DEPARTMENT OF CHEMISTRY
FACULTY OF MATHEMATICAL & PHYSICAL SCIENCES

Collaborative Learning by Measuring Air Pollution: Student Perceptions and Confidence

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RSC INTEREST GROUP
HIGHER EDUCATION

UCL Chemistry Education Research

UCL Air Pollution Project: Background

- Carried out by first-year undergraduate students on chemistry programmes.
- To expose students to **“real research in the scientific sense of finding out something new, rather than simply looking things up”.**[1]
- The project had not been evaluated since its inception → MSci project.

Chemical Outreach

Laboratory Sessions

Collaborative Learning

1. A. Sella (2017). *Nature Rev. Chem.*, **1**, 0090.

Students' Project Experience Timeline

- Teams (3–4) meet.
- Intro lectures.

Checkpoint 1

School Visit 1: Lesson and Tube placement

Checkpoint 2

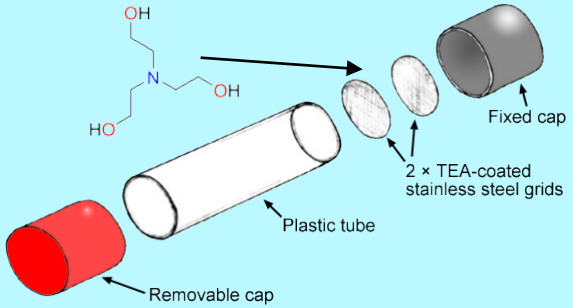
School Visit 2: Reporting Back

October **November** **December**

Assessment

- Test
- Reflective blog

Lab 1: Diffusion Tube Assembly[2]



Lab 2: Diffusion Tube Analysis[3]

2. *UK Urban NO_2 Network Annual Report 2020*, DEFRA, UK, 2020.

3. C. Fabrega *et al.* (2017). *ACS Sens.*, **2**, 1612–1618**.**

MSci Chemical Education Research Project

Carried out by **May Yi Tan**, MSci research project 2022/23.

UCL ethics approval 11925/009.

Research Questions:

1. What are **students' perceptions and confidence** towards collaborative learning, chemical outreach, and laboratory sessions in the project?

2. How does a **student's background** affect their perceptions and confidence towards the project?

3. What **improvements** can be made to help students maximise the benefits they can gain from the Air Pollution project?

Methods

Surveys were sent to all first-year chemistry students (*n* = 237).

Comprised Likert statements and open-ended free-text questions.

Pre-Project Survey (*n* = 62)

- Confidence towards presenting to primary school students.
- Interest in teaching as a career.

Post-Project Survey (*n* = 35)

- Perceptions and confidence towards various aspects of the project.
  - chemical outreach,
  - laboratory sessions,
  - collaborative learning.

Invited interviews (*n* = 4) for clarifications.

Demographics

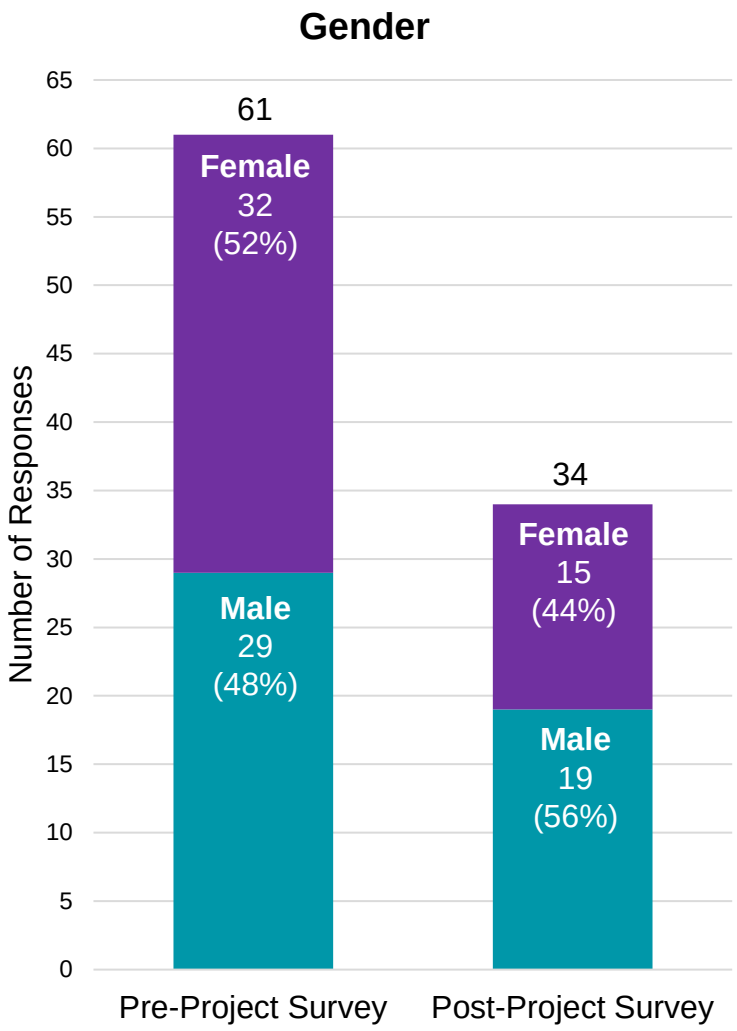
- Gender
- Ethnicity (BAME)
- Native English Speaker

