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# Improving Teamwork and Communications skills for Physics 1 Students through Collaborative Outreach Posters

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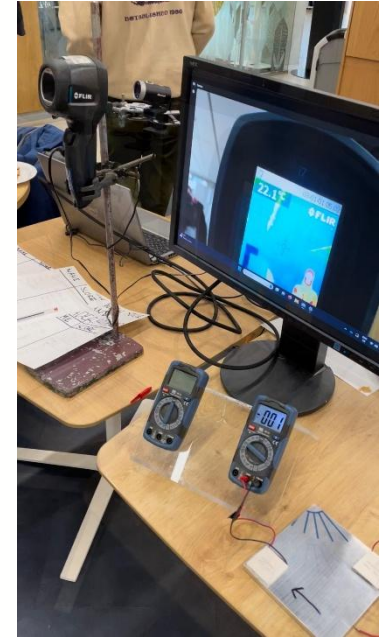
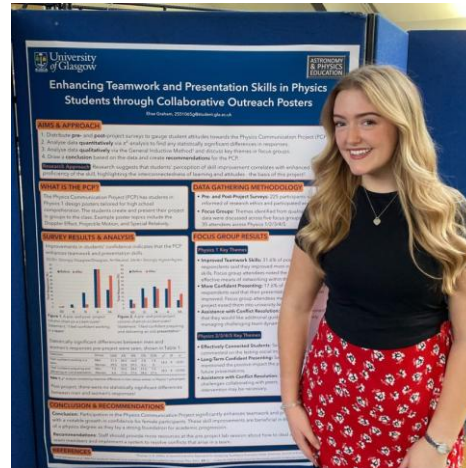




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# Introduction

ASTRONOMY  
& PHYSICS  
EDUCATION



Home / Study / Student life / ... / Undergraduate

## BLOGS

### UNDERGRADUATE BLOGS

Find out more about life at Glasgow with blogs from those who know best, our students.



#### How to Stop Imposter Syndrome: Women in STEM edition

→ Physics student, Elise writes about experiencing Imposter Syndrome and shares her advice on how to combat it.

Published 21 October 2023





## In this presentation ...

- The importance of communication and teamwork skills in undergraduate science students
- Introducing first year students to these skills
  - The Physics Communication Project (PCP)
- Evaluating the PCP and the effect it had on student confidence
- Conclusions



## Importance of skills (1)

- IOP accredited degree framework<sup>1</sup> recognises the importance of “soft” skills.
  - Underscores the necessity of nurturing a broad range of transferable skills throughout the academic program, which are essential for success.
  - Programmes must provide training in a broad range of transferable skills, and their use should be demonstrated throughout the programme.

<sup>1</sup> *IOP degree accreditation framework* [Online]. Available: <https://www.iop.org/sites/default/files/2022-09/IOP-Degree-Accreditation-Framework-July-2022.pdf> (accessed on July 2025).



## Importance of skills (2)

The framework encompasses crucial expectations:

- Stipulates students must undergo training in diverse transferable and professional skills such as communication, teamwork, and presentation.
- Emphasis on the need of acquiring these skills irrespective of the academic program (BSc/MSci/MSc)
- Students taking our introductory physics course can be on a wide range of degree plans ... Physics, Theoretical Physics, Astronomy & Physics, Physics with Astrophysics Maths & Physics, Astronomy & Maths, Physics & Computing, Chemical Physics, Mathematics ...





## Tackling these skills

- PCP tackles communication and teamwork skills right at the start of students' degrees.
- Helps foster friendships between students: beneficial for academic performance and contribute to a supportive environment - can lead to improved academic outcomes<sup>2</sup>.
- Studies demonstrate that collaborative efforts yield superior academic progress, highlighting the importance of teamwork dynamics within the PCP<sup>3</sup>
- Plays a crucial role in sustaining students' interest in pursuing physics. Collaborative projects can deepen field knowledge and increase degree interest, which is especially useful for students uncertain about their academic path<sup>4</sup>. (Yekimov, 2021).

<sup>2</sup> Alotaibi, T. A. et al (2023). The benefits of friendships in academic settings: A systematic review and meta-analysis. *Cureus*, 15(12)

<sup>3</sup> Alexopoulou, E., & Driver, R. (1996). Small-group discussion in physics: Peer interaction modes in pairs and fours. *Journal of Research in Science Teaching*, 33(10), 1009–1114.

<sup>4</sup> Yekimov, S. et al (2021). Using the project method to motivate students studying physics. *Journal of Physics: Conference Series*, 1889.



