

Reponse to Reviewers and Editors

Dear Editor and Reviewers,

We appreciate your time and efforts in improving the manuscript and are thankful for the summarized version of your suggestions. Here we provide specific comments or corrections and a tracked version of the manuscript is also available. We hope that with these changes, the manuscript can be finalized and published.

In response to Editor Summary:

- Please revise the phrasing in the abstract and introduction to avoid referencing topics that are not substantively addressed in the paper. For example:

*In the abstract, reconsider “to provide a template for science communication”

*In the introduction, avoid phrasing such as “ensure... scientists remain working on, and living in, the Arctic,” unless supported by data or discussion.

Thank you. These phrases have been re-written to better reflect the conclusions and focus of the paper.

- Please note also the recommendation to harmonize the introduction and discussion sections. This is an opportunity to clearly state the research questions. I recommend aligning each of the four program aims (outlined in the Introduction) with a corresponding research question. The Discussion section should then be organized to answer to these.

E.g. if Aim 1 were to be recast as What are the trends in participation across age groups, and what indications exist that these programs influence interest in STEM education? – the authors’ analytical contributions address this already, and aligning the Discussion in this way will make those contributions more explicit.

Thank you for this suggestion – it has greatly improved the flow of the manuscript and much better connects the aims to the conclusions. The following research questions have been addressed:

RQ1) What are the trends in participation across age groups, countries and other demographic identifiers?, RQ2) What indications are there that the E&O programs have positively influenced the interest in STEM education?, RQ3) What evidence is there that the Young program has impacted career choices of participants and their knowledge of career options, particularly in the Arctic?

As some of the research questions can address multiple aims, we haven't assigned them that aim 1 = research question 1. For example, RQ1 addresses the number of students engaged in the programs (Aim 1) and number of scientists engaged (Aim 4). However, we do think the three research questions now address each aim and the wider impact of the programs too.

We then used A1 for the aims and RQ1 for the research questions throughout the manuscript.

- The above attention to research questions aligned with program aims, and linked organization of the Discussion section, should then be sufficient to address reviewer's points 2 (Program Description), 4 (Results: Impact), and 6 (conclusions).

Example: In comment 4 (Impact), the descriptive figures are justified when positioned as evidence in response to RQ1 (participation trends and reach). Likewise, participant feedback on interest and careers directly addresses Aim 2 (potential RQ2).

- Please address the reviewer's minor comments, request to add details on survey specifics (e.g. response rates), moving Limitations to the end of Discussion, and suggestion to remove figure 3.

Figure 3 has been removed, and the limitations section has been integrated into the discussion. The discussion has been re-structured to address the research questions. 'Limitations' section is now at the end of the discussion. Due to the large changes, we recommend reading the non-tracked version for clarity.

Final comments: Consider renaming Section 2 to better reflect the paper's analytical framing, as opposed to a purely descriptive approach (to me it reads more like a Program Context and Design section). Ensure Section 4 includes the term "Results" in the heading to clarify its role in presenting findings.

Thank you. We have called section 2 'Program Design' now following your suggestion. Section 4 now has the heading 'Results' and is then split by research question for clarity and structure.

Specific Feedback to Reviewer 1

General comment: the authors have done a commendable effort to showcase the research aspects of assessing the success of the Arctic Frontiers Young Program. The paper is much improved, and with a some final corrections I believe the paper will be a good feature in GC. The comments below concern mostly the harmonization of the paper, and the tables and figures. They are intended to help the authors publish an academic paper, rather than a program overview, and so I hope these comments can be helpful to the authors.

Thank you for your time and great recommendations. We have tried to incorporate as many as possible and the paper is now significantly restructured. Therefore, we recommend reading the non-tracked changed version for ease.

1. Abstract and introduction:

These sections still seem a little disjointed from the survey results and analysis, since the survey does not evaluate the impact of the program on many of the issues raised, e.g. the double leaky pipeline, women in higher level academic positions, and retention

of teachers in the Arctic. The paper also does not provide a template for communication. The paper does provide much detail on the program itself, which begs the question of how other such programs operate, and their comparative success. The paper does raise this issue in the discussion on the limitations of the program, but this adds to the disjointed nature of the paper. Is the paper about what the introduction says or about what the discussion brings up? I recommend harmonizing the introduction and discussion sections.

Thank you for the suggestions. The details of the program were cut down significantly based on the feedback from reviewers in the first round of reviews. The word 'template' was not intended to be read as a direct translation, but rather a blue print/outline/concrete ideas which others could use to develop their own programs. We have now removed this term and changed the abstract/introduction to better outline what the aims of the paper are. However, we believe the context for conducting STEM E&O programs (to have a bottom up approach to improve some of the issues in STEM) should still remain in the introduction. We have bolstered the discussion and conclusion with more connection to the larger STEM issues too.

2. Program description

This section has been tightened and reads better, but it would be helpful to include here data on the participants over the years as part of the description of the program. For instance, the number of participants each year, the map of the countries of residence, but also information about their nationality, sex, etc. This information is currently in the impact section, but the authors may wish to consider moving that information here. Suggest to take out figure 3 as it can be described in one sentence.

Figure 3 has been removed, however we have now re-framed the results and discussion to answer specific research questions, therefore the other data remains in the results section.

3. Data and methods

Please also mention how the survey was structured and how it was administered to each group (email, LinkedIn, on paper, in person, zoom), how confidentiality was ensured, how many people responded to surveys, how many people were interviewed (including the rector), and information about their sex, nationality (other demographics), and the IRB process. Was there an effort made to ensure a representative sample of respondents? Will the survey questions be included in an appendix?

