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**UNDERGRADUATE STUDENTS AS
ROLE MODELS: DELIVERING
ENVIRONMENTAL SCIENCE
OUTREACH TO INCREASE THE
ACCESSIBILITY OF SCIENCE TO
FURTHER EDUCATION STUDENTS**

EVALUATION REPORT

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Undergraduate Students as Role Models: Delivering Environmental Science Outreach to Increase the Accessibility of Science to Further Education Students

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Abstract

This study investigates the impact of undergraduate student-led outreach on the accessibility and perception of science careers among further education (16–18-year-old) students. School and College teachers identified three key barriers to science engagement: influence of family and friends, lack of relatable role models, and limited access to laboratory experiences. Here, a two-session environmental science intervention was designed and was delivered by university students to A-level and BTEC learners across four colleges and school sixth forms. The sessions combined hands-on soil analysis with presentations of scientific data and personal academic journeys. Analysis of pre- and post-intervention questionnaires revealed that 26% of students reported strengthened science career aspirations and 11% reported broadened science career aspirations. Furthermore, 30% perceived science careers as more accessible post-intervention. A-level students showed greater gains in accessibility than BTEC peers, highlighting the need for tailored outreach strategies. The study underscores the value of undergraduate students as accessible role models and the importance of practical, relatable science experiences.

Keywords: role models, accessibility, diversity, outreach, widening participation, science

Abbreviations: STEM: Science, technology, engineering and mathematics

Role Model-led Intervention

An intervention was designed around information from teacher focus groups. The intervention was based on environmental science to increase the visibility and accessibility of science education and research for further education students. The intervention was undertaken over several weeks with two lessons led by university-student researchers.

Session 1: an introduction to the project and a description of soil sampling methodologies. The further education students then undertook soil sampling and conducted several chemistry and microbiology experiments on the soil, including determining the pH, soil type, and soil colour. Soil samples were then further analysed by the university-student researchers on analytical instrumentation at the laboratories at Sheffield Hallam University.

Session 2: the university-student researchers presented the data from the individual class results and the whole project to the further education students. During this session, undergraduate research students also showcased their journeys into science and answered questions about both the environmental science research project and higher education.

To analyse the impact of the intervention, the further education students filled in a pre- and post-intervention questionnaire which included questions around perceived accessibility of science and career aspirations.

Study aim

Using a multiple methodologies approach, this study set out to explore the impact of working with university undergraduate students as accessible role models to deliver a project which aimed to increase the accessibility of science careers amongst these further education students.

1. **Research question:** Can undergraduate-student role model-led outreach increase the visibility and accessibility of science, and more widely science careers in further education students?
2. **Research question:** Will the impact of this intervention vary between BTEC and A-level students?

Methodology

Teachers' focus groups

Further education science teachers were recruited from local schools and colleges to participate in online focus groups. Teachers could choose to attend one of three 60-minute online sessions during which an independent interviewer led discussions based on a list of predetermined questions to investigate teachers' perceptions of student accessibility to science. These questions were author-written and influenced by the literature. Focus groups were recorded followed by transcription by an independent external company (White Transcription Services Ltd., UK).

Focus group transcripts were analysed by a descriptive qualitative research approach that encompassed open coding, axial coding, and thematic analysis. Briefly, focus group transcripts were open-coded by three independent researchers in NVivo. These initial codes were condensed to identify putative categories. An iterative approach was then taken reflecting on the researcher's

putative categories with axial coding and then identifying links between these categories and the existing literature. Direct quotes for each category were identified.

Students' questionnaires

The role-model-led intervention activity was undertaken in two colleges and two school sixth forms with A-level Chemistry and BTEC Applied Science students in March 2021. 97 further education students were involved in the sessions. The intervention questionnaire was completed before and after the intervention, with 79 students opting into the study (81% present and opt-in rate). 64 pre- and post-questionnaires were paired by use of a student-generated anonymous individual key to link questionnaire responses together.

