

Web links to the author's journal account have been redacted from the decision letters as indicated to maintain confidentiality.

Decision letter and referee reports: first round

15th May 20

Dear Dr Hernandez,

First of all, please allow me to apologise for the delay in sending a decision on your manuscript titled "Inspiration, inoculation, and introductions: Critical elements to improving persistence for undergraduate women pursuing geoscience careers". It has now been seen by our reviewers, whose comments appear below. In light of their advice I am delighted to say that we are happy, in principle, to publish a suitably revised version in Communications Earth & Environment under the open access CC BY license (Creative Commons Attribution v4.0 International License).

We therefore invite you to revise your paper to address the remaining concerns of our reviewers. At the same time we ask that you edit your manuscript to comply with our format requirements and to maximise the accessibility and therefore the impact of your work.

EDITORIAL REQUESTS:

Please review our specific editorial comments and requests regarding your manuscript in the attached "CommsEarth Final revisions information checklist". Please outline your response to each request in the right hand column.

SUBMISSION INFORMATION:

In order to accept your paper, we require the files outlined in the attached "CommsEarth Final submission file checklist.pdf"

OPEN ACCESS:

Communications Earth & Environment is a fully open access journal. Articles are made freely accessible on publication under a [CC BY license](http://creativecommons.org/licenses/by/4.0) (Creative Commons Attribution 4.0 International License). This license allows maximum dissemination and re-use of open access materials and is preferred by many research funding bodies.

For further information about article processing charges, open access funding, and advice and support from Nature Research, please visit <https://www.nature.com/commsenv/about/open-access>

At acceptance, the corresponding author will be required to complete an Open Access Licence to Publish on behalf of all authors, declare that all required third party permissions have been obtained and provide billing information in order to pay the article-processing charge (APC) via credit card or invoice.

Please note that your paper cannot be sent for typesetting to our production team until we have received these pieces of information; therefore, please ensure that you have this information ready when submitting the final version of your manuscript.

Please use the following link to submit the above items:

[link redacted]

** This url links to your confidential home page and associated information about manuscripts you

may have submitted or be reviewing for us. If you wish to forward this email to co-authors, please delete the link to your homepage first **

We hope to hear from you within three weeks; please let us know if you need more time.

Best regards,

Heike Langenberg, PhD

Chief Editor
Communications Earth and Environment

On Twitter: @CommsEarth

REVIEWERS' COMMENTS:

Reviewer #1 (Remarks to the Author):

This paper describes the impact of three interventions to improve women's persistence in geosciences that vary in their scope and resource intensity. The authors find that a workshop including aspects of Inspiration (discussion of role models), Inoculation (activities to build skills of resilience and success), and Introduction (a personal connection to a female mentor) was more effective at increasing women's intentions to persist in geosciences than workshops only including the first or the first two of these components. The work involved in putting together these workshops and facilitating these mentoring relationships is clearly substantial, I really commend the authors for how much thought and time and effort has clearly gone into this project. The results are interesting and do offer valuable insight for those looking to diminish the gender gap in geosciences and related STEM fields. I only have a few minor comments where I think things could be made more clear, suggestions for future work in this line of research, and places where I would like to hear more of the authors' thoughts.

I would have liked to see a little more discussion of how the authors arrived at the three different combinations of components in each workshop. The authors make clear that mentoring, rather than role models, is the key factor in women's persistence in geosciences, and that real-world mentoring networks were most facilitated by the Three-I condition (if you'll allow some brevity in the names of the conditions). This suggests that the Introduction is really the most critical component, and made me wonder why there was no Introduction-only condition. It's possible that once the Introduction is made that the mentor may provide information to their mentee similar to what is included in the Inoculation aspect of the other workshop, and if that is true, matching mentors and mentees and sending an introductory email would be far less resource-intensive and could achieve the same results as the full workshop tested here. In future research with this intervention, it would also be interesting to know how much in-person interaction participants report having with their mentor after the introduction and if the amount or quality of that interaction also has an effect on their intentions to persist (the supplemental materials say that the introductory email "set the expectation", but I'm curious to see how many actually complied and were able to maintain this relationship).

