

## Comment on egusphere-2022-16

Below is our point by point response to the reviewer comments:

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### Lucy Beattie (Referee)

#### General comments

**Fig 1. The paper could benefit from a little more information as to how the outreach programme may link to existing education theories. For example Fig 1 refers to a "scaffolding technique" is this derived from known educational theorists e.g. Vygotsky?**

Thanks for the comment – we can add the following descriptions on how the programme links to existing educational theories:

Scaffolding:

*Examples show scaffolding technique to build up the levels of questioning (e.g., **Vygotsky's sociocultural theory and his learning concept of the Zone of Proximal Development (ZPD), Berk and Winsler, 1995).***

Berk, L. E., & Winsler, A. (1995). Scaffolding children's learning: Vygotsky and early childhood education. Washington: National Association for the Education of Young Children.

Plain Language:

*A positive step was to implement 'Plain Speak' English for universal accessibility, **which meant using language and design strategies that make texts easier for target audiences to understand and use (Mazur, 2000; Garwood, 2014). The impact of applying plain language from the start of a course is to allow students to be clear on the content immediately when it is presented, rather than not being unable to understand a technical work and potentially derailing the learning experience. Applying plain language has been beneficial in the medical profession when communicating care to patients (Warde et al., 2018; Sagi et al., 2021) and we create accessible content through using plain language summaries of scientific research (such as the online magazine The Conversation).***

Mazur, B. 2000, Revisiting Plain Language, Technical Communication, 47: 2, p. 205.

Garwood, K., 2014, Plain, But Not Simple: Plain Language Research with Readers, Writers, and Texts, PhD Thesis, University of Waterloo.

Warde F, Papadakos J, Papadakos T, Rodin D, Salhia M, Giuliani M. Plain language communication as a priority competency for medical professionals in a globalized world. Can Med Educ J. 2018 May 31;9(2):e52-e59. PMID: 30018684; PMCID: PMC6044302.

Sagi, D., Spitzer-Shohat, S., Schuster, M. et al. Teaching plain language to medical students: improving communication with disadvantaged patients. *BMC Med Educ* 21, 407 (2021). <https://doi.org/10.1186/s12909-021-02842-1>

Supportive environment:

*For a behavioural, cognitive, and emotional engagement to be achieved for all learners, an open and dynamic teacher-learner relationship must be fostered, built upon sensitive understanding (and adjustment) to a learner's needs and social contexts (Darling-Hammond et al., 2020; **Breakey, 2006; Sanger, 2020**).*

Sanger, C.S. (2020). Inclusive Pedagogy and Universal Design Approaches for Diverse Learning Environments. In: Sanger, C., Gleason, N. (eds) *Diversity and Inclusion in Global Higher Education*. Palgrave Macmillan, Singapore. [https://doi.org/10.1007/978-981-15-1628-3\\_2](https://doi.org/10.1007/978-981-15-1628-3_2)

Breakey, C., 2006. *The autism spectrum and further education: a guide to good practice*. London: Jessica Kingsley.

**Inclusive nature:**

*These two strategies (e.g., not implementing formal examinations and asking 'open' questions) produces a flattening of the power dynamic as compared to a traditional classroom. Linking to the previously mentioned theories on 'stereotype threat' (e.g., fear or anxiety of confirming a negative stereotype about one's social group, Steele and Aronson, 1995) and 'minority stress' (e.g., stress faced by members of stigmatized minority groups), implementing these strategies could remove critical barriers to students' learning (which teachers may or may not be aware of). Indeed, it has been recently highlighted that inclusive science communication could be crucial in addressing the systemic problems of inequitable access to (and engagement with) STEMM (science, technology, engineering, mathematics, and medicine) subjects (Canfield et al., 2020). Careful thought is required when creating content and engaging students if we would like to reach diverse audiences (Canfield et al., 2020).*

Canfield KN, Menezes S, Matsuda SB, Moore A, Mosley Austin AN, Dewsbury BM, Feliú-Mójer MI, McDuffie KWB, Moore K, Reich CA, Smith HM and Taylor C (2020) Science Communication Demands a Critical Approach That Centers Inclusion, Equity, and Intersectionality. *Front. Commun.* 5:2. doi: 10.3389/fcomm.2020.00002

**Figure 1 scientific method is unclear. You talk about a hypothesis (in essence to be proved or disproved), but the table reads more like a research question. Perhaps you need to re-write it as a research question and not use the word hypothesis?**

In terms of an approved flow chart for the scientific method, Figure 1 here is typical. Indeed, it was created based on the most common descriptions of the scientific method, where the word hypothesis is widely used.

