Recruiting talented students, particularly girls, into Physics through engaging students with the power and limits of science: The Epistemic Insight Project.

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1. Introduction

We warmly invite you to a conferral to take place at Somerville College Oxford on Tuesday 14th June from 2pm – 5pm.

The aim of the meeting is to devise the next steps of a project that is seeking to increase the proportion of students and girls in particular who want to study physics and engineering at university by providing students with opportunities to think critically about the nature, power and limits of science in multidisciplinary contexts.

The objectives for this meeting will be to provide an overview of the research to date and the workshops that we have organised for school students, and in addition:

- To propose some examples of key epistemic insights for physics and engineering students.
- To sketch out some possible workshops for tertiary level students that would develop such key epistemic insights.
- To assess what can be done in practice (surveys of students, guest workshops etc).

2. Background

The background to the work is that our existing research findings show that because children learn science within compartmentalised science lessons, they are missing out on thinking critically about what are the characteristics of a 'scientific question' and how to ask a scientific question to inform thinking about a bigger question. So by age 10 many children are saying "science is everything" and "science is facts" and "science can prove things" but are very weak on relating science to making observations for example. And in secondary again, students tending to talk about science in terms of the topics it covers (such as 'gravity') and not how to construct a scientific question. A significant proportion of secondary school students perceive science as a set of limitless and proven facts (Billingsley et al. 2016).

The curriculum objectives that are therefore currently neglected in schools are the ones that lead to an understanding of the nature, power and limitations of science. We're particularly interested in an aspect that seems to be missing in teaching practice at the moment which is - teaching children how to frame up a scientific question which will inform our thinking about a bigger question that cannot be fully resolved scientifically.

Our basis for the proposition that addressing this gap will have an impact on girls' attitudes to physics and engineering is based on data from our existing work which shows that a higher proportion of girls compared with boys hold non-scientistic attitudes to knowledge. A non-scientistic attitude means that science is not perceived as the only valid way to try to address a question. There is also a basis to say that the currently compartmentalised approach to science education fosters the misconception that having a scientific worldview necessarily includes a commitment to scientism.

The implications of this research are twofold:

- Firstly school science courses are failing to help develop a good understanding of the nature, power and limitations of science.
- Secondly it may follow that students who are non-scientistic would be more strongly drawn to STEM subjects if they were given opportunities to think critically about the nature of science.

We are now designing a larger-scale follow up project which will include surveys and workshops with school and tertiary level students –which will:

- Construct a set of the key 'epistemic insights' that students need if they are to be successful both as scientifically literate citizens and on science courses at tertiary levels - when thinking about the nature, power and limitations of science.
- Design run and evaluate workshops for secondary/tertiary level students which develop students' capabilities to frame their scientific questions beyond the constraints of their often compartmentalised science lessons.
- Inform curriculum and examination specifications for STEM subjects at school and tertiary level. A key output of the work will be a set of recommendations to guide the writing of the scientific literacy questions that appear in GSCE papers. If the recommendations are then accepted this would mean a clearer view on what children should be expected to know by this age, so that it becomes more teachable and testable. This would give some more assurance for teachers and students that the 'learning they do' will then be useful in exams.

3. Supporting Case

Our proposal that this approach may bring in a new audience to physics is further supported by the research we have conducted for our current project which focuses on biology education and exploring the links between biology and the broader question, what does it mean to be human. For a number of years we have organises events on our campus for school students who come for a day of talks and workshops exploring these questions. Each event to date has been oversubscribed and students' evaluations of the events have been overwhelmingly positive. Events have taken place on our own campus at the University of Reading and also at the Sheldonian Theatre Oxford. We have days designed for each of two age group – 10 year old students and 14-16 year old students. The project received national and international coverage on BBC TV and the report is available at http://www.bbc.co.uk/news/uk-19974380




Following the session, participants will be sent invitations to discern who would like to develop the project further.

References

Billingsley, B., Brock, R., Taber, K. S., & Riga, F. (2016). How Students View the Boundaries Between Their Science and Religious Education Concerning the Origins of Life and the Universe. *Science Education*, n/a-n/a. doi: 10.1002/sce.21213 http://onlinelibrary.wiley.com/doi/10.1002/sce.21213/abstract

Collins, S., Osborne, J., Ratcliffe, M., Millar, R., & Duschl, R. (2001). *What 'ideas-about-science' should be taught in school science? A Delphi study of the 'expert' community*. Paper presented at the Annual Conference of the National Association for Research in Science Teaching, St Louis, MO.