

# Concept inventories in physics: from development to impact

Dr Holly Hedgeland, Professor Sally Jordan



A team based in the School of Physical Sciences has been working to develop and validate a free-text response question format for use in measuring student conceptual understanding. Concept inventories are popular tools in the physics education community for quantifying learning gain and guiding instructional approaches. However there have been concerns around the multiple choice questions they typically use in terms of gender bias. In this work, we seek to evaluate whether our new question type provides a fairer alternative.

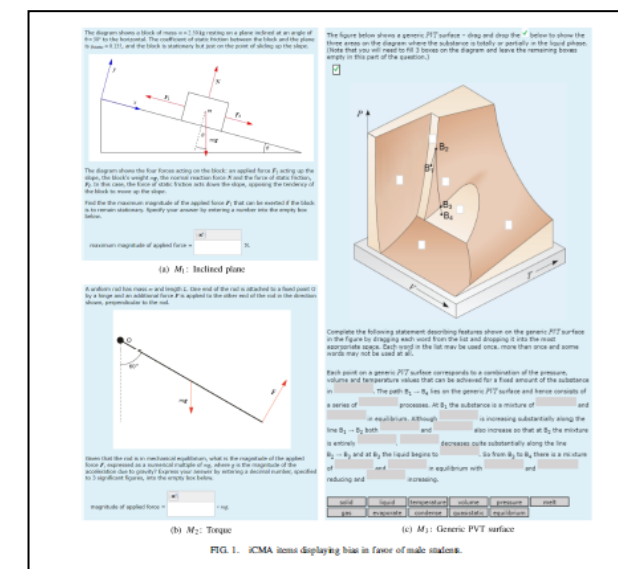
## 1) What's the gender gap when the questions are free text?

The initial phase of work on this research question will be analysis of a free-text response inventory covering concepts in Newtonian mechanics at both question level and instrument level for differences in performance by gender. A smaller, parallel project will be to analyse the same data for a second inventory that covers concepts in general relativity.

The second phase of the project will be to evaluate this data for statistically significant trends and report on the findings.

## Background

Our previous work (right and below) has looked into whether different questions types, such as multiple choice, or those involving the interpretation of particular types of diagrams show evidence of systematic gender bias.



The free-text response Newtonian mechanics inventory during testing.

PHYSICAL REVIEW PHYSICS EDUCATION RESEARCH 13, 020117 (2017)

### Impact of scaffolding and question structure on the gender gap

Hillary Dawkins, Holly Hedgeland, and Sally Jordan

School of Physical Sciences, The Open University, Walton Hall, Milton Keynes MK7 6AA, United Kingdom  
(Received 24 April 2017; published 13 September 2017)

We address previous hypotheses about possible factors influencing the gender gap in attainment in physics. Specifically, previous studies claim that scaffolding may preferentially benefit female students, and we present some alternative conclusions surrounding this hypothesis. By taking both student attainment level and the degree of question scaffolding into account, we identify questions that exhibit real bias in favor of male students. We find that both multidimensional context and use of diagrams are common elements of such questions.

DOI: 10.1103/PhysRevPhysEducRes.13.020117

OPEN ACCESS  
IOP Publishing

Eur. J. Phys. 39 (2018) 055704 (7pp)

European Journal of Physics

<https://doi.org/10.1088/1361-6404/aad169>

### Investigating male bias in multiple choice questions: contrasting formative and summative settings

H Hedgeland, H Dawkins and S Jordan

School of Physical Sciences, The Open University, Walton Hall, Milton Keynes, MK7 6AA, United Kingdom

## 2) Can we adapt the validated Newtonian mechanics free-text response inventory for wide dissemination?

The current test version of the inventory is housed within the OU Moodle, behind our authentication system, which has made it difficult for users from other institutions to interact with. As we reach the goal of a validated instrument, not only do we seek to make it readily available to our own students, but we will also prepare a version that can be readily used within a standard Moodle installation. The adaptation will allow us to promote uptake by other HEIs following publication of the validated instrument, and so increase the impact of the work.