Additionally, I thought the discussion could have gone into more detail about why only science identity emerged as a psychological variable responsible for mediating the effect of mentor networks on intentions to persist in geosciences. The authors clearly have a great deal of experience and expertise with these workshops/interventions, and I wondered why being better able to cope with obstacles would not also lead to greater intentions to persist. Any thoughts that the authors have would be clarifying and useful to the reader.

One thing that I found confusing as a reader was the presentation of the number of role models and mentors being presented categorically (0/1/multiple) as opposed to continuously. While the supplemental materials do indicate that the measurement of these numbers only allowed participants to report up to 3 of each, I think it would still be informative to see how these analyses look when the number of role models/mentors is treated as a continuous variable (and in future work to allow for participants to report more than three if they wish). In Supplemental Table 2 the pre-test number of role models and mentors are presented continuously while the post-test numbers are presented categorically, and it would be helpful to see them and treat them on the same terms. Along these lines, I think it would be informative to have a table or some discussion of how participants look in terms of how their numbers of role models/mentors change from pre to post-test. That is, are most women going from 0 to 1, or 2 to 3, or something else? And does this differ by condition?

Again as I stated above, I truly appreciate the amount of work that went into this project and the heroic effort at data collection that went on here. However, in 2020 I think it is appropriate to even have a cursory sentence addressing statistical power in a fully between-subjects design with n of about 50 per cell.

The supplemental materials state that all three workshops included “a discussion of challenges to success in scientific careers (e.g., implicit bias)”. I would love to have this unpacked more in the supplemental materials’ description of the workshops. Implicit bias itself is a widely publicized, often understood concept, implicit bias training is a whole subliterature in and of itself and I’d be very interested to know what specific information about implicit bias was being presented to the girls in this program.

As one final note: this is obviously not a huge deal but if you ever use these measures again it might make more sense to have the response options for the Scientific Career Persistence Intentions (described as “strongly disagree” to “strongly agree”) match the content of the items (which are “what is the likelihood...” and two “to what extent...”, neither of which you can actually agree or disagree with).

Reviewer #2 (Remarks to the Author):

The current article is important in that it is one of the few to examine what the important elements of a good mentorship intervention are for undergraduate women in STEM. Thus, this research is a novel and important contribution to the mentorship literature. Specifically, in this study, the authors examined whether mere exposure to women in geoscience, exposure to women in geoscience coupled with training on career success and networking, or exposure to women in geoscience, training on career success and networking, and being paired with a local woman in geoscience after the workshop impacted women’s science identity, coping skills, seeking of emotional support, seeking of informational support, and intentions to persist in science. They found that if you show undergraduate women women in geoscience, give them the training on career success and networking, and introduce them to a local woman in geoscience in combination undergraduate women are more likely to report having more mentors as well as having an enhanced science identity and intending to persist in science.

While reading the article, some points of confusion emerged. I provide the following recommendations to the authors to clarify the research study.

- In the main article, I did not understand how participants were randomly assigned to only 1 of the three workshops and I misunderstood why the workshops were on different days. The good

news is that this confusion was resolved in the supplemental materials. However, I recommend that the authors clarify this in the main manuscript because many readers will not take the time to look over the supplemental materials.

- In the general discussion, I recommend that the authors acknowledge that many of the barriers to success that women in geoscience face have to do with the institution they are a part of and the culture of geoscience. Even though training is important, I recommend that the authors acknowledge that training women on career success does not mean that women need to toughen up to make it in geoscience (which is what some people might take away from these types of programs, which turns into a victim-blaming interpretation of why women are underrepresented in STEM fields). By acknowledging the culture in geoscience, the authors can help move the conversation away from what women are or are not doing and move it towards a more productive conversation of what can we do to support women.