**I.75 It would be interesting to dig deeper into the ways in which a nurturing environment have been fostered in this programme to promote learning. You cite the Darling- Hammond paper (2020) which discusses the ways in which a supportive learning environment in schools fosters a healthy resilient pathway to adult learning. How does this work in other adult Further Education (FE) contexts?**

We can add more references on supportive learning in FE contexts, such as adding in the work of Breakey (2006) (which looks at supporting adults with autism through university) and Sanger (2020) (which highlights Inclusive Pedagogy approaches in diverse environments). We can also expand upon the sentence below with further examples into what we did to nurture the environment:

*A challenge here was to create course content that celebrated each student individually, rather than revert to our mainstream education norms. For a behavioural, cognitive, and emotional engagement to be achieved for all learners, an open and dynamic teacher-learner relationship must be fostered, built upon sensitive understanding (and adjustment) to a learner's needs and social contexts (Darling-Hammond et al., 2020; Breakey, 2006; Sanger, 2020). In the preparation of course material, it was important to simply acknowledge the intersectionality of potential students and change the expectation of each submission of work based on the learner's needs. In class, the instructor would acknowledge that each student can bring individuality to the course through the open questions on scientific topics (see Inclusivity section). In addition, small acts of flattening the power dynamic within the prison environment can help to nurture a supportive learning landscape (e.g., making a coffee for students during the break).*

**We also considered a number of points related to language.** Resources whilst teaching in prison are scarce, and often the only teaching aid available (apart from a pen and paper, Figure 2) is language (which turns out to be key). If the language used was terminology heavy or uses allegory, metaphor, or other forms of figurative or culturally specific language, this may have been difficult to process for many students. Potentially, this may have disadvantaged autistic students, or those with learning differences (Kalandadze et al., 2018).

*A positive step was to implement 'Plain Speak' English for universal accessibility, which meant using language and design strategies that make texts easier for target audiences to understand and use (Mazur, 2000; Garwood, 2014). In practice, this means not using technical words without a proper introduction. An example for discussing different types of volcanoes would be to avoid using the word viscosity in the initial comments, opting for 'runny' or 'thick' until low and high viscosity can be scaffolded in (Berk and Winsler, 1995).*

**The impact of applying plain language from the start of a course is to allow students to be clear on the content immediately when it is presented, rather than not being unable to understand a technical work and potentially derailing the learning experience. Applying plain language has been beneficial in the medical profession when communicating care to patients (Warde et al., 2018; Sagi et al., 2021) and we create accessible content through using plain language summaries**

**of scientific research (such as the online magazine *The Conversation*).** We also follow up with taking into consideration who and what was rewarded and prioritised in interactions with students (e.g., are we celebrating getting a correct answer or for asking question of clarification?).

Mazur, B. 2000, Revisiting Plain Language, *Technical Communication*, 47: 2, p. 205.

Garwood, K., 2014, *Plain, But Not Simple: Plain Language Research with Readers, Writers, and Texts*, PhD Thesis, University of Waterloo.

Warde F, Papadakos J, Papadakos T, Rodin D, Salhia M, Giuliani M. Plain language communication as a priority competency for medical professionals in a globalized world. *Can Med Educ J*. 2018 May 31;9(2):e52-e59. PMID: 30018684; PMCID: PMC6044302.

Sanger, C.S. (2020). Inclusive Pedagogy and Universal Design Approaches for Diverse Learning Environments. In: Sanger, C., Gleason, N. (eds) *Diversity and Inclusion in Global Higher Education*. Palgrave Macmillan, Singapore. [https://doi.org/10.1007/978-981-15-1628-3\\_2](https://doi.org/10.1007/978-981-15-1628-3_2)

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**Do you think that the learners on "Think like a scientist" are perhaps re-engaging with a learning hiatus from childhood? Why was there a hiatus? E.g do you have any stats about prisoners in general do they leave school early? And why? Can this link in to any research on positive support/emotion/nurture in adult learners in other disadvantaged contexts e.g. refugees, victims of abuse etc etc. Would just be interesting to see if this expands and links to other areas of adult FE.**

Personally, I know that a number of students have indeed had a hiatus from learning since childhood. One of the comments on the pre-course questionnaire was:

"I am really looking forward to this course and being able to improve myself in a field I have not ventured into since my school days."

However, in visiting prisons to research the best way of teaching, it was clear from informal discussions that there had been a hiatus from a large number of people in prison and that there were many barriers to them accessing education. Therefore, we developed this framework to address what we understood was happening with potential students (without gathering formal data). We spent 18 months going in and out of different prisons (and talking to different education providers), gathering research to find best practices (culminating in this paper).

