

Introduction

In every region of the world, female researchers remain underrepresented in Science, Technology, Engineering, and Mathematics (STEM) fields (*UNESCO, 2018*). For example in the Netherlands, only 14% professionals in technical fields are women (*Monitor Techniekpact, 2023*). However, since studies have shown that there is no difference between genders in terms of interest or capability (*Spelke, 2005*), this disparity must be related to other factors.

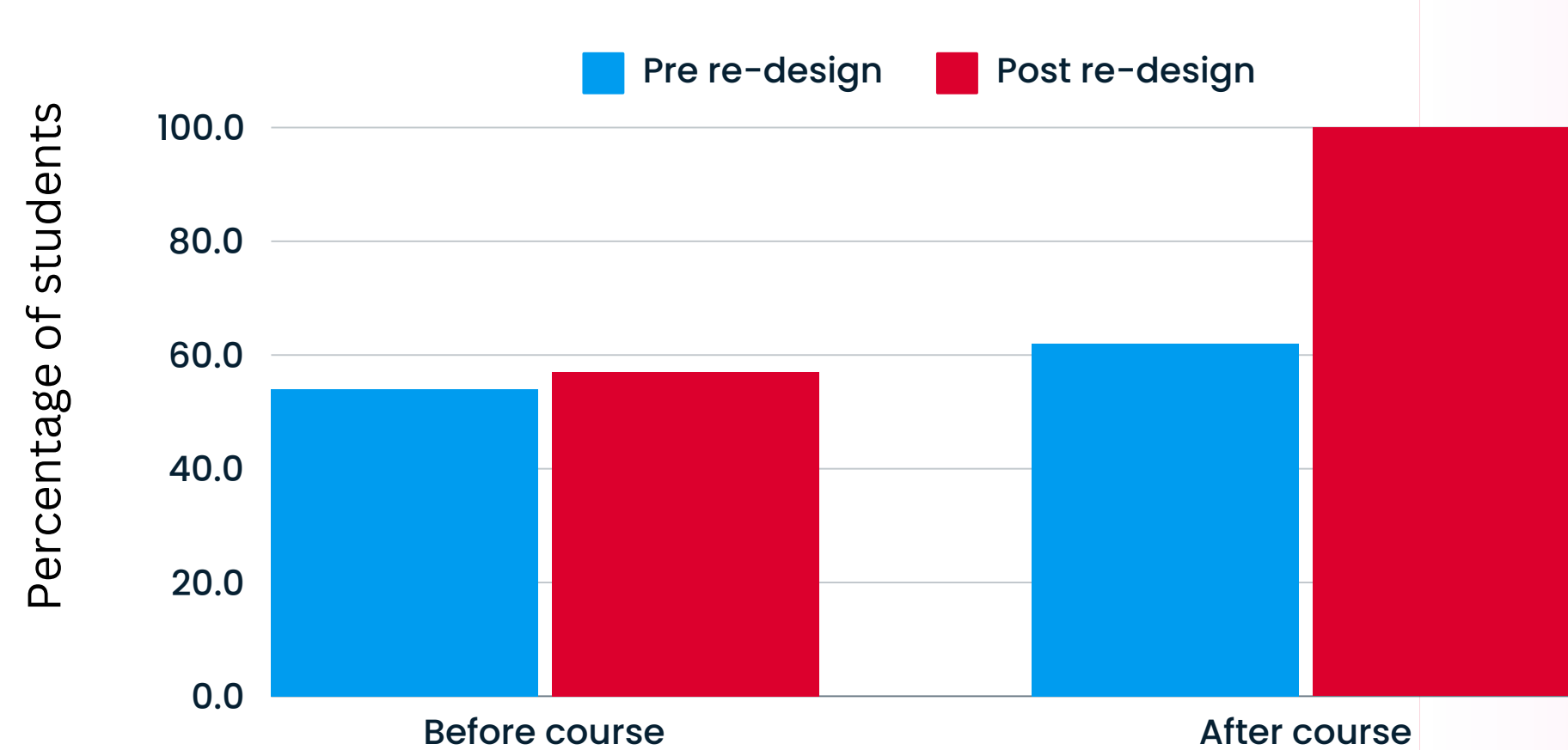
As such, in addition to recruiting women and girls to STEM fields, there is a necessity to actively retain them. Teaching and the classroom environment can play a big role in shaping the STEM identity of female students, building their confidence and ultimately motivate them to stay in STEM fields.