- In the main manuscript, at first read, it was very unclear what the model the authors analyzed looked like and that the analyses reported were part of that model. I recommend that the authors provide a model explanation section in the main manuscript to resolve this confusion. This should be provided once before going into the explanation of the individual parts of the model.

Additionally, in both the supplemental material and the main manuscript, I recommend that the authors provide a figure depicting a full version of the model tested is needed (which would include all variables entered in the model). By providing this model, the authors would provide the reader with a better idea of what was tested and what effects were significant.

- I recommend that the authors change the label of the y-axis for the bar graphs presented in the main manuscript as the current labels are confusing. Instead of the y-axis just having %, I recommend that the authors instead say % of participants. Furthermore, I recommend that the authors make the x-axis labels for the bar graphs consistent with the figure labels provided as in the current manuscript, they are inconsistent, which makes them confusing to the reader.

- I also recommend that the authors discuss in the general discussion the fact that half of the participants are indicating 3 months after the workshops that they do not have women mentors in STEM.

- I also recommend that briefly in the main manuscript the authors mention what happened for the groups other than the inspiration, inoculation, and introduction group in the path model. Because these groups are mentioned heavily through the introduction and method section, the reader is left wondering what happened to them in the model.

- I also recommend that the authors make some minor changes in the tables provided in the supplemental materials to help with readability. Specifically, it would be advantageous for the sources in table 3 to be on a single line instead of being on multiple lines. Further, for Table 4, instead of using superscripts to designate whether the measure was included in the pre or posttest, it would be easier for the reader if the authors just labeled the measure by writing pre or posttest next to each label.

Responses to Reviewers

Dear Dr. Langenberg,

We thank you and the reviewers for your insightful feedback and helpful comments on our manuscript. We have carefully considered the critiques and list below our approach to addressing each one. Please note that we have italicized our responses.

Reviewer 1

This paper describes the impact of three interventions to improve women's persistence in geosciences that vary in their scope and resource intensity. The authors find that a workshop including aspects of Inspiration (discussion of role models), Inoculation (activities to build skills of resilience and success), and Introduction (a personal connection to a female mentor) was more effective at increasing women's intentions to persist in geosciences than workshops only including the first or the first two of these components. The work involved in putting together these workshops and facilitating these mentoring relationships is clearly substantial, I really commend the authors for how much thought and time and effort has clearly gone into this project. The results are interesting and do offer valuable insight for those looking to diminish the gender gap in geosciences and related STEM fields.

Thank you.

I only have a few minor comments where I think things could be made more clear, suggestions for future work in this line of research, and places where I would like to hear more of the authors' thoughts. I would have liked to see a little more discussion of how the authors arrived at the three different combinations of components in each workshop. The authors make clear that mentoring, rather than role models, is the key factor in women's persistence in geosciences, and that real-world mentoring networks were most facilitated by the Three-I condition (if you'll allow some brevity in the names of the conditions). This suggests that the Introduction is really the most critical component, and made me wonder why there was no Introduction-only condition. It's possible that once the introduction is made that the mentor may provide information to their mentee similar to what is included in the Inoculation aspect of the other workshop, and if that is true, matching mentors and mentees and sending an introductory email would be far less resource-intensive and could achieve the same results as the full workshop tested here.

We have now expanded on our rationale for choosing the three conditions for identifying the critical elements of the professional development workshop and mentoring (see 6th paragraph of the Introduction section). In addition, we have expanded our discussion of the future for research to test the benefits of mentoring alone (see limitations and future directions paragraph of the Discussion section).

In future research with this intervention, it would also be interesting to know how much in-person interaction participants report having with their mentor after the introduction and if the amount or quality of that interaction also has an effect on their intentions to persist (the

supplemental materials say that the introductory email “set the expectation”, but I’m curious to see how many actually complied and were able to maintain this relationship).

We agree that this would be very interesting to investigate, but we do not have the data to do so. We have added this suggestion to future directions for research.

Additionally, I thought the discussion could have gone into more detail about why only science identity emerged as a psychological variable responsible for mediating the effect of mentor networks on intentions to persist in geosciences. The authors clearly have a great deal of experience and expertise with these workshops/interventions, and I wondered why being better able to cope with obstacles would not also lead to greater intentions to persist. Any thoughts that the authors have would be clarifying and useful to the reader.

This is an interesting point and one we now expand upon in our discussion of the findings. Specifically, we note that these self-regulation skills may be due to the large effect of identity statistically overwhelming the more modest influence of coping skills (see Discussion section).

One thing that I found confusing as a reader was the presentation of the number of role models and mentors being presented categorically (0/1/multiple) as opposed to continuously. While the supplemental materials do indicate that the measurement of these numbers only allowed participants to report up to 3 of each, I think it would still be informative to see how these analyses look when the number of role models/mentors is treated as a continuous variable (and in future work to allow for participants to report more than three if they wish).

Thank you for identifying the confusion caused by our presentation of role models and mentors being presented categorically. Your points are well taken and are informing our plans for future studies, in addition to the current manuscript. First, we have modified both the main narrative to better explain our rationale for measuring and treating the data as we have done. Specifically, we measured these variables in a censored range (0-3) due to our focus on a prior literature that has emphasized important distinctions between 0, 1, and multiple role models/mentors – which is now made more clear in the main narrative. Our approach to measurement essentially produced rank ordered categorical data that does not / could not conform to a normal distribution. Second, our approach to the measurement of these outcomes and our focus on mediation analysis necessitated our current approach to the plan of analysis, as now described in the Methods section. As we note in Methods, an alternative equivalent approach would be to use logistic ordinal regression; however, such an approach would preclude mediation analysis. Third, we have made note of the limitations of our approach to measuring and analyzing changes in role modeling and mentoring outcomes and included recommendations for future studies in the main narrative (see limitations and future directions in Discussion).

In Supplemental Table 2 the pre-test number of role models and mentors are presented continuously while the post-test numbers are presented categorically, and it would be helpful to see them and treat them on the same terms. Along these lines, I think it would be informative to have a table or some discussion of how participants look in terms of how their numbers of role

models/mentors change from pre to posttest. That is, are most women going from 0 to 1, or 2 to 3, or something else? And does this differ by condition?

Thank you for identifying the confusion caused by tables and narrative. We have now modified supplemental Table 2 to present pre- and posttest role modeling and mentoring similarly. Therefore, we present both the median and interquartile range, as well as presenting percentages per category of response (e.g., no role models). In addition, we now provide a description of pre-to-post changes in role modeling and mentoring in the main narrative (see main narrative Results section).

Again as I stated above, I truly appreciate the amount of work that went into this project and the heroic effort at data collection that went on here. However, in 2020 I think it is appropriate to even have a cursory sentence addressing statistical power in a fully between-subjects design with n of about 50 per cell.

Agreed, this was an oversight on our part. We have now added a few sentences on statistical power to our Method section of the Method section.

The supplemental materials state that all three workshops included “a discussion of challenges to success in scientific careers (e.g., implicit bias)”. I would love to have this unpacked more in the supplemental materials’ description of the workshops. Implicit bias itself is a widely publicized, often understood concept, implicit bias training is a whole subliterature in and of itself and I’d be very interested to know what specific information about implicit bias was being presented to the girls in this program.

We have added a more detailed description of the topics covered in the workshop that specifically covered implicit bias and other related topics. This was only included in Workshop 1. All three workshops included a broader discussion of challenges in many different forms. These challenges surfaced in the panel discussions. Workshop 2 and 3 discussed this in the context of fixed versus growth mindset.

As one final note: this is obviously not a huge deal but if you ever use these measures again it might make more sense to have the response options for the Scientific Career Persistence Intentions (described as “strongly disagree” to “strongly agree”) match the content of the items (which are “what is the likelihood...” and two “to what extent...”, neither of which you can actually agree or disagree with).

Thank you, we will certainly re-evaluate the response scale of these items when we use these survey questions in the future.

Reviewer 2

The current article is important in that it is one of the few to examine what the important elements of a good mentorship intervention are for undergraduate women in STEM. Thus, this research is a novel and important contribution to the mentorship literature. Specifically, in this study, the authors examined whether mere exposure to women in geoscience, exposure to

women in geoscience coupled with training on career success and networking, or exposure to women in geoscience, training on career success and networking, and being paired with a local woman in geoscience after the workshop impacted women's science identity, coping skills, seeking of emotional support, seeking of informational support, and intentions to persist in science. They found that if you show undergraduate women in geoscience, give them the training on career success and networking, and introduce them to a local woman in geoscience in combination undergraduate women are more likely to report having more mentors as well as having an enhanced science identity and intending to persist in science.

Thank you for this accurate and concise summary of our study.

While reading the article, some points of confusion emerged. I provide the following recommendations to the authors to clarify the research study. In the main article, I did not understand how participants were randomly assigned to only 1 of the three workshops and I misunderstood why the workshops were on different days. The good news is that this confusion was resolved in the supplemental materials. However, I recommend that the authors clarify this in the main manuscript because many readers will not take the time to look over the supplemental materials.

Thank you. We have now added a more thorough description of the random assignment and workshop scheduling procedures in the main narrative.

In the general discussion, I recommend that the authors acknowledge that many of the barriers to success that women in geoscience face have to do with the institution they are a part of and the culture of geoscience. Even though training is important, I recommend that the authors acknowledge that training women on career success does not mean that women need to toughen up to make it in geoscience (which is what some people might take away from these types of programs, which turns into a victim-blaming interpretation of why women are underrepresented in STEM fields). By acknowledging the culture in geoscience, the authors can help move the conversation away from what women are or are not doing and move it towards a more productive conversation of what can we do to support women.

We wholeheartedly agree here. Thanks for helping us make sure this is clear in the manuscript. We have added a strong referenced sentence at the end of the second to last paragraph of the Discussion section that acknowledges culture issues in the geosciences.

I recommend that the authors change the label of the y-axis for the bar graphs presented in the main manuscript as the current labels are confusing. Instead of the y-axis just having %, I recommend that the authors instead say % of participants. Furthermore, I recommend that the authors make the x-axis labels for the bar graphs consistent with the figure labels provided as in the current manuscript, they are inconsistent, which makes them confusing to the reader.

Thank you for the recommendations. Done.

I also recommend that the authors discuss in the general discussion the fact that half of the participants are indicating 3 months after the workshops that they do not have women mentors in STEM.

We have added the following text to the Implications Section: “Even with introductions, our rate of mentorship was relatively low (Figure 2). In all our efforts associated with this project, we have found that many undergraduate women are hesitant to initially engage with mentors, even same-gender mentors within geoscience fields.”

I also recommend that briefly in the main manuscript the authors mention what happened for the groups other than the inspiration, inoculation, and introduction group in the path model. Because these groups are mentioned heavily through the introduction and method section, the reader is left wondering what happened to them in the model.

We agree. We have now added a brief description of what happened for each of the three groups in the main narrative before delving into our path model (see first paragraph of the Results section). In addition, we have added an extended description of what happened for each of the three groups in the main narrative (see first paragraph of the Results section).

I also recommend that the authors make some minor changes in the tables provided in the supplemental materials to help with readability. Specifically, it would be advantageous for the sources in Table 3 to be on a single line instead of being on multiple lines. Further, for Table 4, instead of using superscripts to designate whether the measure was included in the pre or posttest, it would be easier for the reader if the authors just labeled the measure by writing pre or posttest next to each label.

Thank you for this feedback on how to improve the clarity of results. We have modified Supplemental Tables accordingly.