Interactive comment on "Transforming school students' aspirations into destinations through extended interaction with cutting-edge research: "Physics Research in School Environments"" *by* Martin O. Archer et al.

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Thank you to the authors for working to summarize their program and research as part of the PRiSE program. It is clear that this group has taken the task of creating and evaluating their educational program seriously and I commend them on identifying many different facets of the program to document and share with the broader community. The paper is generally well presented but as a reader first learning about this program I have some major revisions to suggest.

We appreciate the reviewer's attention to our manuscript and are particularly grateful for raising our awareness of areas that are not as clear as we intended them to be. We have carefully considered the reviewer's points and respond to them below.

Major Considerations for Revision: While I see the clear value and need to share this work with the broader community, especially given the authors' goal to "introduce a scalable framework for protracted research-based engagement with schools", I have some questions about how this and the other papers submitted simultaneously in review in Geoscience Communication about the same program differ from one another and how they each meet the journal requirement of making "a substantial contribution to scientific progress within the scope of Geoscience Communication (substantial new concepts, ideas, methods, or data)"

The demarcation of the different papers submitted to Geoscience Communication are outlined on lines 115-117, and concern three separate areas:

- This paper: An introduction to the framework of this programme, the considerations made in its provision and support, and how they have been perceived by stakeholders (so-called process evaluation).

- Impact evaluation exploring the actual benefits for students and teachers that might have resulted from the programme.

- Audience evaluation assessing the diversity, accessibility and equity within the programme for the schools we work with.

Each paper contains clear and separate conclusions. Other published papers in this field by other authors, for example the various papers cited on IRIS's programme, also split the content and focus up in similar ways thus we feel this is appropriate.

Further, based on the references cited in this manuscript, the lead author also has another paper in review at another journal that seems to align with a similar premise being presented here.

The other paper that the reviewer refers to is an in-press landscape review of various engagement programmes that use repeated interventions rather than one-offs and thus features a wide range of other programmes. We will highlight this in the manuscript for clarity.

As a reader (who hasn't read all of these manuscripts to know exactly how they differ), I'm left wondering why someone would need to read four papers about a program to understand the structure and impact.

How the papers differ in their focuses is outlined on lines 107-117 but we will try to clarify the differences between the three papers. The programme is significantly more extended, consisting of several different parts, than typical one-off engagement approaches published in this journal and others, thus it is not surprising that a full exploration of its structure and impact is lengthy. (As noted, the fourth is a review of a range of programmes and reading it is not necessary to understand the structure and impact of this particular programme.)

While I fully appreciate the appropriateness of evaluating and interpreting results from a program like this in multiple ways, the current structure of the arguments suggests that they might be able to present their work in one well-structured and concise paper (or two) that really uses the data to substantiate the claims being made and demonstrates how they are meeting their Theory of Change which states: "The intended impact of PRiSE is to contribute towards the increased uptake and diversity of physics at higher education."

We initially aimed to combine the current framework paper with the papers on impact and diversity. However, including sufficient information for clarity and to support our points made the paper exceedingly long, and awkwardly structured. Consequently, for

clarity, we split the manuscript into three papers. Each paper stands alone and does not rely upon the results of the others, however, we feel that reframing the papers to make their independence clearer and removing unnecessary cross references would assist readers. Recombining the three papers would not work as either a coherent (due to their different focuses) or concise (due to excessive length) paper. While we agree that doing so, on the surface, would seem to make sense, our experience highlights that it would not allow for a full exploration of all aspects of the programme and its evaluation to the level of rigour required by the journal.

As a reader new to the program, and taking the abstract at face value, I found myself asking fundamental questions about the structure, resources, personnel and design of the program. This is touched on in brief in various parts of the paper but some challenges about the program structure are mentioned starting in line 500 that seem to warrant further comment, especially in the context of thinking about scalability of this program.

We have tried to concisely discuss the structure, resources, personnel and design of the programme but appreciate there may be areas where more detail is required. We will re-examine the description to see where further elaboration is likely warranted.

Other details like the core resources or research that undergird the program are mentioned in the latter part of the paper and seem a bit out of place. Perhaps some of the text could be instead captured in visuals or a diagram?

We feel it is important for readers to gain some idea about the student activities involved in the current projects. We have tried to incorporate these elements in a concise manner, whilst also bearing in mind the range of backgrounds among the readership, though we would be happy to consider specific recommendations on visuals or diagrams and will re-visit this possibility.

Overall, while the Theory of Change and surrounding literature review are helpful for framing the need and context of the PRiSE program, the body of the text and

data presented don't seem to directly align with or support the premise of the paper as articulated in the abstract and conclusions.

Our premise in this paper is to detail the considerations made in developing the programme (in light of its aims), in particular detailing the structure, support, and resources offered by active researchers as part of PRiSE. Thus, the main bulk of the text and data presented are related to the provision and support offered as part of PRiSE and not the impact of the programme itself, as this is assessed in a different paper. However, in light of the reviewer's comments, we will try to more clearly articulate the premise of the paper in both the abstract and conclusions. Furthermore, as raised by other reviewers, we will aim to link back to the Theory of Change more throughout our discussion of the structure, support, and resources. Finally, upon reflection we feel that changing the title of this manuscript might also help in conveying its contents better, so we will alter this to "Developing a framework to bolster school students' aspirations through extended interaction with cutting-edge research: 'Physics Research in School Environments'".

To concretely illustrate this, in the abstract the authors state "This illustrates that the model appears to provide highly positive experiences that are otherwise not accessible to schools and that the extraordinary level of support offered is deemed necessary with all elements appearing equally important. Researchers and public engagement professionals seem receptive to the PRiSE framework of schools engagement and it has started to spread to other institutions." While the authors present some data to demonstrate their programmatic success, for their most critical claims, they point the reader to a different paper (as above) and don't really touch on the focal point of their theory of change.

Our intention was for the claims made in this paper only to pertain to the framework of the programme and how it is perceived by participants, rather than to the impact of the programme. The theory of change is presented to outline the aims of the programme and how that has influenced how we developed the programme's provision. This is similar to other published papers which introduce theories of change (e.g. Davenport

et al., 2020). We will edit the paper to make our premise for and focus in this paper clearer.

Davenport, C., Dele-Ajayi, O., Emembolu, I., Morton, R., Padwick, A., Portas, A., Sanderson, J., Shimwell, J., Stonehouse, J., Strachan, R., Wake, L., Wells, G., and Woodward, J.: A Theory of Change for Improving Children's Perceptions, Aspirations and Uptake of STEM Careers, Res. Sci. Educ., https://doi.org/10.1007/s11165-019-09909-6, 2020.

Further, they mention on several occasions in the paper the "extraordinary level of support" needed and offered through this program by the researchers but do not elaborate on how this might be a barrier to the scalability of their program. It would be helpful to the readers if the authors were more explicit about how much time is required from researchers to support this type of programming, how researchers are recruited and rewarded/acknowledged for their participation and how the program itself is funded or supported, especially in light of the acknowledged barriers to sustaining engagement by researchers. These types of structural and programmatic details are key to seeing how the program supports their ToC and offers valuable insights for those seeking to recreate this type of 'research in schools' program.

We have touched upon some of these elements within the manuscript, for example in discussing the different roles within the programme (lines 266-273). However, it is clear that more needs to be done. We will clarify in section 2.2 that the scalability we refer to mostly concerns the balance of reach and impact discussed here. We will also further explore aspects of scalability to other institutions, which is only briefly touched upon. We will also emphasise that many of these points will be highly dependent on specific structures and policies present within institutions (something which was briefly noted on lines 268-269).

Building on the other reviewer's comments, I think there is ample opportunity to

streamline the text, and clarify the presentation to only those details most salient to communicating to the reader the design and implementation elements of the program, while being much more explicit about how the data they have collected demonstrate if/how (or not) the program 'meets' their Theory of Change.

We agree that achieving an appropriate balance between being concise and providing sufficient detail is always a challenge. However, given that the other reviewers have lauded the detailed description of the various elements and that our aim with this paper is to provide sufficient detail required so that readers could replicate or create a similar programme, we hesitate to streamline or cut too much. While we hope that we have provided enough detail to exemplify relevant aspects of our Theory of Change (e.g. what the various inputs, activities and assumptions are), the exploration of potential impacts or outcomes are the subject of the accompanying paper.

This is essential to demonstrate a) how the program is scalable and b) the documented value and impact and therefore, why it is a model that should be scaled to other schools/locations/programs.

We agree with the reviewer that the paper would benefit from more exploration on scalability, which we will add. The value in terms of impact on participating students and teachers is explored elsewhere. While in some ways, it could be ideal to explore all of that in a single paper, this proved unfeasible.

I would encourage the authors to significantly revise this manuscript and to think about how to present the details about how the program works and the data they have that indicates that the program is successful (and why) together in one paper.

As noted, one single paper was not sufficient to fully explore all the aspects of the PRiSE programme and its evaluation to the level of rigour required by the journal.

Based on the review criteria, this article falls short in demonstrating (in relation

to the other papers submitted for review at the same time) how each makes a unique and substantial contribution that warrants publication, and as currently written, this paper does not really provide sufficient evidence to support the interpretations and conclusions.

The evidence and conclusions in this paper concern the experiences of participating students and teachers and their feedback on the level of support offered, as well as perceptions of researchers at other institutions about the potential scaling or spread of the framework and programme. We will try to ensure more clarity around the scope and aims of this particular paper, as well as noting that we do not aim to claim impact.

I have no doubt that through some more careful writing, streamlining of the text and analysis of the data alongside the programmatic structure, that readers would see the substantial contribution being made through this program and its structure and the value it offers as a model that could be replicated elsewhere.

While there is work to do, I really do commend the authors on their thoughtful approach, clear investment in data collection and analysis, and for developing and iterating on a program that seeks to make a novel contribution for bringing research to schools. They certainly have invested an enormous amount of time and dedication to the PRiSE program and I really hope to see this work shared with the science communication and education communities.

We thank the reviewer for their acknowledgement of the work that has gone into this programme and its evaluation and we hope that our changes will provide more clarity in the paper.