To address this, the project provides a set of concrete, evidence-based practices as part of an innovative, gender-inclusive course that can easily be implemented by instructors at a high school or university level. These instructional practices were implemented and evaluated in the Calculus 1 course, to see their effect on the development of STEM identity. Additionally, we developed an interactive online platform to advise university instructors about these best practices with extended practical examples from various STEM courses.

Results

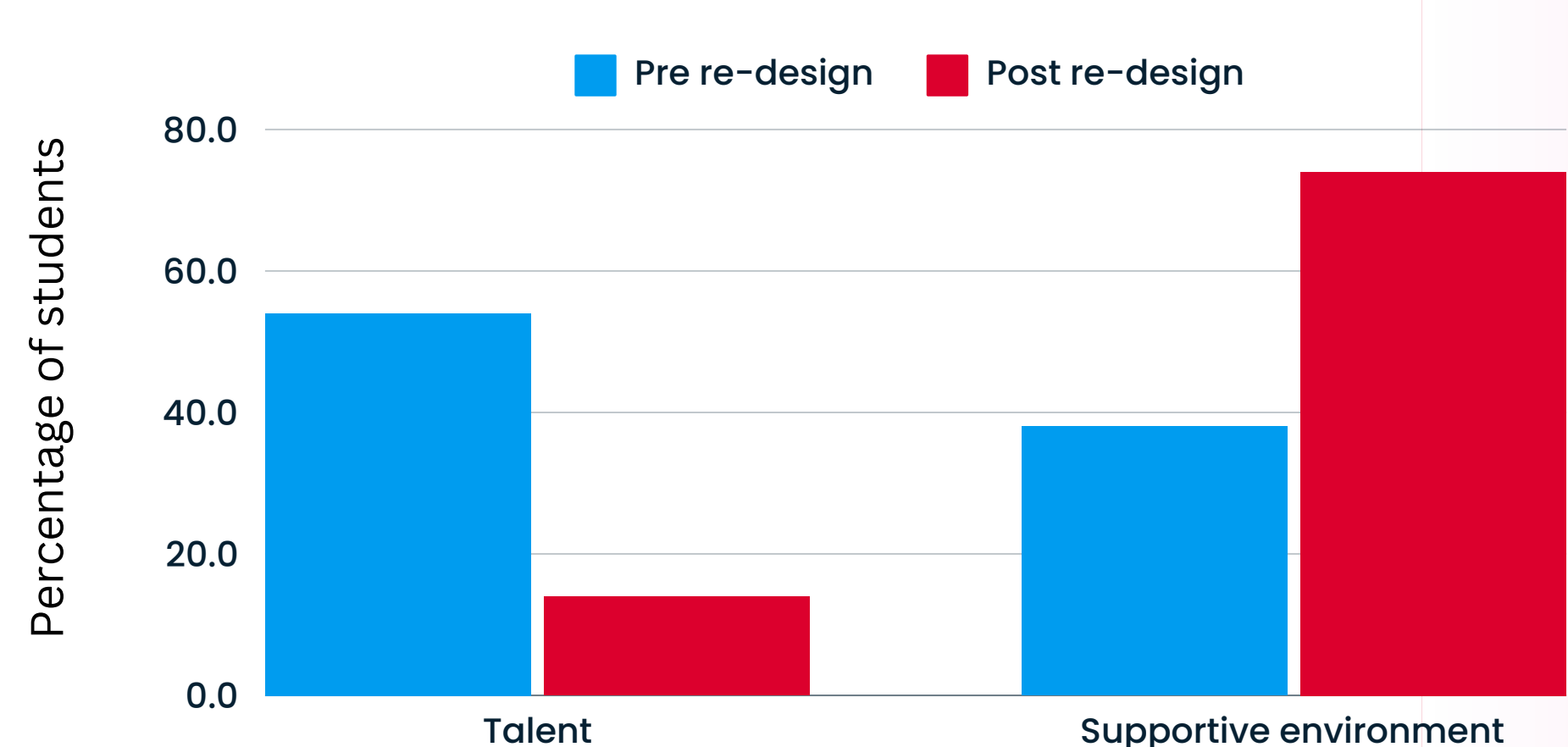
Building upon literature, this project explored the role of the university classroom in supporting the development of a strong STEM identity and specifically the view of self as a competent science person. The project consisted of two parts. In the first part, student-led desktop and empirical research focused on generating evidence-based recommendations for how an introductory Calculus course could be redesigned to be more gender-inclusive. The second pertained to the evaluation of the redesigned Calculus course with a survey asking qualitative and quantitative questions to assess students' attitude towards calculus.

