

Interactive comment on “School students from all backgrounds can do physics research: On the accessibility and equity of the PRiSE approach to independent research projects” by Martin O. Archer

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Received and published: 24 August 2020

This is a valuable and well-written submission. It tackles an important issue and makes good links with the existing literature; the analysis is excellent and the findings add considerably to what is already known in the published literature.

We thank Prof Reiss for taking the time to review the manuscript and for their assessment of its quality.

There is a degree of self-congratulation in the comparisons with other pro-

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grammes – but the comparisons are very interesting!

We have limited comparisons between PRiSE and other similar programmes merely to data about the schools involved as well as to the national statistics. Our aim was to objectively present any significant differences in these data and critically reflect on them, for example we note in the manuscript required improvements in PRiSE's targeting by school type and admissions policy in order to be more representative of all schools nationally, highlighting the policies enacted to help achieve this. However, if the reviewer has specific comments on phrasing that could be altered to mitigate a self-congratulatory tone then we would be happy to consider these.

1. I have one major comment. It is a huge pity that “for ethical reasons we did not collect any protected characteristics (such as gender or race) or sensitive information (such as socio-economic background) from the students involved” (lines 67-68). Such data are not infrequently collected by educational researchers (indeed, they are collected by the DfE and available in the NPD) and I note the paragraph on gender that spans pages 7 and 8 (some might object to identifying gender in this way, though I am less of a purist). As the author is well aware, this means that all the conclusions made can only be made at school rather than individual student level. This, I am afraid, is not a trivial point. It is perfectly possible that the students who participate in these projects are far from representative of their schools. I think this should be made much clearer in the submission – in my view even the “School students from all backgrounds can do physics research” in the title is misleading and needs changed.

We hope that the reviewer bears in mind that this evaluative work has resulted from a university department's schools engagement programme with limited resource that has been delivered and evaluated by physics researchers. It is therefore not an educational research project in and of itself and as such comes with many ethical and practical limitations. While educational researchers may be able to utilise data available in the UK Department for Education's National Pupil Database, it is somewhat impenetrable

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in accessing even school census level data from a practitioners' perspective. Given these practicalities and the limited number of educational research studies into diversity and equity in STEM independent research projects at present, we felt that analysis even at the school-level would make a worthwhile contribution to the literature and in sharing good practice to other practitioners. However, we do take the reviewer's point that the manuscript could better flag the potential issue that PRiSE students may not be representative of their entire schools. We will therefore alter the title of the manuscript to "Schools of all backgrounds can do physics research", ensure phrasing throughout makes it clear our conclusions are limited to the school-level only, and expand the discussion justifying this school-level approach as follows:

This was done for both ethical and practical reasons, bearing in mind that this is a schools engagement programme delivered and evaluated by physics researchers and not an educational research project in and of itself. For example, it was deemed that requiring students or their teachers to provide protected or sensitive information upfront would have risked some students, or indeed entire schools, declining to participate. This limits the conclusions that can be made to only the school-level. However, it has been recognised that the clustering of students within schools results in students within the same school having more in common with each other than with students in different schools, an important consideration in the uptake of post-compulsory physics education for example (Gill and Bell, 2011). While multilevel models could account for this hierarchy, this is beyond the scope of what is practical for PRiSE. We note that schools typically involve entire (or significant fractions of) cohorts of A-level physics students in PRiSE (see M.O. Archer et al., 2020, for further discussion) and so while we have no indication that PRiSE students differ in any substantive way from their schools' wider student-base, we cannot rule out that they may not necessarily be representative. Finally, since one of the aims of PRiSE is to impact on

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teachers' practice and schools' STEM environments, school-level considerations are valuable in this context regardless of the specific characteristics of the students engaged in PRiSE.

2. I suspect the "issue" with IRIS is not in "their targeting" (line 155) but which schools respond to its offer

We thank the reviewer for this perspective. While indeed the makeup of IRIS's schools may be simply due to those that respond to their offer, this somewhat passes the buck of the issue onto schools which is rather unfair. PRiSE and ORBYTS have demonstrated that there is interest in 'research in schools' projects from schools from a wide variety of backgrounds. Both these programmes have made considerations in developing their programmes to make them accessible for schools from a variety of backgrounds with the support provided, discussed further in M.O. Archer et al., 2020. Furthermore, PRiSE advertises via school networks (such as through the Institute of Physics and Ogden Trust) that specifically target disadvantaged schools, finding responses from a diversity of schools which is reflected in the statistics on participation. However, given that this brief comment positing potential reasons for the differences in schools engaging with IRIS and HiSPARC to those with PRiSE are merely conjecture, we would be amenable to remove them from the manuscript as they are not essential to its main messages and results that are rooted in objective data.

3. I think it would be worth discussing briefly whether maximising retention of schools across years is always a good.

The reviewer makes a good point which we will expand upon as follows:

Maximising the retention of schools across years is necessarily a function of the capacity of a programme. While bringing new schools into the programme is certainly beneficial, we have seen that teachers' ability and confidence in supporting project work in their school develops not only across

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the 6-month programme but over several years (M.O. Archer et al., 2020). Therefore, a practical balance could be to aim to involve schools directly for just a few years to the point that they can sustainably run projects with fewer interventions from the university, perhaps just an on campus kick-off and then the conference as researcher capacity is less of an issue with these. We acknowledge though that some schools might no longer participate without the full suite of interventions. This approach would enable the wider impacts on schools that benefit from multiple years of participation (M.O. Archer and DeWitt, 2020) while also ultimately freeing up capacity in the long-term for new schools to be able to benefit from the programme.

4. Was there any ethical clearance for the research element of the work?

Requirements for ethical clearance were discussed with an expert in ethics from Queen Mary's Joint Research Management Office. From these conversations it was deemed by them that the nature of this work (a schools engagement programme in physics delivered by physics researchers) and the ethical considerations put in place both within the programme and its evaluation (anonymisation of schools and participants, no protected/sensitive data being collected etc.), as well as the purpose of the publications being that of sharing practice with practitioners resulting from evaluative work were sufficient that Queen Mary did not require it to go before a formal ethics board.

5. With reference to the qualitative data, there is a clear account of thematic analysis but then no evidence that this was actually undertaken. What these were identified? Can we have some quotations related to such themes?

We apologise that the themes identified pertaining to accessibility, diversity and equity were not clear in the manuscript. We have now emboldened within the text the themes to clarify them, with the quotes within their respective paragraphs exemplifying the different aspects within these themes. The themes identified concerned:

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- Valuing the diversity of the schools
- Equity in terms of students' ability
- Issues around communication

We hope that this is sufficient.

References

Archer, M. O., DeWitt, J., and Thorley, C.: Transforming school students' aspirations into destinations through extended interaction with cutting-edge research: Physics Research in School Environments, *Geosci. Commun. Discuss.*, <https://doi.org/10.5194/gc-2020-35>, in review, 2020.

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Gill, T. and Bell, J. F.: What Factors Determine the Uptake of A-level Physics?, *International Journal of Science Education*, 35, 753-772, doi: 10.1080/09500693.2011.577843, 2011.

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