EGUsphere, author comment AC3
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Reply on RC2

Philip J. Heron and Jamie A. Williams

Author comment on "Building confidence in STEM students through breaking (unseen) barriers" by Philip J. Heron and Jamie A. Williams, EGUsphere, https://doi.org/10.5194/egusphere-2022-16-AC3, 2022

Thank you for your thoughtful review. We have addressed the points below and added a supplementary zip file that shows the feedback and figures that would be added in relation to the review.

This sounds like a great program, and I hope it was well received. There are many strengths, and although I have recommended major revisions, these are due to the lack of data to support conclusions and recommendations. I wish the rating options included "missing" as well as "poor", because poor is too harsh and does not convey this pint. Please do not be discouraged by the comments. The aim behind this project is excellent. Mostly, I'm looking for a stronger theoretical framework and understand more information about the design, data, and results.

Thanks for this summary! Much appreciated!

In the rationale, "confidence" is discussed, but this term is vague and more commonly used in everyday English than educational research. It is up to you how you want to frame this, but I recommend using "self-efficacy" and social cogntive learning theory as a theoretical framework, as I believe this supports the underlying values of the rationale and what I can see from the design. Similarly, rather than "fit", you will find more literature on "sense of belonging".

Thank you for this comment – we can modify the text in the places outlined below (replacing the word confidence). However, we would prefer to use self-agency over self-efficacy. The students have the ability to complete goals (self-efficacy) but lack the agency to do so. We'd also prefer to keep 'confidence' in the title and abstract for the reason you mention in that it is more commonly used in everyday English, and we are hoping to cast a wide net in the audience for this submission.

A student's low confidence in their own ability can lead to non-engagement ***(e.g., low self-agency)****in the classroom (Angus et al., 2008; Legault et al., 2006; Statistics Canada, 2002). In particular, science, technology, engineering, and math (STEM) subjects have shown to generate negativity amongst students (Holmes et al., 2018), with the reasons behind such low* ***self-agency*** *being multi-factorial.*

In this short commentary, we discuss a framework put in place to build student ***self-***

agency *during the teaching of a STEM course in English prisons in 2019 (Heron, 2019; 2020).*

As a result, the focus of our course was to act as a stepping-stone to more formal education (e.g., high school diplomas and undergraduate courses) through increasing ***student self-agency*** *in the short and long-term.*

As there is no right or wrong answer, the students were given a voice on cutting edge science - the impact on this on student's ***self-agency****can be significant.*

*Even though our course was designed with the restrictive and complex prison education system in mind, there is a wider application to this work specifically in settings where students are not engaging in formal education due to low c****self-agency****.*

This framework produces dialogue focused course that is relatable, accessible, inclusive, and offers encouragement (RAIE method), which can allow students to build their ***self-agency when learning*** *STEM subjects.*

There is good consideration of many of the contextual barriers to education in the prison system and what information is presented about the methodology, but this also needs to factor in the massive problem of illiteracy and lack of educational qualifications, especially among young and first offenders. This could explain partly why some of the participants opted out of the assessments.

This is a great point. However, it not applicable to the 2019 Think Like A Scientist courses. To sidestep this issue (for now), we set a minimum education level (level 2 in the English prison system) which meant that all participants would be able to read. So, in theory this shouldn't be an issue (however, there is always a difference between theory and practice in prison education!)

It is a great thing to consider how all learners can have their voices heard, and this is very important in EDI, but we need more information on how you operationalise and collect data for this. How did you know *all* of the learners had their voices heard? Is simply speaking out, regardless of content, enough?

This is a great point. The relevant section is here:

In our course, students were often asked to give their thoughts on current topics (after reading recent research) with which there is no scientific consensus (e.g., should we colonize Mars? Is there life outside our Solar System?). As there is no right or wrong answer, the students were given a voice on cutting edge science - the impact on this on student's self-agencycan be significant.

In terms of data, it is difficult to collect such points on whether their voices were heard. Our work is based on our experience in the classroom and on our student feedback through pre- and post-course questionnaires. We will add the course feedback to the supplementary material as 'data'. Below we highlight the comments made by students with regards to having their voices heard, or increasing 'confidence' in themselves and education:

- I am gaining a sense of confidence academically I never thought I had in me. That I do have a view and ideas and a thirst for knowledge - this course has ignited that.
- my mind feels like it has expanded and I no longer feel like that stupid kid that never holds their hand up and hold their breath when the teacher asks a question
- it has made me think like a scientist and broaden my thoughts
- Helped me re-engage with science again

- The course has given me more confidence and made me understand and see the world and universe around me in a different light

Furthermore, our student feedback (*n=20*) indicates that the course increased student interest in science (95% of students agreed with the statement "this class increased my interest in science) and that the course encouraged students to think for themselves (65% agree with the statement "the class encouraged me to think for myself").

As a summary of this data, we can add in the attached figure to help with the data and include the full responses as supplementary information. However, we don't explicitly state that all learners had their voices heard, but that students were "given a voice on cutting edge science" if they so choose to act upon it. We are happy to take any additional advice if there are areas where we may overstate the impact or reasoning behind our educational setup.

Designing taught sessions and assessments to follow open ended questions rather than dipstick questions to check if the learners have the correct knowledge is a great idea! This would reinforce the self-efficacy/social cognitive learning theory, should you choose to use this as a theoretical framework.

Thanks!

Lastly and most importantly, we need more information about the data. Without more details of who the learners were, how they experienced and perceived the programme, especially in regards to learning transfer, it is difficult to judge this manuscript. Without this, the framework of barriers listed as bullet points are more useful as a guide for future research than recommendations for practice. This is especially important given the title and emphases of the intervention on thinking critically and using empirical evidence to support conclusions.

This is a great point! As mentioned above, we will include our qualitative feedback on how the students perceived the program (and have attached it here). We do not have data on the learner's backgrounds (except for two learners who have been released). In our pre- and post-course questionnaires, we do not ask any personal information about age and education background (etc) as this may stigmatise the potential learners. Furthermore, complex intersections of the learner's age, gender, and/or class/race/background require nuance in quantitative analysis, whereas qualitative can be more effective at prioritising the voice of the students. Also, given the students we are working with, we are limited with the information we can gather. The restrictive prison environment means that we cannot even take physical paper in or out of most of the establishments, so we are limited in our methods of data collection. Indeed, there are significant ethical challenges about formal data collection from people in prison for academic purposes, and the questionnaires provided were about the limit of data the institutions would agree to.

Although the data is limited to n=20, we are looking to create a more longitudinal study in the future (once prison education returns to somewhere near normal post-covid). The pre- and post-course questionnaires are attached (and will add to supplementary material) and we welcome any advice on new questions that could provide insight that would be beneficial to the wider community.

On the last point, we feel that the framework we outline can be both a recommendation for practice and a guide for future research, given our experience and qualitative student feedback. The initial research we conducted into students in prison (who we found have

low self-agency) prompted us to create an education framework that we outline in this manuscript. Our qualitative data shows a positive outcome for students, and therefore we are sharing in this publication our educational setup. However, we welcome any comments, given the data provided here, to make sure we do not overstate our findings or that we misrepresent the impact of our methods.

Please also note the supplement to this comment:
https://egusphere.copernicus.org/preprints/2022/egusphere-2022-16/egusphere-2022-16-AC3-supplement.zip