Students that considered their ability in mathematics "rather good" pre and post course re-design



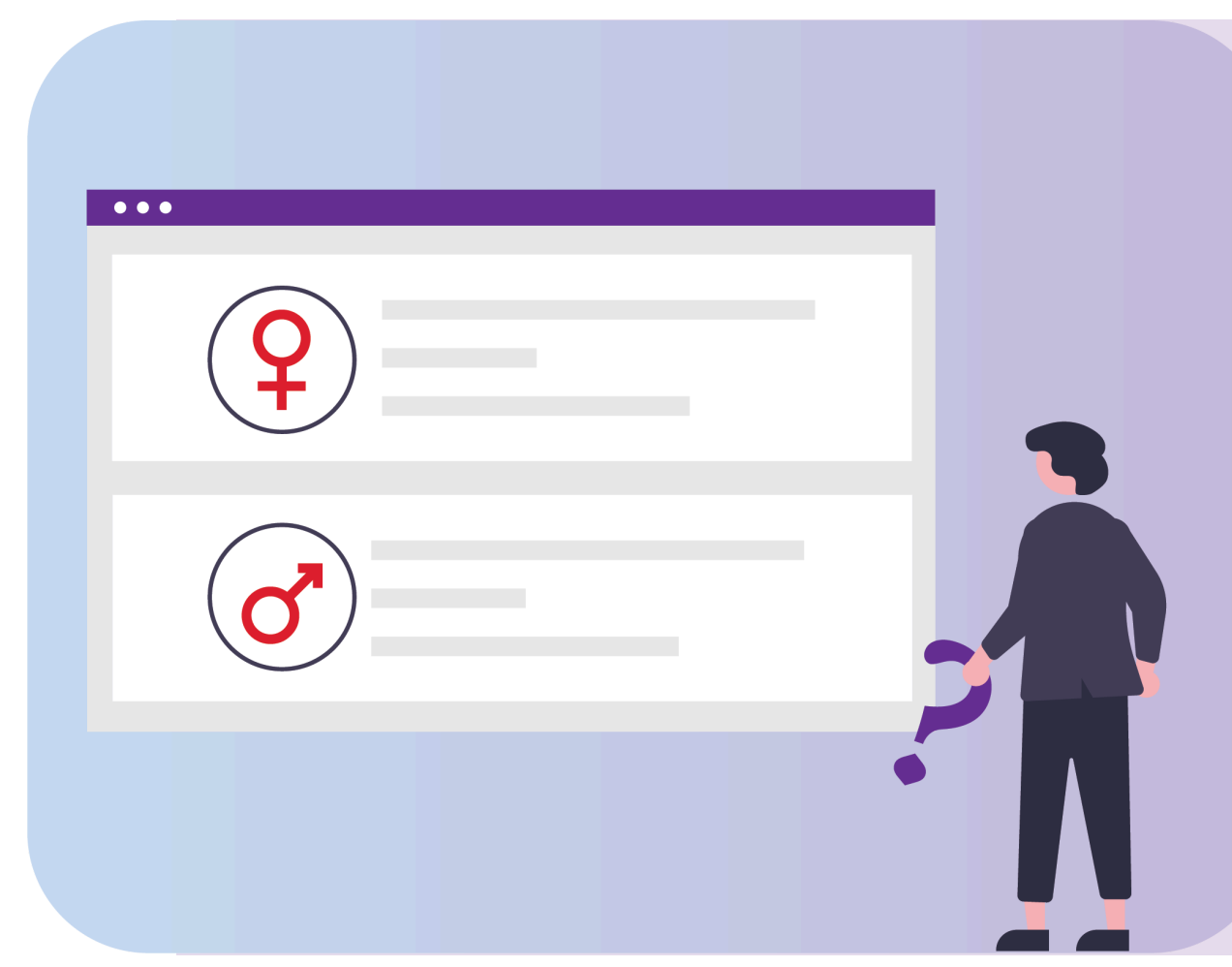
The course re-design resulted in an increase in the amount of students that were confident in mathematics

Factors that students considered important in mathematics pre and post course re-design



The course re-design resulted in a shift from considering inherit ability to environment as important in mathematics. This indicates a change from a fixed to a growth mindset.