The impact of the intervention on career aspirations was determined by the question "Do you have any career aspirations?" with the Likert response format "1 - no firm ideas" to "5 - strongly held specific career aims" and the response to the open text question "What specific careers or career areas are you considering?". Respondents were categorised into groups based on their responses (Table 1).

Table 1. Respondents were categorised into the following groups based on their responses to the closed question "Do you have any career aspirations" and the open question "What specific careers or career areas are you considering?".

Category	Description
No change	Neither the strength nor career aim changed.
Firmer science	The strength of career aspiration increased.
Broader science	A student widened their career aims, but still within science.
Away from science	Career aim moved away from science.
No STEM aspiration	A student did not have STEM career goals before and after the intervention.

Ordinal data such as Likert response format data were analysed as non-parametric data, via bivariate analysis with student demographics. Statistical significance was determined by the Chi-squared test.

The accessibility of science was determined through analysis of the question "Do you think you could become a scientist?" and participants answered from the options of "yes", "maybe" and "no". Paired student responses (before and after the intervention) were then categorised into different groups (Table 2).

Table 2. Respondents were categorised into the following groups based on their responses to the question "Do you think you could become a scientist?" in the pre and post questionnaires.

Category	Description
More accessible	If the participant answered the question with: <ul style="list-style-type: none"> • No (pre-intervention) to Maybe (post-intervention) • No to Yes • Maybe to Yes

Same	If the participant answered the question with: <ul style="list-style-type: none"> • Yes (pre-intervention) to Yes (post-intervention) • Maybe to Maybe • No to No
Less accessible	If the participant answered the question with: <ul style="list-style-type: none"> • Yes (pre-intervention) to No (post-intervention) • Yes to Maybe • Maybe to No

Further education students were also asked before and after the environmental science intervention “What skills does a scientist have?” (n = 63) to determine their understanding of skills needed in science careers.

Analysis of free-text responses within the questionnaires was performed through data-driven thematic analysis and themes were subsequently identified (Jones, *et al.*, 2020; Nowell, *et al.*, 2017). Briefly, questionnaire free-text responses were collated in Excel and read through independent of other data. Putative themes were identified then the free-text responses were reviewed and the putative themes were adjusted as required. This process was undertaken by a minimum of three independent researchers. Once putative themes were independently identified, an iterative approach was taken reflecting on the researcher's themes to determine thematic examples. Free-text responses were then aligned to each theme and bivariate analysis was undertaken to determine if themes varied between participant demographics.

Ethics

Ethics approvals were granted via Converis (ER10419578) according to Sheffield Hallam University Research Ethics Policies and Procedures.

Results

Teachers’ perceptions of barriers and enablers in inspiring further education students to undertake future scientific careers.

To gain educators’ perspectives on the perceptions of further education students’ visibility and accessibility of science careers, teachers’ focus groups were undertaken with seven further education school and college teachers. Focus groups were online, audio recorded, transcribed, and then analysed to determine common themes. Three themes were identified.

Theme 1: family and friends. Teachers felt that family and friends have a significant role in influencing students' further study and career choices. This influence of family and friends might conflict with the expectations and guidance that teachers have for students.

“students from Asian backgrounds ... often have had experience of family members going into medicine or ... dentistry or pharmacy,”

“a very white farming area... most of the working-class boys ... go into things such as farming or building”

“prior views .. from their family... isn’t necessarily most appropriate direction to be going in”

Theme 2: accessible role models. Teachers felt that lack of exposure to accessible role models was a barrier for further education students to being a scientist.

“there is still the stereotype that it is, that if you're not upper-class white and male that [being a] chemist is not, you know, research chemist is not a career for you”

“[students] still had that view that being a female scientist was an unusual thing”

“think you’d have to have people that [students] would relate to... they come from a similar background so they can see themselves getting to that same position”

Theme 3: laboratory work. The final theme indicated the importance of laboratory work in the students' perceptions of science, with teachers feeling that access to practical work is a key source of inspiration to study a particular field.

“none of them [students] have any interest in anything to do with sort of field work ... potentially due to a lack of experience”

[how to interest students in research] “I suppose it is lab-based experience. I think that’s what, you know, they don’t have those aspirations because they haven’t got that experience”

University-student-led outreach impacts further education students’ career aspirations.

This environmental science research-based study was informed by the teacher focus groups and was designed to provide accessible role models and practical based learning with the aim of increasing the visibility and accessibility of science to further education students.

The impact of the intervention on further education students' science career aspirations and the strength they were held was determined (Table 3).

Table 3. Impact of university student-led environmental science sessions on further education students' career aspirations and strength they held. Respondents were categorised into groups based on their responses to the closed question “Do you have any career aspirations” (n = 62) and the open question “What specific careers or career areas are you considering?” between the pre and post intervention questionnaires.

Category	Total	Before career and strength example	After career and strength example
No change	31 (50%)	“Forensics” (4)	“Forensic scientist” (4)
Firmer science	16 (26%)	“Biology (either pathology or something plant based)” (2)	“Agriculture” (3)
Broader science	7 (11%)	“Vet” (5)	“Veterinary, biology, chemistry, biomedical, psychology” (3)

Away from science	1 (2%)	"Forensics or biomedical" (3)	"Primary school teaching" (4)
No STEM aspiration	7 (11%)	"Sports, medicine" (4)	"Medicine" (5)

The role model-based intervention had an impact on the career aspirations and the strength they held them in 24 of 62 paired student responses (38%), of which many had firmer science career aspirations (26%) or broader science aspirations (11%). Only one student had moved away from a science career (2%).

University student-led outreach increases the visibility and accessibility of science careers.

When asked about the skills that were needed for science careers, before and after the sessions most students mentioned teamwork, organisation, and problem-solving skills. Prior to the intervention, 10 students mentioned fixed intelligence attributes compared to 7 afterwards. Pre-intervention only 3 of the 63 students mentioned "research" skills compared to 10 after the intervention.

To determine how accessible further education students find a career in science, they were asked "Do you think you could become a scientist?" with the answer options of "yes", "maybe" and "no". The difference before and after the intervention was analysed (Table 4).

Table 4. Accessibility of science careers after the university student-led intervention. "Do you think you could become a scientist?" with the answer options of "yes", "maybe" and "no" compared before and after the intervention (n = 51).

Category	Total (n = 51)	A level study (n = 38)	BTEC +/- A level study (n = 13)
More accessible	16 (30%)	14 (37%)	2 (15%)
Same	29 (58%)	22 (58%)	7 (54%)
Less accessible	6 (11%)	2 (5%)	4 (31%)

Almost one-third (30%) of the further education students reported an increase in accessibility of science careers after the intervention. 11% reported a decrease in accessibility, whilst the remaining students (58%) stated no change in how accessible they felt a scientific career was to them. Interestingly, A level students were more likely to have an increase in this accessibility compared to students studying a BTEC as part of their further education qualifications (A level vs BTEC +/- A level: Chi-squared test, χ^2 6.8058, $p < 0.05$). There was no difference in the impact of the intervention based on gender or ethnicity.

Finally, further education students were asked "Is there anything else you would like to tell us about science/participating in our activity". Common themes identified that the school students viewed

the undergraduate students as accessible and knowledgeable, indicating their potential to act as role models for further education students.

"It was fun and [student researcher name] and [student researcher name] were very nice and friendly"

"I really enjoyed all of the people I met there, and they were very knowledgeable and helpful"

Discussion

This study aimed to further understand the accessibility of science amongst further education students and to explore whether an undergraduate student-led project could increase the accessibility and perception of a career in science.

