Exploring Interdisciplinary Competence through Categorisation of Problems in Physics and Science

Rosaria G. LENA, Charlie BURNETT, Frances BRESLIN

SUPA, School of Physics and Astronomy, University of Glasgow, Glasgow G12 8QQ, United Kingdom

Abstract. In this research, we aim to gain insights into the epistemological factors facilitating interdisciplinary skill development in students, during and after the degree. We designed and conducted surveys containing similar problems presented in various disciplinary contexts, and participants from Physics and other Schools in Science and Engineering were asked to categorise these problems based on problem-solving approaches. Preliminary findings suggest that joint-honours students in Science outperform their single-honours counterparts in connecting topics across disciplines, transcending superficial problem features, and that such ability improves with expertise in Physics.

Introduction

The integration of disparate fields fosters innovation, as seen for instance in ongoing advancements in quantum technologies, impacting diverse sectors from science to healthcare and finance. Collaborations among experts are essential for effectively sharing insights and exporting knowledge across disciplines, particularly as complex problems require multidisciplinary approaches. Higher education must therefore prioritise equipping students with both specialised knowledge and interdisciplinary skills, as endorsed by recent accreditation frameworks such as the Institute Of Physics (IOP) in the UK.

While the epistemological processes driving interdisciplinary skill development remain unclear and are currently subject of studies [1], they likely intersect with problem-solving proficiency. Gaining more insights on how students and experts approach interdisciplinary problems can aid the design and improvement of effective learning, teaching, and assessment methods to favour the students' ability to apply their knowledge across topic boundaries.

Research Questions, Methods and Findings

Previous research used "categorisation tasks" to study the development with expertise of problem-solving skills in Physics [2-3], where participants were asked to categorise single-discipline (e.g. dynamics) problems, based on problem-solving approach. Our study replicates these tasks to investigate how participants in Science are able to export problem-solving methods across topics and develop interdisciplinary competence. The novelty here is that we designed interdisciplinary problems, challenging participants to find analogies in problem-solving approaches across seemingly disconnected contexts. For instance, a question from our surveys probes participants' understanding of the physics behind LIGO gravitational wave detection, examining if they focus on 'superficial elements' added for context, e.g. astronomy-related keywords, or grasp the core principles of the problem that would be needed to answer the questions, e.g. interferometry/optics, deemed as 'good' categories.

The project comprises two parts, each addressing distinct research questions related to the categorisation tasks of interdisciplinary problems. In part I we explore the performance of students from various Science schools, investigating whether certain degrees foster better interdisciplinary skills. In part II we examine how the ability to export knowledge across different fields of Physics changes with expertise. In Part I, we distributed a survey consisting of 10 interdisciplinary problems in Science to students across all the Schools in the College of Science and Engineering at the University of Glasgow (UofG). For Part II, we surveyed undergraduate and postgraduate students, as well as academic staff, in the School of Physics and Astronomy at the UofG with another set of 10 interdisciplinary Physics questions. Despite low response rates (n=23 and n=22 for Parts I-II and p-values over the 5% threshold), the results from Part I suggest that students in joint degrees, such as Physics with Mathematics, outperform those in single-honours degrees, likely due to exposure to a wider range of courses. Preliminary findings from Part II indicate that interdisciplinary skills improve with expertise, aligning with trends observed in prior categorisation studies of problem-solving skills in Physics [2-3].

Conclusions

Preliminary results seem to agree with the expectation that the ability to export knowledge across disciplines and topics improves with the development of problem-solving skills, with expertise. Joint honours degrees seem to be better at providing students with interdisciplinary connections in problem solving. However, we need to collect more data to draw statistically significant conclusions and to gain insights about which degrees, courses and practices provide students with better interdisciplinary skills across the Schools.

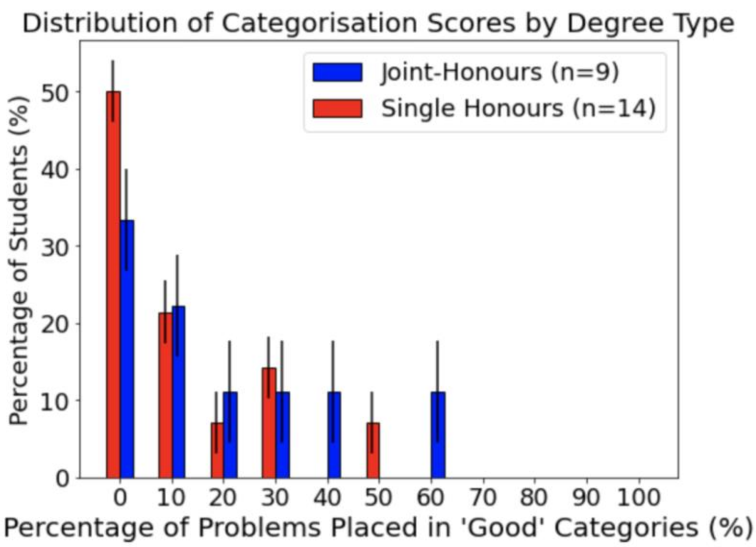

Figure 1: Percentage of problems placed in ‘good’ categories by participants from different Schools in the College of Science and Engineering, in two degree types, for part I of the project. The error bars show the standard errors.

References

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[3] A. Mason and C. Singh, Assessing expertise in introductory physics using categorization task, *Physical Review Special Topics-Physics Education Research* **7** (2011) 020110.