Recommendations for teachers



Monitor your interaction with different genders

- When teaching, you can **keep track** of how you interact with different genders: It might be surprising to see the **ratios** of different genders **answering or asking** questions (*Saggi, 2018*)
- Keeping a note, and try to **keep the balance**

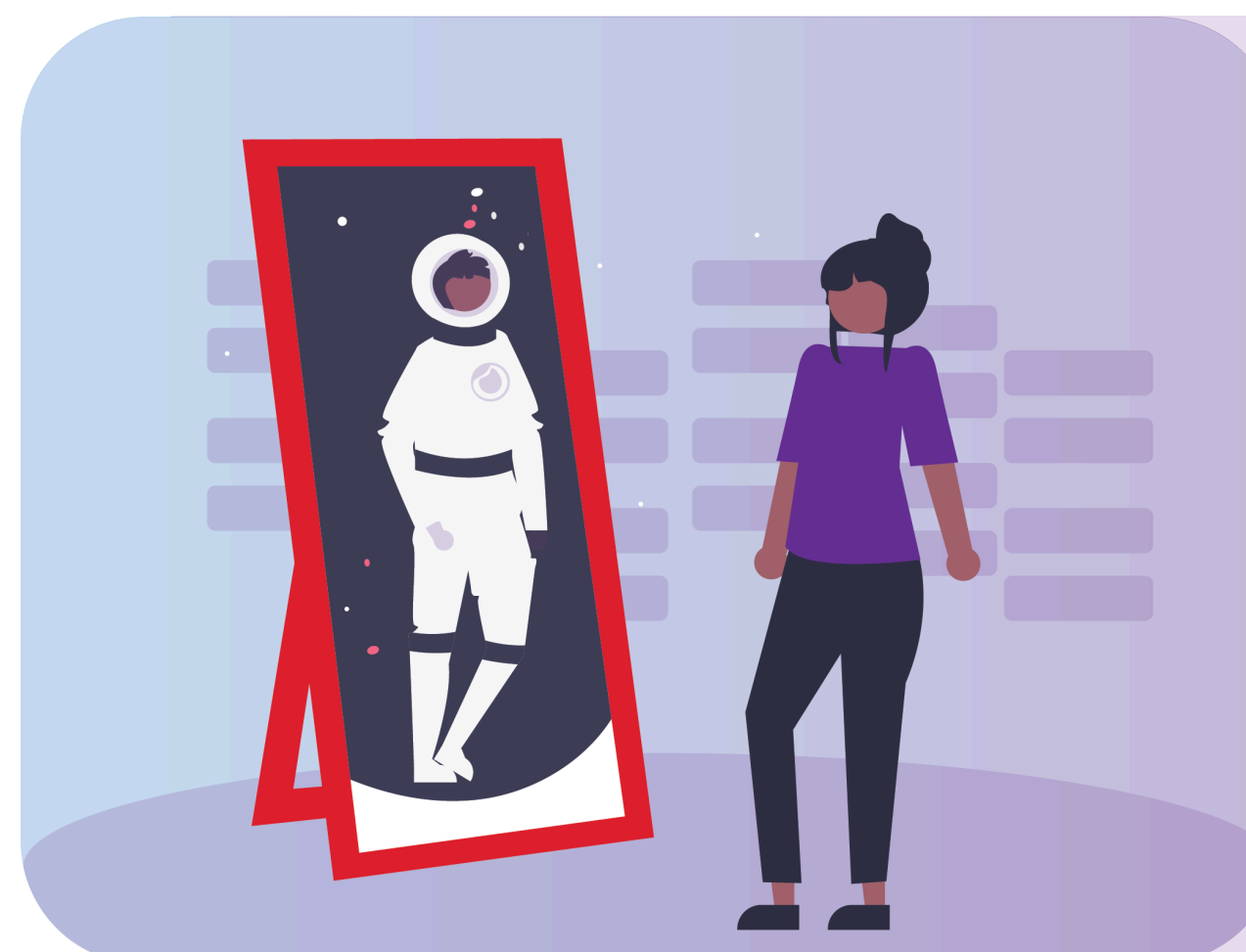
Create a gender-neutral learning environment

- Using gender-neutral pronouns where possible, or using a **range of pronouns** in offered **problems and examples** can help create a more neutral learning environment
- One can also check if **teaching materials** (such as textbooks, videos and slides) are **biased**



Connect learning to diverse role models

- Having a role model similar to oneself can have a really positive impact on **confidence** and increase the likelihood of choosing a **career in the same field** (*Millar, 2022*)
- