the challenges faced in doctoral education, outlined above, I propose instructional strategies for cultivating interdisciplinarity as an independent skill at the doctoral level. The strategies I propose are based on the interdisciplinary education literature, the use of technology in education, and my own interdisciplinary research practice, and are the result of a self-study I undertook to reflect on and improve my teaching practice (Rashid, 2021). For example, the "Broad Model" of interdisciplinarity, a framework designed to encourage students to articulate and integrate disciplinary insights, can be combined with blended learning to promote collaboration amongst students from different STEM disciplines. I have also adopted Eigenbrode et al's (2007) "Toolbox Project", a set of questions designed to elicit students' views on the philosophical aspects of research in an interdisciplinary context, to promote face-to-face and online cross-disciplinary discussions. I also like to present my own interdisciplinary research work as case examples because my past and present work provide an opportunity to share my personal experiences, e.g. how being interdisciplinary in my doctoral research led to much-needed novelty for my thesis. I have synthesized these strategies into a unified framework for developing competencies in interdisciplinarity at the doctoral level (Rashid, 2021).

As the pressing problems of the real world are not organized into disciplinary categories, there is an urgent need to make doctoral education more interdisciplinary. In addition, to take full advantage of such a rare opportunity to revamp our curriculum, I have extended my original framework to emphasize other qualities we hope to see in our students, e.g. commitment to ethical and sound scientific practice, and proficiency in communication and collaboration. In this symposium, I will outline the features of the extended framework, discuss some of the anticipated benefits, and propose how it might be adapted to non-STEM fields.

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