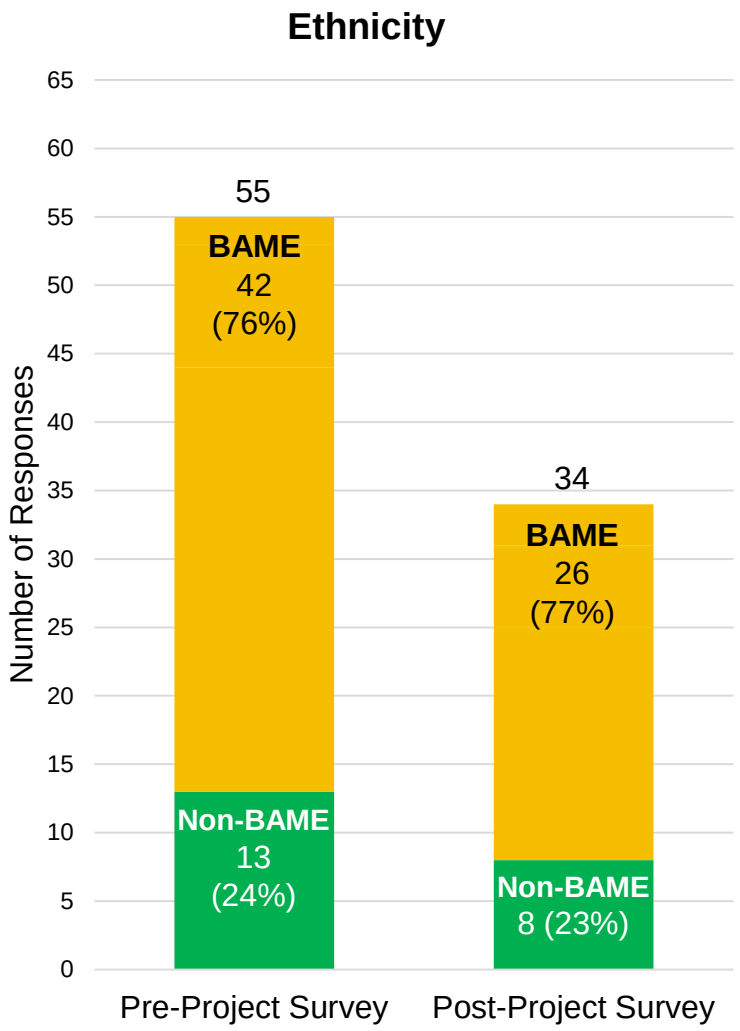
Analysis

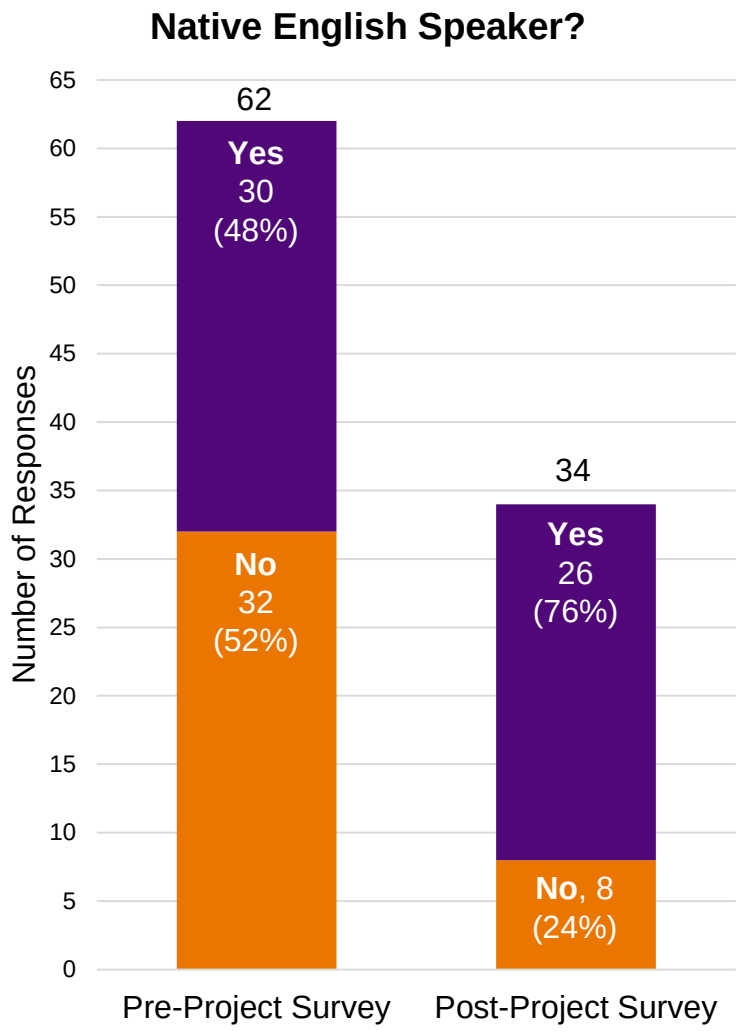
- **Likert statement responses:** Kruskal-Wallis one-way ANOVA (95% confidence interval).
- **Free-text questions and interviews:** thematic analysis.