## PCP Structure (1)

- Runs across Weeks 2, 3 and 4 of first semester
  - Week 2 - training week
  - Week 3 – feedback week
  - Week 4 - presentation week
- We use the lab class as this splits the 250+ students into 5 groups of ~50.
  - They are then randomly assigned to a group of 4/5 members
  - Given a choice of three topics to choose from ...



## PCP Structure (2)

Before we introduced this system ...

A-05	
A	Youngs Double Slit Experiment
B	Elastic and inelastic collisions
C	The Ideal Gas Law

C-12	
A	Superposition/Interference – constructive and destructive
B	Simple Harmonic Motion
C	Pressure in fluids

Theme	Count
Doppler Effect	24
Newton's Laws of Motion	9
Young's Double Slits	5
Thermal Expansion	3
Heat Transfer Mechanisms	2
Superposition and Interference	1
Conservation of Energy	1
Momentum and Collisions	1
Time Dilation	1
Simple Harmonic Motion	1
Lasers	1
Refraction	1
Projectile Motion	1
Total	51





## . Outreach:

- What is “outreach”?
- Why is outreach important?
- What kinds of outreach are there?
- What makes good outreach?

## . Posters

- What makes a good poster?
- How do you actually make a poster in PowerPoint?

## Working in a team

- Why do people work in teams?
- What makes a good team?
- What role would you best take in a team?

## Reflecting on your work

- Critical self-reflection is an essential skill, and we’ll look at some useful ways to do this.



## Feedback & Presentation

- Week 3 lab class time given over to development time for students, with staff on hand to provide feedback on works in progress.
- Week 4 – presentations.
  - Each day split into three sessions, so class present to around 20 people
  - Posters presented electronically
  - 5 minutes for presentation + 5 minutes for Q&A



	Weighting	Criteria for full marks
<b>(A) Quality of poster</b>	40 %	<ul style="list-style-type: none"><li>Clearly defined layout and structure; appropriate choice of font; not too much material; professionally created; suitable to audience; followed submission rules</li></ul>
<b>(B) Technical content</b>	20 %	<ul style="list-style-type: none"><li>Good quantity of accurate, technical content appropriate for the level of the target audience; sources of information given</li></ul>
<b>(C) Presentation, Response to questions and teamwork</b>	40 %	<ul style="list-style-type: none"><li>Presentation of poster was handled confidently; questions answered clearly and confidently; evidence that the students had worked well as a team; questions handled equally, presentation shared amongst members, all contributed to poster preparation.</li></ul>





## Personal reflection

- Students only receive their marks if they complete a personal self-reflection statement
  - Reflection itself is not marked – we simply want them to explore this
- What personal strengths and skills do you think you best displayed during this project?
- What do you think your personal weaknesses were?
- What worked particularly well in your team? Why?
- What did not work well in your team? Why?
- Why do you believe the references you chose are reliable?

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& PHYSICS  
EDUCATION

## THERMAL EXPANSION

### ABSOLUTE ZERO

Temperature describes the internal energy of a substance, the higher the temperature, the greater the average internal energy of each individual molecule of a substance is.

There is a lower limit of temperature at which there is no internal energy found in any of the molecules of a substance.

This is known as Absolute Zero at approximately -273 °C or 0K on the Kelvin scale which is an absolute scale such that an increase in 1K is the same as 1 °C.

[Source: en.wikipedia.org/wiki/Absolute\\_zero](https://en.wikipedia.org/wiki/Absolute_zero)

### Thermal Expansion of Water

Like any other liquid, water expands proportionally to its temperature. However, at around 4 °C, its volume slightly decreases instead, before expanding as normal as its temperature increases.

This unique behaviour is what allows marine life to thrive as when the surface water approaches 4 °C, it will increase in density and sink to the bottom of the ocean, creating a uniform temperature of 4 °C for the sea creatures to live in.

[Source: presbos.lcccampus.ca/collegephysics/chapter-the-mechanics-of-liquids/](https://presbos.lcccampus.ca/collegephysics/chapter-the-mechanics-of-liquids/)

### THERMAL EXPANSION

- Clamped materials including metal beams, concrete and wood all expand or contract due to a large change in temperature usually by extreme weather.
- When there is a change in length due to the temperature, the mechanical tension in the material will increase to negate the expansion.
- Over time, this tension will develop thermal stresses on the material which can eventually cause the material to break, posing serious safety hazards.
- [Source: proper.com/the-effects-of-thermal-expansion-on-common-building-materials](https://www.proper.com/the-effects-of-thermal-expansion-on-common-building-materials)