Data on education hiatus status of people in prison is not easy data to get a hold of and is something that would be difficult to measure in our students going forward. We'd be

reluctant to ask potential students when the last time they were in formal education for fear of stigmatisation.

However, there is a study from the early 2000s in American prisons that does show that people in prison have less time spent in education than the (non-prison) general population: <https://bjs.ojp.gov/content/pub/pdf/ecp.pdf>. We will add this reference into the paper at the following point:

*However, due to restrictive prison environments (Rogers et al., 2014; O'Brien et al., 2021), a lack of funding for prison educational programs, and (most importantly) the impact of prisoners' previous struggles with traditional classroom settings (Harlow, 2003), teaching in prison is a complex endeavour. As such, educational needs are largely unmet for those in custody (Geib et al., 2011).*

From our experience, the setup we outline here could be applied to any student (adult or otherwise) who has low confidence in the education system or themselves. So, to your point, we'd be very excited to apply these principles to any other adult FE setting (as we outline in the Conclusion).

**I.105 It would be good to expand on these theories a bit more in the context of inclusivity and perhaps contrast to other research on the hierarchies in STEM classrooms there is some interesting work in inclusive sci-comm you could look at Canfield, K.N., Menezes, S., Matsuda, S.B., Moore, A., Mosley Austin, A.N., Dewsbury, B.M., Feliú-Mójer, M.I., McDuffie, K.W., Moore, K., Reich, C.A. and Smith, H.M., 2020. Science communication demands a critical approach that centers inclusion, equity, and intersectionality. *Frontiers in Communication*, p.2.**

The section in question here is:

*Related to the previously mentioned 'stereotype threat' and 'minority stress' theories, this flattening of the power dynamic within the classroom meant that learning was made more inclusive and critical barriers to students' learning (which teachers may or may not be aware of) were removed.*

We can modify this paragraph to the following to take into consideration this comment:

*These two strategies (e.g., not implementing formal examinations and asking 'open' questions) produces a flattening of the power dynamic as compared to a traditional classroom. Linking to the previously mentioned theories on 'stereotype threat' (e.g., fear or anxiety of confirming a negative stereotype about one's social group, Steele and Aronson, 1995) and 'minority stress' (e.g., stress faced by members of stigmatized minority groups), implementing these strategies could remove critical barriers to students' learning (which teachers may or may not be aware of). Indeed, it has been recently highlighted that inclusive science communication could be crucial in addressing the systemic problems of inequitable access to (and engagement with) STEMM (science, technology, engineering, mathematics, and medicine) subjects (Canfield et al., 2020). Careful thought is required when creating content and engaging students if we would like to reach diverse audiences (Canfield et al., 2020).*

**I. 120 I like the framework for breaking down barriers. It is a useful how-to guide.**

Thanks for this comment – we sought it fitting to share to see if it could be useful to others.

**Overall an interesting read and engaging information about this programme which is clearly valuable outreach to such a marginalised community. Do you think this work can transfer some aspects to other marginalised communities within the prison system? E.g. have you considered working in Mother and Baby/Child units within prisons?**

Yes, we have been working on transferring this education framework to other areas within the prison system (e.g., vulnerable prisons). We have previously also worked with young people in London who have experienced homelessness. However, your specific point of working with Mother and Baby units within prisons is a good one – we have been working on funding to provide family education for women who have been released from prison, allowing mothers and children/parents to learn together. We have also applied for funding to take this work to overseas prisons and to refugee camps (no luck... yet).

**Technical**

**The UK prison system is not a whole system. Scotland and Northern Ireland have devolved criminal justice systems, therefore this should perhaps be made more clear in line 26 perhaps refer to England rather than UK.**

Yes, this is an excellent point and one we don't go into. We will change UK to England in the following line to make it clear that we didn't work on other devolved areas:

*In this short commentary, we discuss a framework put in place to build student confidence during the teaching of a STEM course in **English** prisons in 2019 (Heron, 2019, 2020).*

**Line 16 should multi-factorial be multifactorial?**

We can change this.

**Line 103 "the impact on this on student's" should read "the impact of...."**

We can change this.

**Line 113 "really interesting" is perhaps a little bland can this be expanded or explained in a more vibrant way?**

Agree! We can modify this line to read:

*Incidentally, by setting a task to express their thought process, rather than 'testable' questions, the work submitted **not only reflected upon the subject matter, but also their personal experiences with the topic.***

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**Julie Jebsen (Referee)**

**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 point. 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 cognitive 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. 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 confidence 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 ~~confidence in the student's abilities~~ 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 ~~confidence~~ 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 ~~confidence~~ 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~~ confidence 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-agency can 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.