Demographics

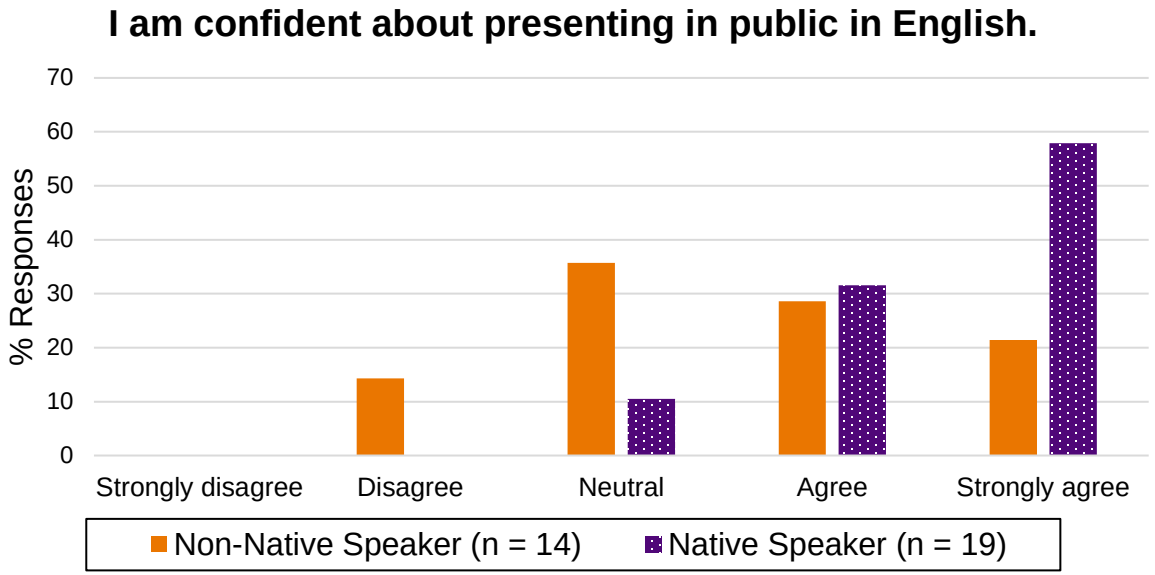
Pre-project survey (*n* = 62), post-project survey (*n* = 35).