Previous work has mainly reported A level students' perceptions and aspirations of scientific careers (Archer et al., 2022), however a significant number of further education students in the UK study alternative qualifications including BTECs. As vocational qualifications, BTECs are designed to deliver work-related, practical learning to students and act as a pathway both into higher education and directly onto employment. The cohort of BTEC students tends to be more ethnically diverse and studied by a larger percentage of young people from socioeconomically disadvantaged backgrounds than traditional A levels (Moote et al., 2021). BTEC qualifications are important for widening access to higher education in the UK. If we want to increase diversity in science, understanding the views and opinions of these students is of great importance. The sample of BTEC students in this study is smaller than our A-level participant cohort, however, this mirrors the overall qualification landscape, with 24,000 BTEC Applied Science students and 54,000 A level chemistry students in England in 2022 (Gov.UK, 2022).

This study emphasises the importance of presenting science as being accessible to students with a variety of skills and from different academic pathways. Students studying on BTECs can face barriers progressing in the sciences and experience stigma on these pathways. For example, Gartland and Smith (2018) reported an example where students studying on BTECs were described in a belittling manner by A-level students.

Our student researchers successfully delivered an environmental science project in our collaborating schools, positively impacting 26% of the further education students' aspiration strength towards a science career pathway. Within this study, we found that the university student-led project was more impactful for those studying A level in comparison to their BTEC-studying peers. It is tempting to speculate that as BTEC students are known to have lower science capital (Moote *et al.*, 2021), therefore may require longer or several interventions, as well as efforts to increase other elements of their science capital, to see the same impact as that on A-level students. Student role models in our study were not matched to specific groups of school students, therefore maximum impact effect might not have been seen. Careful consideration therefore of qualification route and individual student group demographic is likely to highlight the most relatable scientist role models.

Limitations

Whilst we demonstrate the potential in engaging undergraduates as role models to A-level and BTEC students the relatively short duration of undergraduate capstone projects (6 weeks) meant that

further education students had a short length of time to develop interpersonal relationships with the undergraduate student researchers. Previous work suggests that longer interventions can be more impactful (Buck *et al.*, 2008; Herrmann *et al.*, 2016; Olsson and Martiny, 2018; Archer *et al.*, 2014). However, the nature of capstone projects meant the interventions were limited to two sessions of contact rather than numerous points of contact during the year. The design of the study also incorporated multiple elements, any of which could have been responsible for the positive impact seen on the further education students. It is difficult to say therefore how great the role-model effect was on top of the intervention impact.

The smaller BTEC science cohort across the UK in comparison to science A level students makes it difficult to recruit representative study participants across both qualification types. The differences seen in our study results between the A-level and BTEC students reflect and build upon those reported previously in the literature, however, some interesting findings not highlighted before were identified. For scientists to expand the impact of outreach and widening-participation interventions across the UK, future work should aim to represent vocational qualification and A-level students equally, as these cohorts of vocational-qualification young people tend to represent more diversity across ethnic and socioeconomic groups.

Finally, this study was limited by only working with further education students. Previous studies suggest that attitudes towards science are fixed by this age and that primary school students might be more open to having their perception of scientific research changed (Miller *et al.*, 2018, Speering & Rennie, 1996). Future work should focus on this demographic to compare the impact of a multi-element study of this nature on a range of age groups.

Conclusions

Diversity amongst scientists results in better innovation and as a society, we need to maximise the progression of science. The disproportionate impact of the COVID-19 pandemic on minoritized groups (Kimble-Hill *et al.*, 2020) has potentially exacerbated the ethnic and social progression gap into further science education and ultimately science careers. It is important therefore that as a community of scientists, we focus on supporting young people from underrepresented groups further to minimise any widening of progression gaps already evident prior to the pandemic. We have shown that undergraduate students can positively impact the perception of and accessibility to science subjects. Moving to recruit a more diverse undergraduate role model base has the potential to widen access in underrepresented groups; universities would benefit from building this approach into their outreach strategy. Further work needs to be carried out to understand the complex barriers in progression amongst young people studying on vocational further education qualification routes, including whether the positive impacts demonstrated in this study can be replicated in younger school students.

Conflicts of interest

The authors report no conflicts of interest.

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