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**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.

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**Scott King**

**This is a really cool idea and I've been following it on social media. I'm glad to see such a nice clear writeup on your project along with some best practices. I only have a few minor comments, mostly along the lines of expanding some of your thoughts. I think about these issues a lot in my own intro STEM course for STEM students, so I could not help adding a few words of support along the lines of encouragement.**

Thanks Prof King!

**With regard to creating a neutral environment, do you have any thoughts for those of us who are trying to teach in a university setting? I still remember (quite fondly) a class I had in college where the professor (after the formal lecture at the chalk board) sat on the front edge of the desk and simply 'talked' to the class about experiences and ideas. The fact that I vividly remember this 30+ years later tells something about how personally engaging it was. That is an example that worked for me but that was an upper division course and I was already a STEM major.**

Phil Heron response: This is something that I have been dealing with myself, now that I am more involved in university level teaching. One thing that is becoming clear to me is that teaching in any level is more about personality than performance, in that I am bringing more of my personality into teaching than trying to mimic any 'set' lecturer behaviours. For instance, I recently taught a field class where I would regularly bring in insight from my own previous experiences, or add

more historical context to field sites. These are things that are interesting to me, and hopefully to the students – allowing for (slight) meanderings rather than rigid topics.

However, this may be more difficult in a seismology classroom than when you are walking in fields for a week. My rule of thumb now is to build in more relatable activities into courses, which has come from teaching this prison course. Creating relatable content will help students engage – and we need to be creative in how we can make material relatable.

This is a really great point, Scott, that has got my mind racing. The fact that you remember this from 30+ years ago stands out!

Jamie Williams response: The actions of the professor all those years ago acted to flatten the power dynamic, which may have helped to promote a more collegiate learning environment.

**It would help to clarify if you could expand a bit on 'Plain Speak'. Is there a citation to the 'Plain Speak' idea? I have read that some introductory science courses actually introduce more vocabulary than a first semester foreign language course so I tend to agree with you (I don't seem to have the reference to the statement above). I personally think there needs to be a balance here because the "Upgoer V" challenges, for example, while fun actually can force someone into such strange vocabulary that I feel they obscure rather than enlighten. Where is the balance? What is your experience? I would find some examples of 'Plain Speak' worthwhile to help my thinking. For example, in some AGU outreach literature they suggest avoiding using the term 'mantle' yet even my third graders Earth Science class introduced the idea of a crust, mantle, and core.**

The way we approach Plain Speak/Plain Language is to make it as easy as possible for a student to follow the material. In our prison classes, we are conscious that the students learning experience could be quickly derailed by not understanding a technical word (and not having the confidence to ask for clarification). Academic papers can be very limiting to non-experts, so we use plain language summaries (such as *The Conversation*) to stimulate the scientific discussion. We can edit the paragraph to give this concrete example:

*A positive step was to implement 'Plain Speak' English for universal accessibility, which meant using language and design strategies that make texts easier for target audiences to understand and use (Mazur, 2000; Garwood, 2014). In practice, this means not using technical words without a proper introduction. An example for discussing different types of volcanoes would be to avoid using the word viscosity in the initial comments, opting for 'runny' or 'thick' until low and high viscosity can be scaffolded in (Berk and Winsler, 1995).*

*The impact of applying plain language from the start of a course is to allow students to be clear on the content immediately when it is presented, rather than not being unable to understand a technical work and potentially derailing the learning experience. Applying plain language has been beneficial in the medical profession when communicating care to patients (Warde et al., 2018; Sagi et al., 2021) and we create accessible content through using plain language summaries of scientific research (such as the online magazine *The Conversation*). We also follow up with taking into consideration who and what was rewarded and prioritised in interactions with students (e.g., are we celebrating getting a correct answer or for asking question of clarification?).*

A reference we found useful was the Introduction to Dr Garwood's PhD thesis on plain language

<https://uwspace.uwaterloo.ca/bitstream/handle/10012/8401/GarwoodKim.pdf;sequence=3>.

Our experience in teaching this course in prison is to watch the students and be quick to explain any word you think may have not landed. For many students, they will not speak up to ask a clarification, so to be vigilant (admittedly, watching body language is very difficult online, however).

**Your point about discussion questions with no right or wrong answer is a good one. I have been using this in my online course to engage the students and for them to think more broadly about the topics and share in a non-threatening setting. I find that works well in my online course. I get 80-90% participation whereas in class it would always be the same 3-4 people speaking up.**

Fantastic, we need some data on this to share more formally.  
Potential paper?