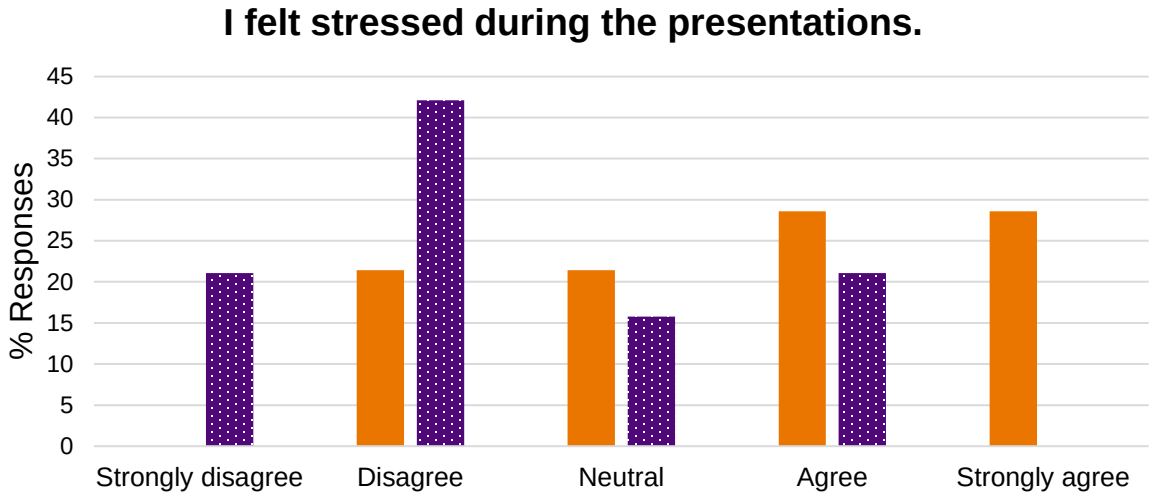






Chemical Outreach: Confidence





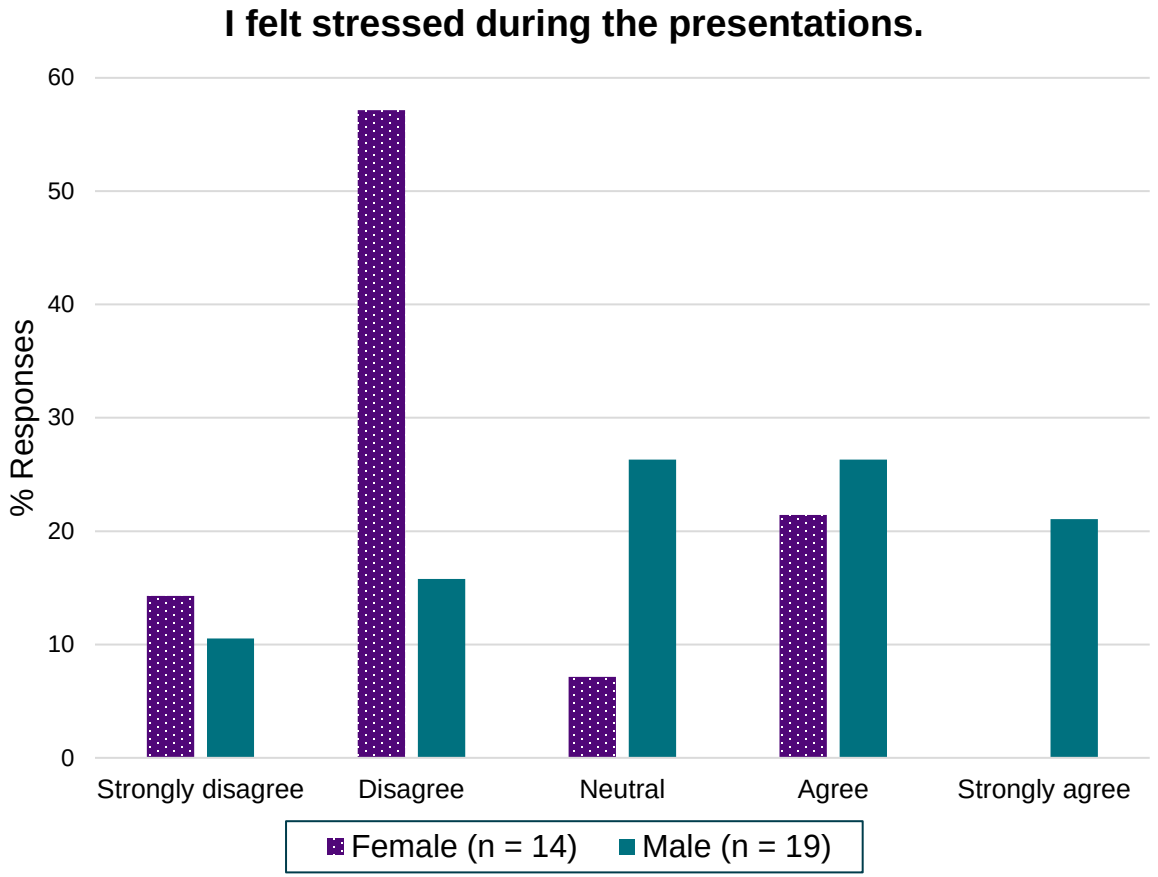
Native English speakers:

- Reported **more confidence** in presenting in English ($p = 0.012$).
- Reported feeling **less stressed** during the presentations ($p = 0.005$).

From interviews:

> [Non-native English speakers come] **from a very different background,** [they] **found it particularly stressful to give presentations to local kids**.