### ELECTRICAL FAULTS

- Likewise, cables carrying electricity between pylons can expand, causing the cables to sag which can be a safety hazard.
- It can also weaken the structural integrity of the pylons and exert stress on the electrical insulators in the cables, potentially causing electrical faults.
- [Source: climatix.com/arc-exposure-on-metallic-cable-stays-adapting-overhead-line-supports-to-changing-temperatures-in-uk](https://www.climatix.com/arc-exposure-on-metallic-cable-stays-adapting-overhead-line-supports-to-changing-temperatures-in-uk)

### OFF THE RAILS

- Train tracks can also buckle under extreme temperatures.
- To avoid this small gaps are left in between rails and some parts of the track are painted white to absorb less heat.
- [Source: networkrail.co.uk/running-the-railway/looking-after-the-railway/delays-explained-buckled-rail-and-summer-heat](https://www.networkrail.co.uk/running-the-railway/looking-after-the-railway/delays-explained-buckled-rail-and-summer-heat)

### POTHOLES

- Potholes and cracks in the road are caused by water getting trapped in small cracks in the concrete.
- Over time they can freeze and expand, exerting a force on the concrete and eventually breaking it.
- [Source: www.transport.net.nz/faq/how-do-potholes-form.html](https://www.transport.net.nz/faq/how-do-potholes-form.html)

### THERMOMETERS

However, there are ways we can take advantage of thermal expansion such as using thermal expansion of mercury in a typical thermometer.

When the temperature of the mercury increases, the liquid expands up the tube and vice versa, giving us an accurate measurement of temperature.

[Source: science4allclassroom.com/1255/thermal-properties/1-temperature-and-thermometers](https://science4allclassroom.com/1255/thermal-properties/1-temperature-and-thermometers)

### Linear Expansion

- The change in linear length  $\Delta L$  in 1 dimension has been found to be proportional to the change in temperature and original length which can be represented in the equation  $\Delta L = \alpha L_{original} \Delta T$  where  $\alpha$  = "Change in" and  $\alpha$  is the coefficient of linear expansion.
- The coefficient of linear expansion is a constant for each material determining the change in length per degree of temperature, materials with larger coefficients will be more susceptible to expansion or contraction under change temperatures.
- Liquids cannot expand in 1 dimension only, so this equation does not apply to them.

### Volume Expansion

Experimentally, we can determine that there is a directly proportional relationship between the change in temperature and the change in volume, and we can derive the equation to the right

For solids, we know that they will remain at a fixed shape as their temperature increases. However, liquids expand into the shape of its container and are fixed.

This means when we consider the thermal expansion of liquids, we can only use the equation of volume expansion, whereas for solids both the linear and volume expansion equations apply. Liquids generally have a much higher coefficient of volume expansion than solids due to their atoms being further apart so less work needs to be done to separate them from their bonds, allowing them to expand more quickly.

The relationship between the coefficient of volume and linear expansion can be written as  $\beta = 3\alpha$  due to volume expansion being in 3 dimensions unlike linear expansion in 1 dimension, therefore it must be 3 times greater to account for each dimension.

[Source: Physics.universityphysica.com/Modern-Physics/page-576](https://www.physics.universityphysica.com/Modern-Physics/page-576)

### The coefficient of Volume Expansion ( $\beta$ )

$$\Delta V = \beta V_0 \Delta T$$

Original volume  $V_0$

Change in volume  $\Delta V$

Change in temperature  $\Delta T$

$$\Delta V = \beta V_0 \Delta T$$

Original volume  $V_0$

Change in volume  $\Delta V$

Change in temperature  $\Delta T$

# Relativity

Nothing Is As It Should Be

Consider two objects, A and B that are moving relative to one another...

The relative velocity is the velocity that object A appears to be travelling to an observer relative to object B and vice versa.

So, THE Usain Bolt is running on a walkway (ironic, we know) at 12.3 m/s! The walkway is moving at a rather measly 1 m/s...

Due to classical relativistic effects...

How fast do YOU see Usain running?

$V_{u/y} = V_{u/w} + V_{w/y}$   
 $= 12.3 \text{ ms}^{-1} + 3 \text{ ms}^{-1}$   
 $= 9.3 \text{ ms}^{-1}$   
Trippy, right?

In the frame of the platform and train A:

In the frame of train B:

Small Print

Unfortunately, these special effects aren't noticeable in day to day life because we aren't moving anywhere near the speed of light...sorry

## THROW YOUR TWIN INTO SPACE!

Trust Us...

Michael and Masood are twin brothers - by definition, they are the same age. In this case, 2 years old.

If Masood is sent hurtling through space at 0.98c light speed on a 10 year return journey...

This is the time dilation equation, used to calculate how much older Michael would be.

$$t' = \frac{t}{\sqrt{1 - \frac{v^2}{c^2}}}$$

He would be 12 years old upon his return to Earth, as expected...

MICHAEL WOULD BE 52 YEARS OLD!

Einstein developed a theory about space

And it was about time too





# Data gathering methodology



Physical survey's, one before  
and one after the PCP



Focus groups with first-year  
students



Focus groups with senior  
students.





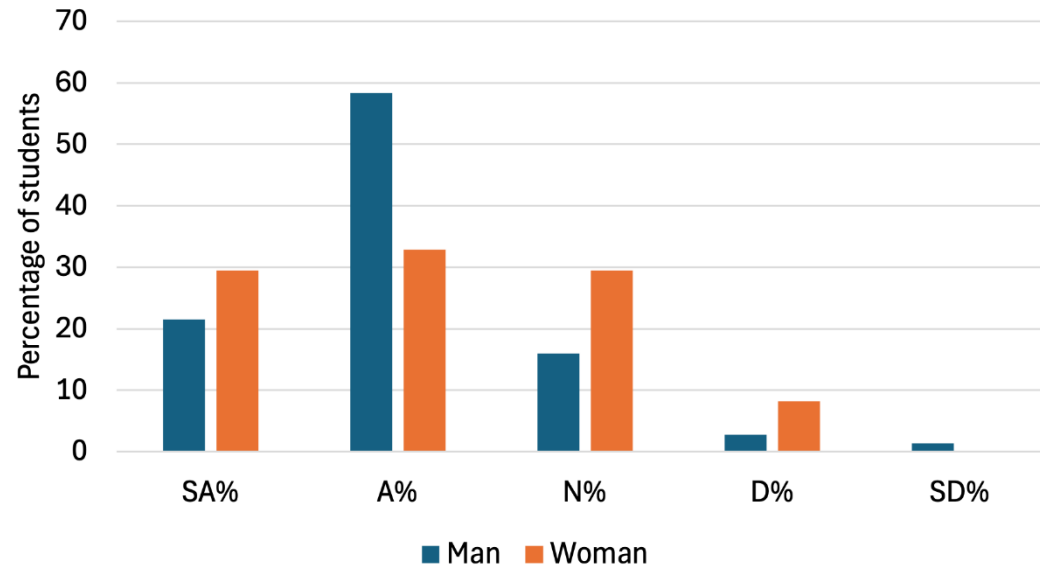
## Structure of physical survey

- *Section 1.* Investigating students' confidence using a particular skill.
- *Section 2.* 'Are there any aspects of the Physics Communication Project you are looking forward to?'
- *Section 3.* 'What skills would you like to improve through participating in the PCP?'
- *Section 4.* 'What new skills would you like to learn from participating in the PCP?'

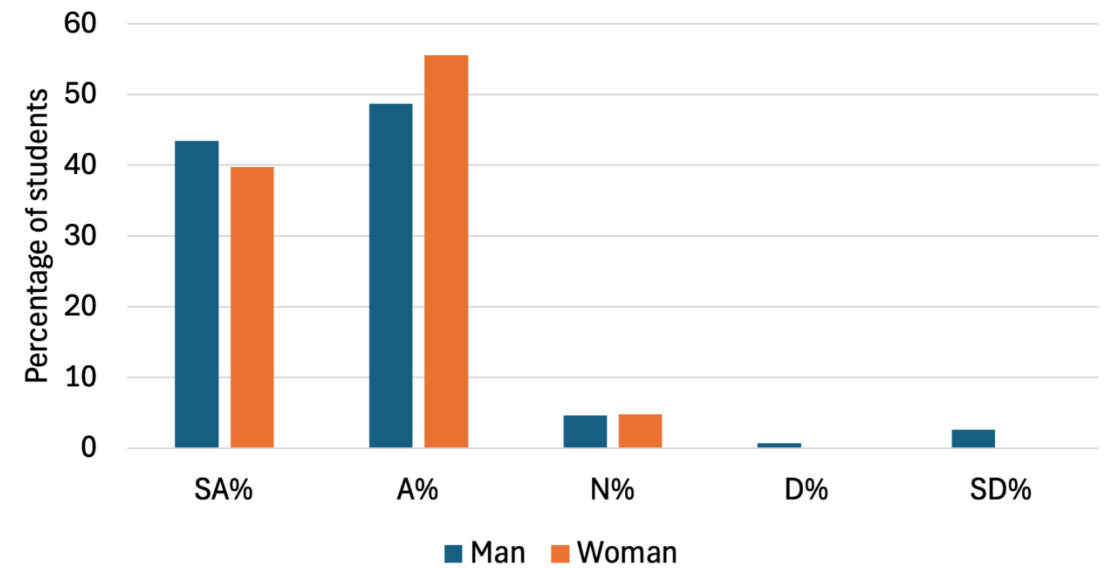


# Men versus women pre-post PCP

I feel confident working in a team- Before PCP



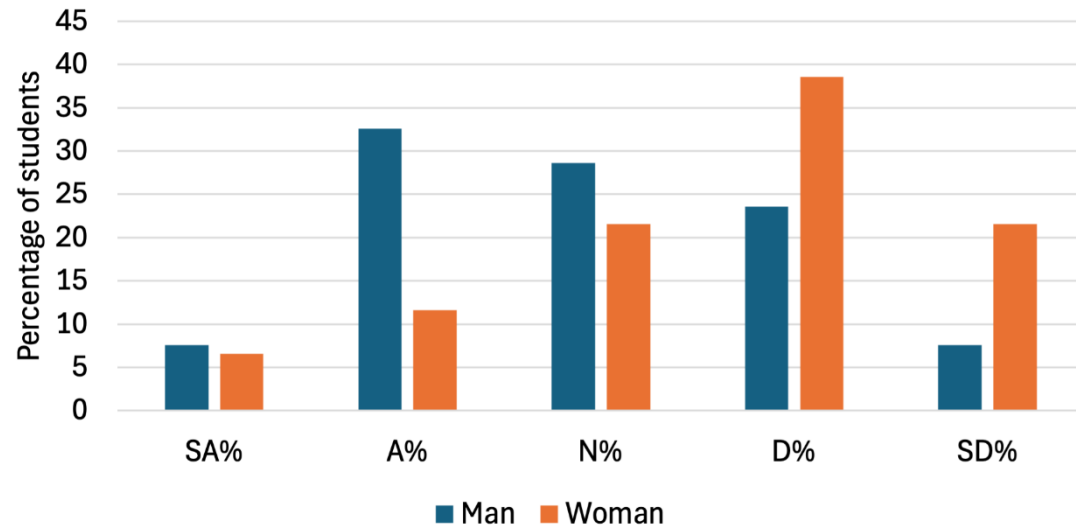
I feel confident working in a team - After PCP



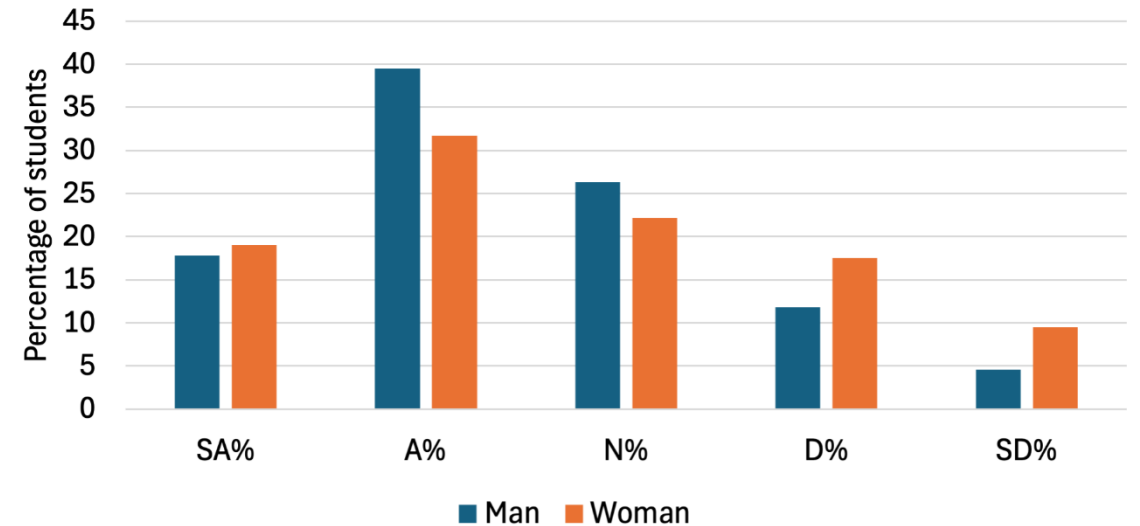


## Men versus women pre-post PCP (2)

I feel confident in preparing and delivering an oral presentation - Before PCP



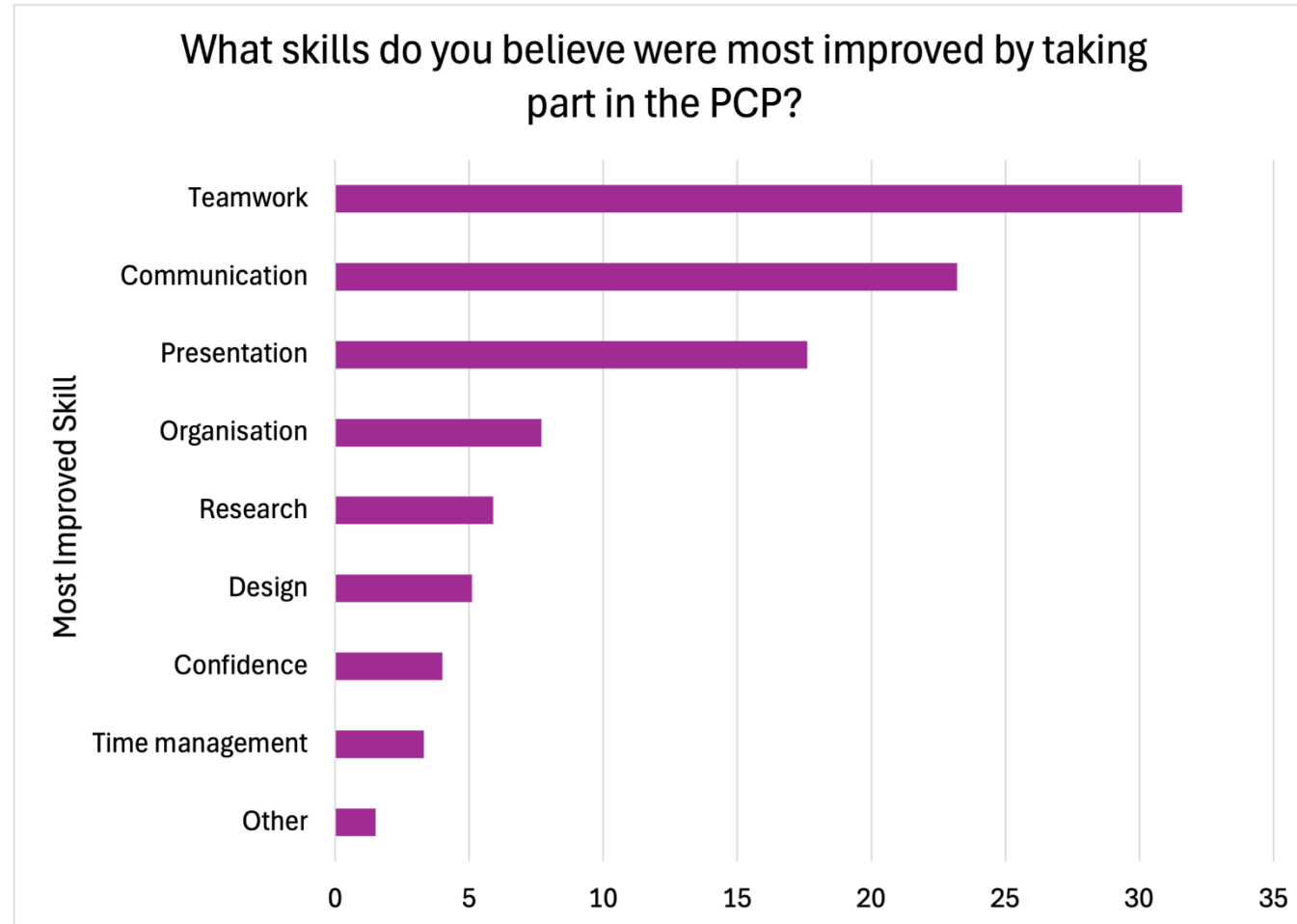
I feel confident in preparing and delivering an oral presentation - After PCP







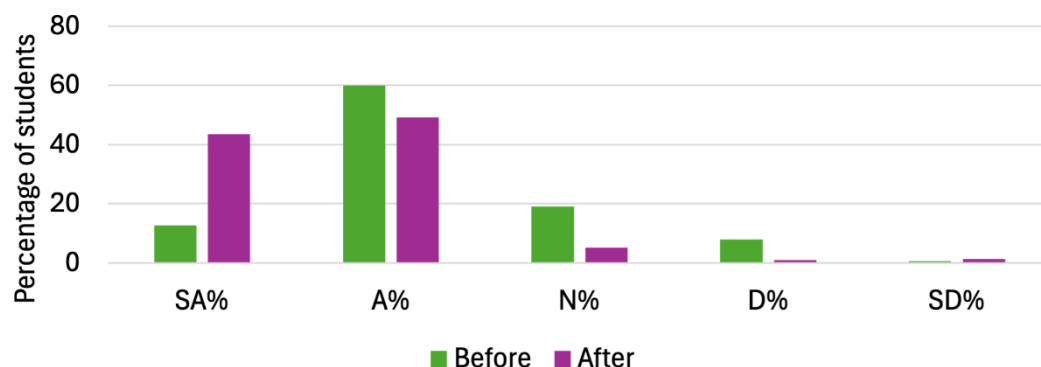
## Most improved skills



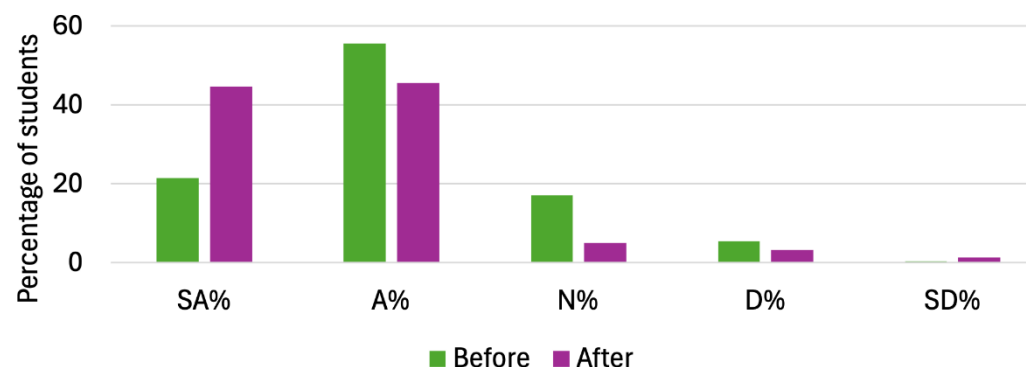


# Before versus after the PCP

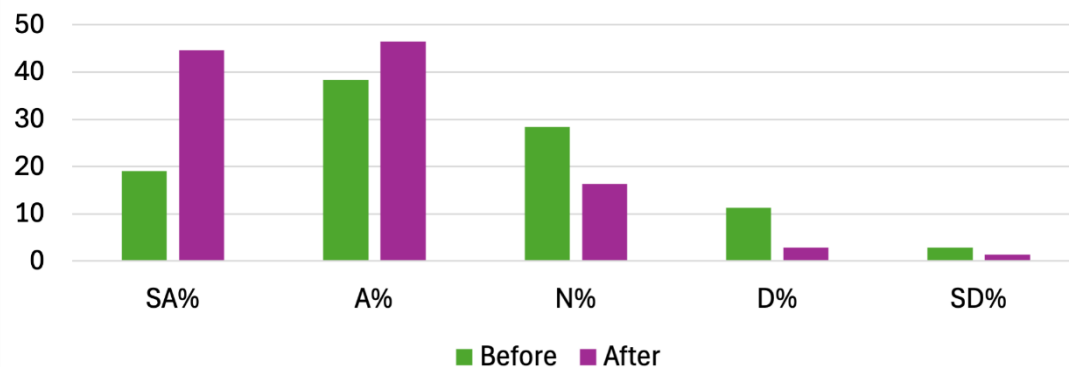
I feel confident setting goals and creating a plan with my team



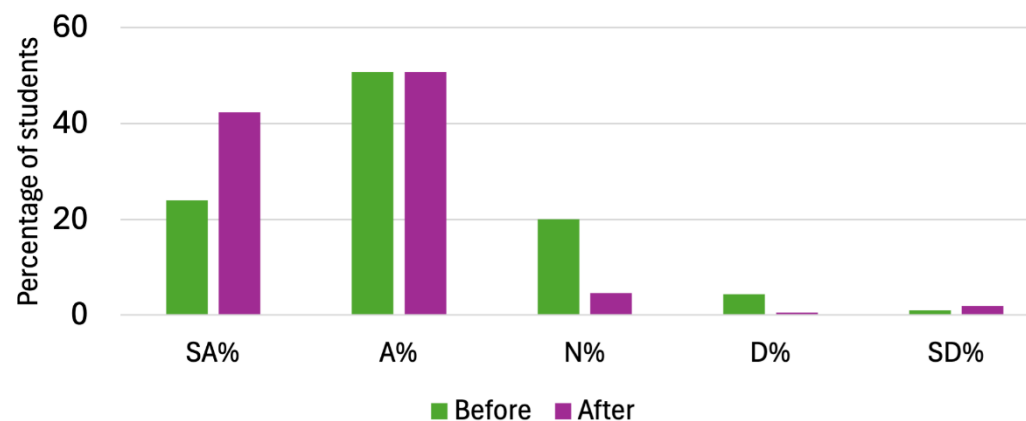
I feel confident in using my contributions from others to create a joint project



I feel confident in creating a poster to communicate my ideas



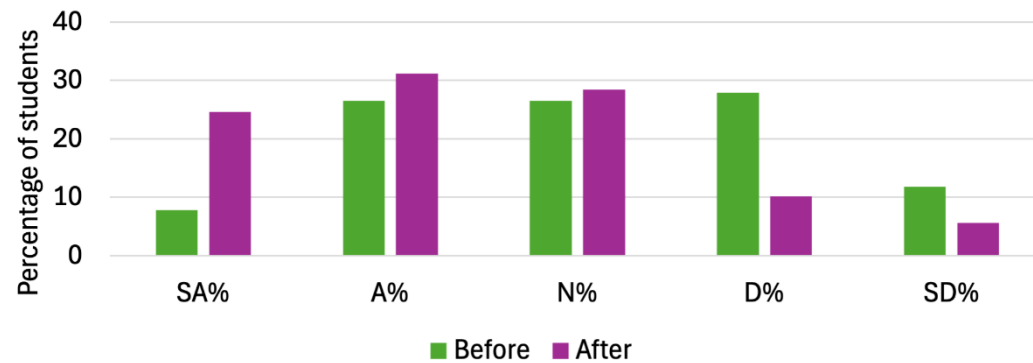
I feel confident working in a team



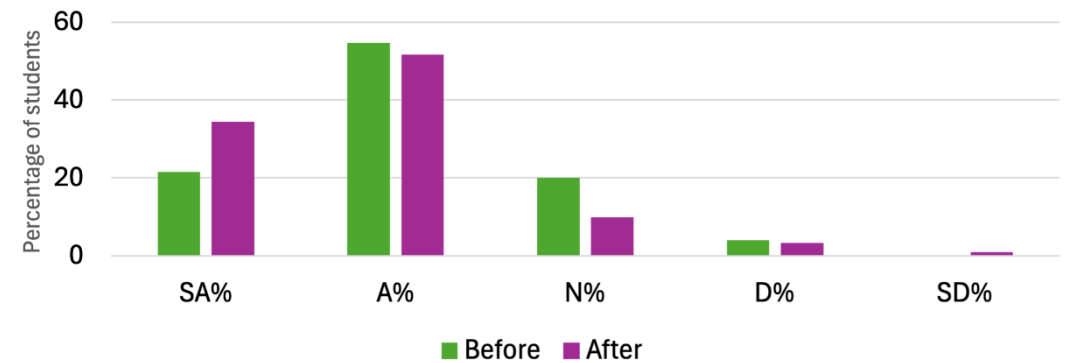


## Before versus after the PCP (2)

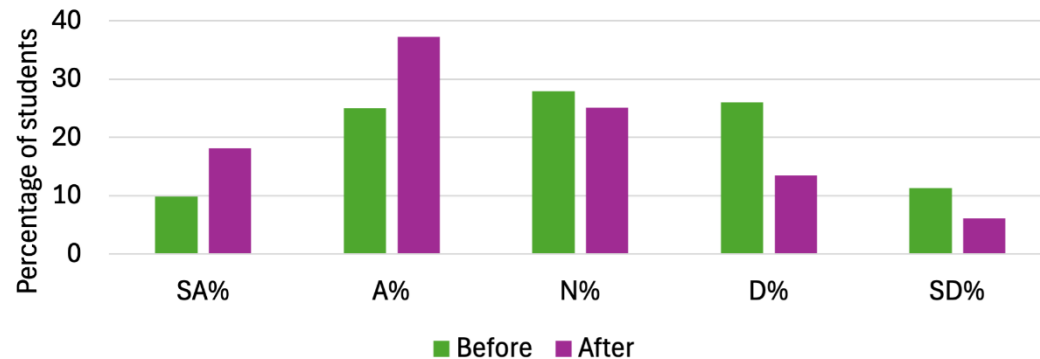
I feel confident answering questions in front of an audience



I feel confident in assessing the quality of my own work before it is completed



I feel confident in preparing and delivering an oral presentation







## Focus group key themes

### *First-years said...*

- Enhanced teamwork skills
- More confidence presenting
- Required support on conflict resolution

### *Second-, third-, fourth-, and fifth-years said...*

- Lasting friendships created
- Sustained enhancement of presentation skills
- Required support on conflict resolution



## Conclusions

- *Improved confidence in presentation skills*

Addressed gender discrepancies in confidence levels with a marked reduction in disparities following the PCP.

- *Enhanced confidence in teamwork skills*

Students' attitude toward teamwork significantly improved.

- *Lasting friendships*

Students gained a sense of community, correlated with improved academic performance. Helped others with degree path navigation.



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Thank you for listening ...

Questions?

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