As discussed in the limitations of the program, the survey was not intended to collect data for a scientific publication, it was rather intended as a way to monitor the programs and ensure that we were evaluating and improving the services. In addition, the surveys have changed over time when there were new requests for information (e.g from funding agencies). We do not collect the demographic data of many participants – especially the younger ones. The demographic data from the other participants is also removed from the surveys and they are anonymous. This was a request of most participants, who were not willing to answer questions about their gender or other

demographics. Therefore, the information on demographics (figures in the main paper) are split from the qualitative data. We have provided more information about the survey collection in the data/methods section.

4. Impact of the young program

The figures and tables are a bit jumbled relative to the text that discusses them, and I recommend placing them immediately following the relevant paragraph. As it is, the text is difficult to navigate, between deleted text and figures/tables at long distances from their reference text. Generally, the figures counting participants per year, and their nationality seem less of a result than a description of the program, and I would have recommended placing them in the program description, saving this section for the survey results about the program itself and its outcomes. Regarding the connection between the introduction and the discussion, the survey seems to have asked more about how the participants experienced the program, rather than following how the program impacts retention and career choice, and so more related to the discussion on the limitations of the program than to the introduction. For instance, at Line 335, you say that "Students and teachers were not directly asked what impact the program has had on their educational path," and therefore does not help the authors speak to the topics introduced in the introduction (but they do help vis a vis the discussion on educational programs).

Thank you for your suggestions. We have now amended the introduction and research questions for the paper. Due to the many structural changes across the multiple review stages, I recommend looking at the non-tracked changes version, so that the figures are in the correct place. Hopefully, following type-setting, they will also be formatted into the correct location.

5. Limitations of the study

Should this section more helpfully be called discussion? The paper currently lacks a dedicated discussion section to tie together the arguments, but this section nevertheless contains many elements of a discussion.

This section has now been tied into the discussion and the discussion has been restructured following reviewer and editor suggestions. Thank you.

This section is useful and brings many good points relevant to the results just presented. However, it is not tied well to the introduction, and the citations are very different (except Cole and Vennix). I suggest needing to harmonize the introduction and discussion so that the paper is also harmonized. The survey has not gathered data that helps develop understanding of outcomes for the issues raised in the introduction, but it may still be relevant for the discussion. For instance, the authors may want to consider including a discussion of how future surveys can be structured, or how alumni might be engaged, or even how other statistical sources (e.g. SSB) could be used to explore the program's impact. The program has been running for 12 years so there might be some evidence.

Thank you for these suggestions. We have now included a paragraph in the discussion which discusses future data collection plans and we have created better connection between the introduction and discussion.

A few key questions seem important to come back to in this section. First, why there are so many women participants but so few women in higher academic positions; second, why the program has been so successful at recruiting Indigenous participants (higher than percent of residents); third, why and with what consequences the majority of participants are not nationals but residents from other nations; and fourth, how impacts on studies and careers can be monitored. These issues merit some more discussion here.

Thank you for raising these important yet complicated questions. We have attempted to investigate them further in the discussion. We explained how we are able to include Indigenous participation so readily, identified studies to shed light on the gender results and also looked more into the citizenship vs residency result. These can be found in various parts of the discussion.

6. Conclusion

The conclusion indicates the paper has been an assessment of the program. Please tie this back to the introduction where the paper is also about the wider issue of STEM in the Arctic and how the program contributes.

The conclusion has now been improved following your feedback – thank you. It has changed significantly, so we recommend reading the non-tracked version for ease.

Ethical statement

Did the authors secure IRB approval? The authors also raise Indigenous knowledge. How does the program engage with this topic?

No, we did not secure IRB approval – in Norway this is not a formal requirement and ethics approval appears connected to health and medical research. There are a number of national committees for various topics of research, but these are advisory committees and they do not grant approval. Research institutions have overall responsibility for ethics, and some Norwegian universities have their own ethics boards, however the authors are not affiliated to such institutions. More information is available here: <https://www.forskningsetikk.no/en/resources/the-research-ethics-magazine/2022-2/many-approve-the-research-themselves/>.

Despite this, we make every effort to adhere to GDPR regulations, provide clear, prior information to the participants, and their demographic data is not attributed to their survey responses. If participants chose to use their name or are included in videos or photographs, they sign a form which provides us permission to use this information. If they want to remove their participation from videos, text etc. this is possible and we remove their information. Photos and feedback from children is provided following the receipt of parental consent forms. We have included more information in the ethical statement and in the paper to clarify some of these steps.

We do not research Indigenous peoples or their knowledge systems. Indigenous peoples are included as mentors or participants in various programs (information now included in the paper), however the programs are not targeted towards Indigenous peoples as a specific group (rather, all relevant and interested young people). Despite this, we have collaborations with various Indigenous peoples and organisations, and follow their guidelines on correct useage of language and Indigenous knowledge in our programs.

Line 55 The description of Arctic Frontiers needs a sentence or two linking it to the previous sections on STEM careers, or perhaps its own heading.

Thank you – the description of Arctic Frontiers now comes immediately after the sentence calling for institutions to focus on E&O and take the burden away from scientists. Additional sentences have been added for further clarity and link to the paper.

Line 292 has a syntax issue. “Thereby...”

This sentence has been removed in the restructuring of the paper to focus more on research questions.

Figures and tables are jumbled and need to be placed as soon as possible after the referencing text so as to ease reading.

This has now been done – hopefully the layout is also easier to follow once proper proof editing and template work has been done.