Chemical Outreach: Presentation Stress

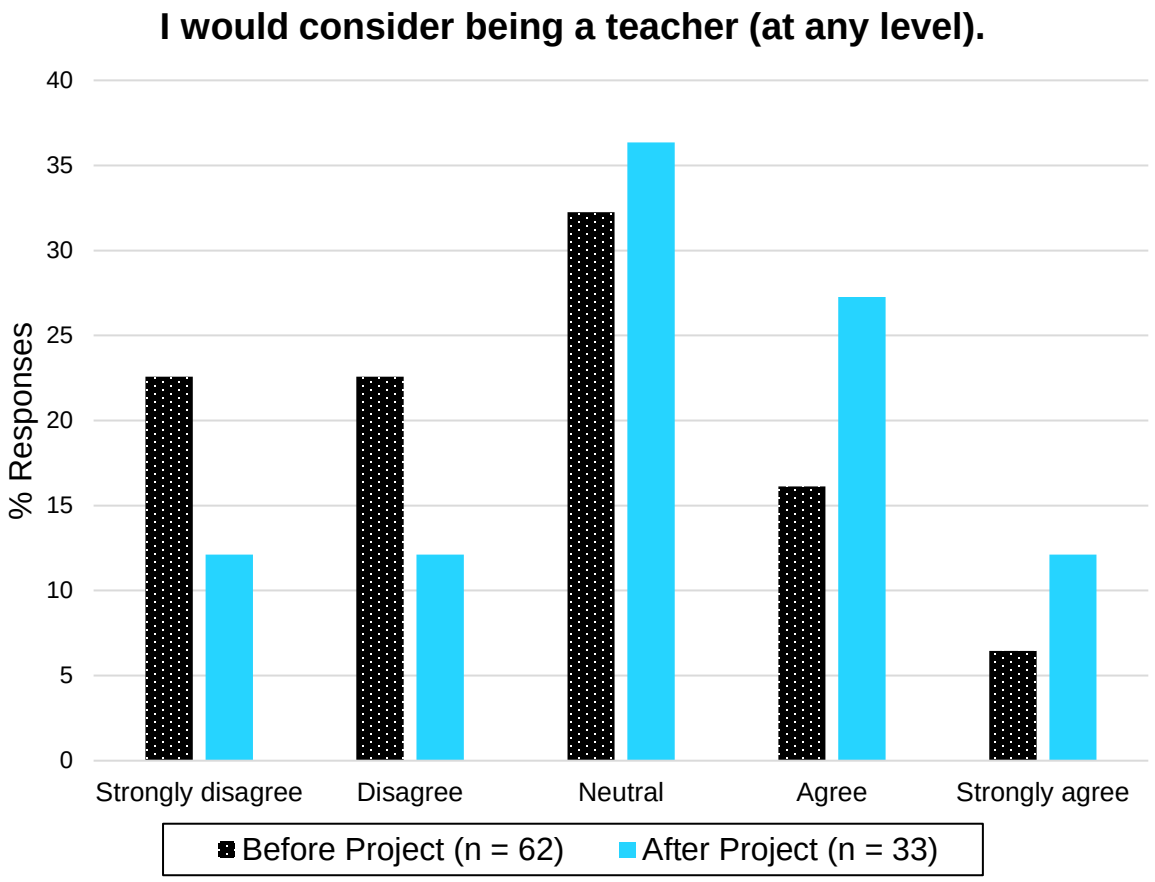


Male students:

- Felt **more stressed** during the presentations than female students ($p = 0.035$).
- Are generally less prepared for the presentation **content**.[4]
- Focus more on how they come across to the audience.[4]

4. S. Sahid *et al*. (2018). *Int. J. Humanit. Innovation (IJHI)*, **1**, 35–46.

Chemical Outreach: Perceptions of Teaching



- Increase in students considering a teaching career after the project ($p = 0.035$).
- Teaching primary school children was:

meaningful

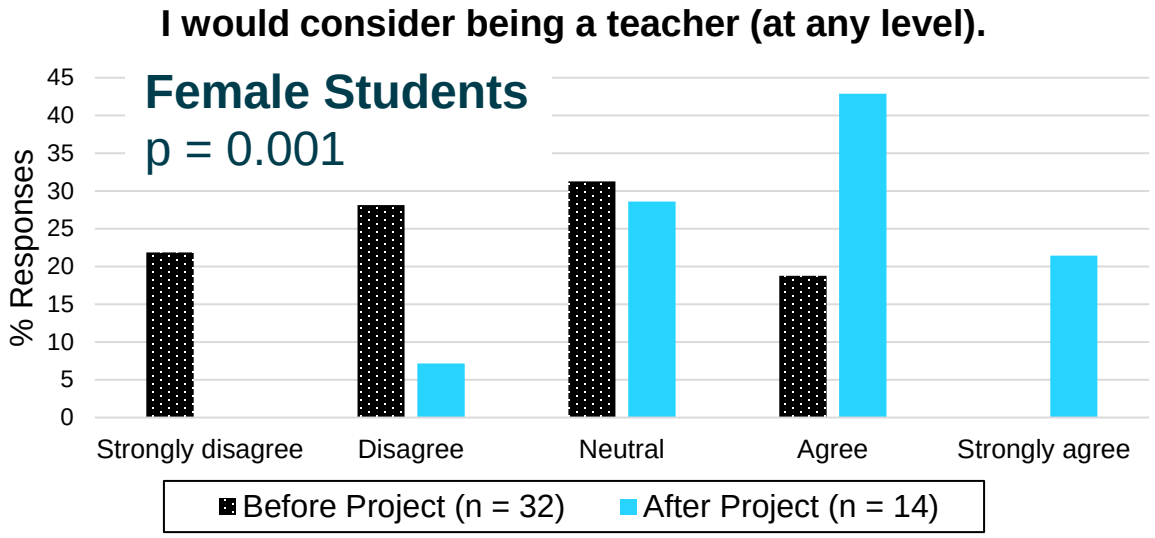
satisfying

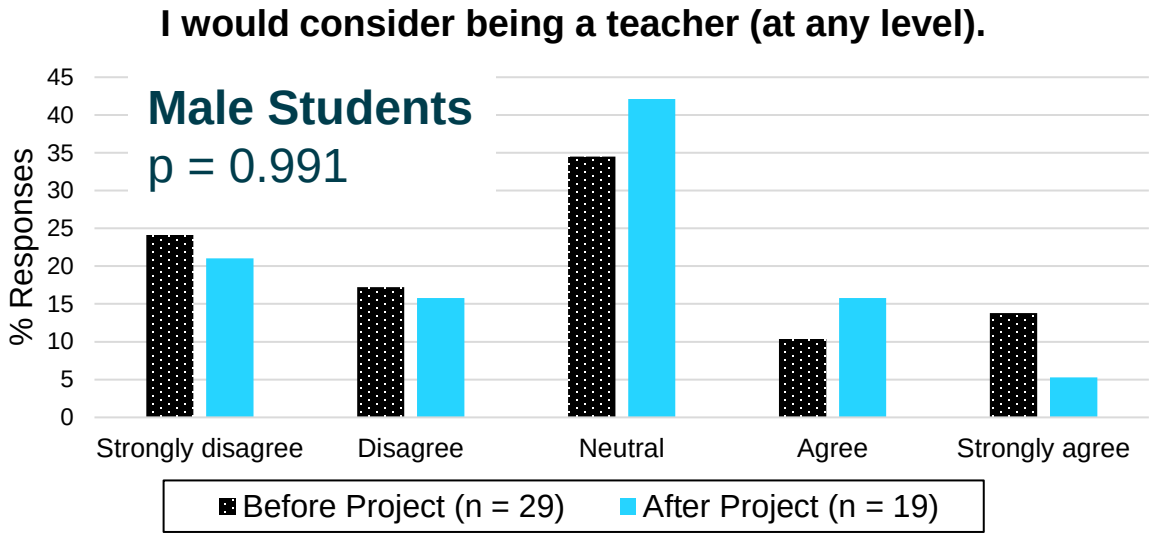
enjoyable

rewarding

[We have] **a greater appreciation for teachers!**

Chemical Outreach: Teaching and Gender





- Only **female** students reported an **increase in interest** in teaching after the project.
- Lingering societal stereotypes of females being more nurturing.[5]
- Negative associations of males taking up teaching roles?[6]

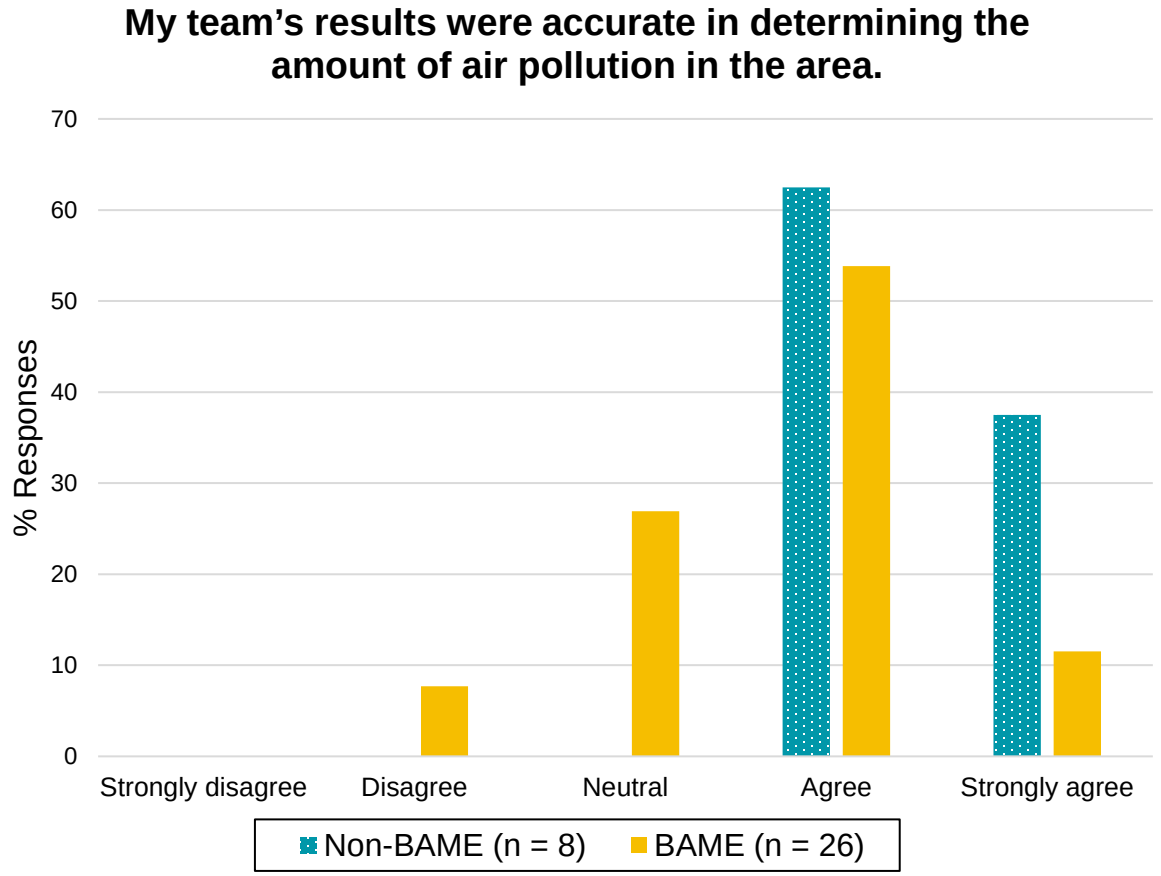
5. J. Johnston *et al.* (1999). *J. Educ. Teach.*, **25**, 55–64.

6. B. Carrington (2002). *Educ. Stud.*, **28**, 287–303.

Laboratory Sessions: Perceptions of Accuracy

BAME students:

- Tended to be **less confident** in the accuracy of their results ($p = 0.026$).
- Societal stereotypes of BAME students as "less intellectual" being reinforced by **microaggressions**.[7]
- Students from Asian educational backgrounds typically **"listen and memorize correct answers and procedures rather than to construct knowledge themselves"** which may be difficult in this project where there is no "correct" answer.[8]



7. J. Quinn (2013). *Drop Out and Retention of Under-represented Students in Higher Education in Europe*, European Commission.

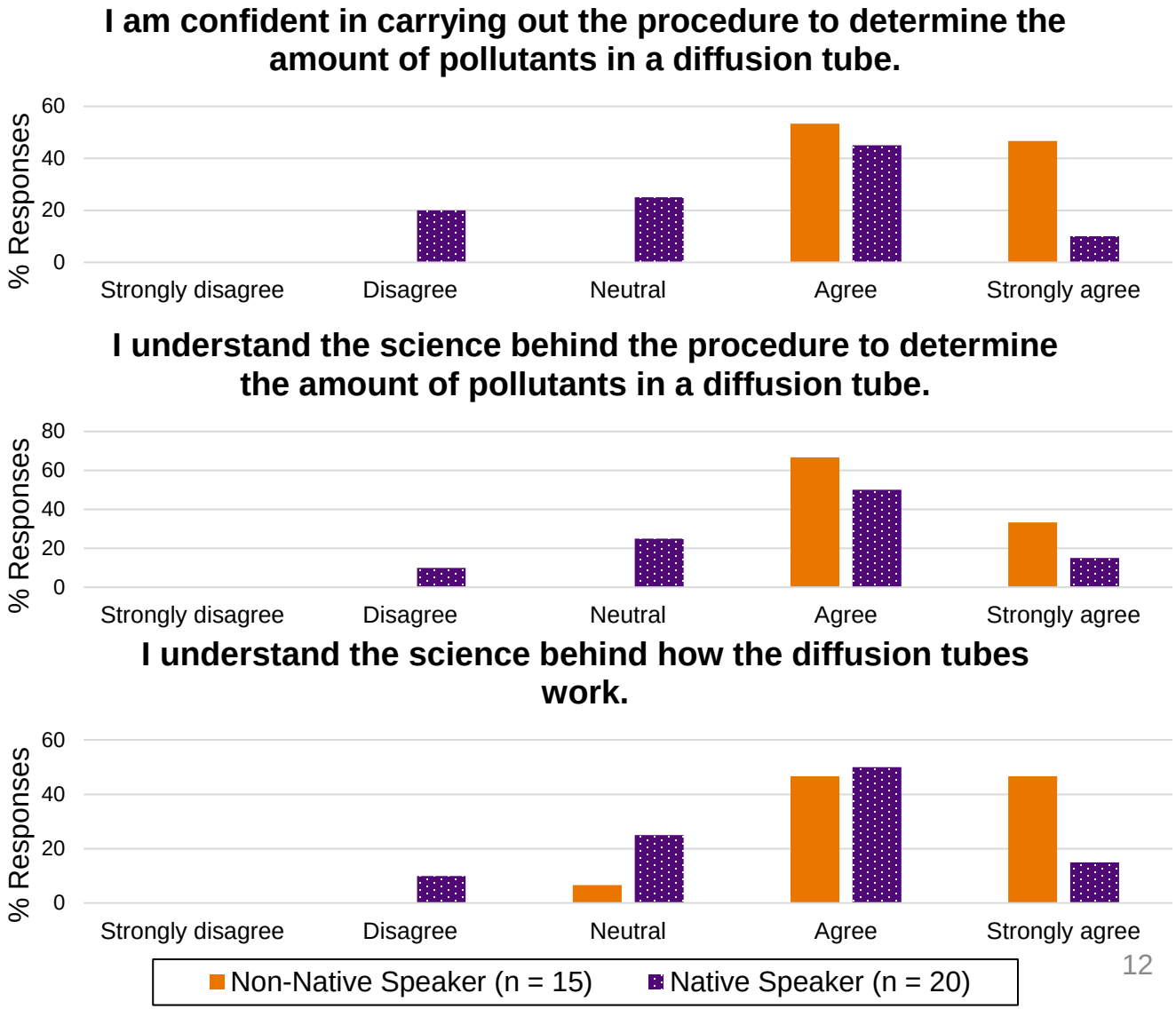
8. J. Stigler and H. Stevenson (1991). *Am. Educ.*, **15**, 14–20.

Laboratory Sessions: Practical Procedure

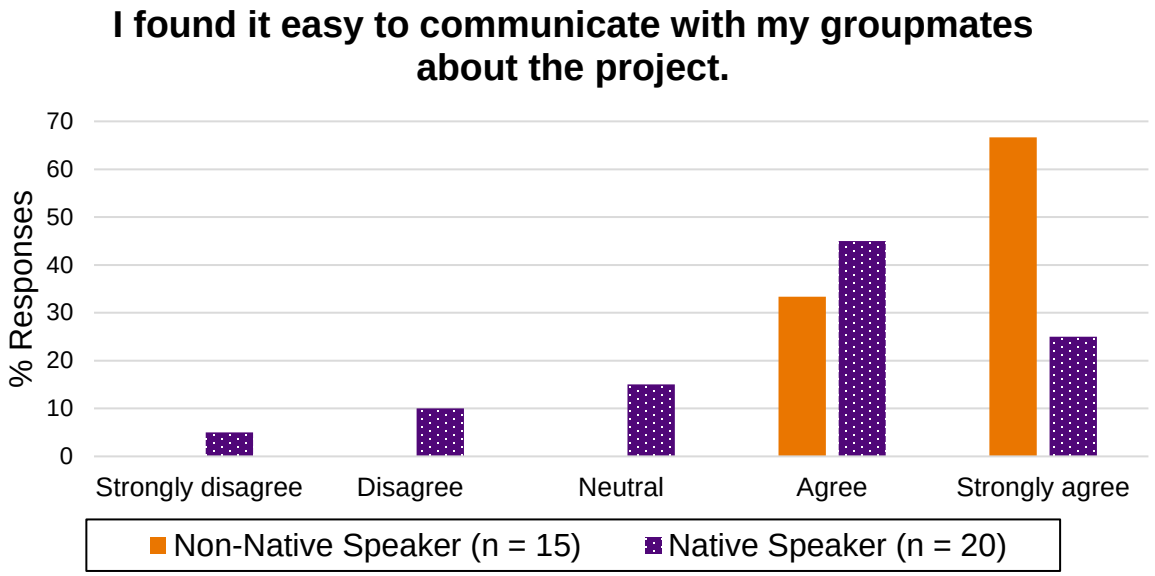
Native English speakers tended to be:

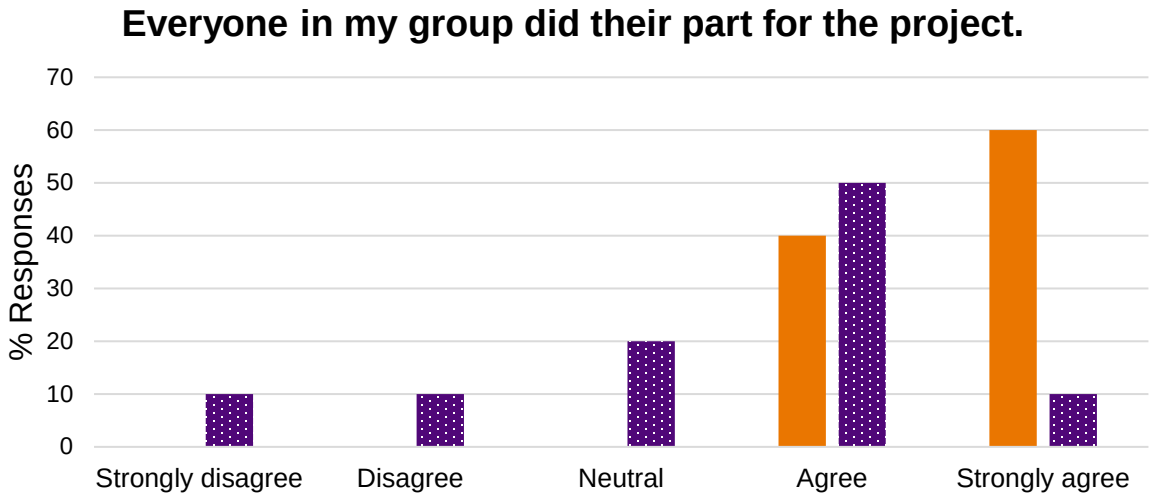
- **less confident** in carrying out the practical procedure (p = 0.001),
- less likely to **understand the science** behind the procedure (p = 0.020) and **"just did it because it was necessary"**,
- less likely to **understand how the diffusion tubes worked** (p = 0.014).

Theory information was in the lab manual, but one student said **"it was very text-heavy"**.



Collaborative Learning: Language Barrier?





Native English speakers:

- More likely to report **difficulties with communication** ($p = 0.034$).
- More likely to feel **others aren't putting in as much effort** ($p = 0.001$).
- More effort required to get the message across to teammates.
- Leads to the feeling that others aren't pulling their weight.

Conclusions and Recommendations

Chemical Outreach

- Native English speakers
  - felt **less stressed** during presentations and
  - **more confident presenting** in English
- than non-native speakers.
- Males **felt more stressed** during presentations than females.
- Females viewed a **teaching career more favourably**.

→ Dedicated lectures or tutorials on giving presentations.
→ More feedback sessions.
→ Clearly structured feedback sessions.

Laboratory Sessions

- BAME students were **less confident in the accuracy** of their results.
- Native English speakers were **less confident in the science** behind the project/procedure.

→ Use (micro)affirmations.
→ Clearer resource signposting.
→ Dedicated lecture(s) on background theory.

Collaborative Learning

- Native English speakers were more likely to **disagree** that
  - **communication was easy** with groupmates and
  - their groupmates had **done their parts** for the project.

→ Assessed group submission + peer mark.
→ Team mentors.

Limitations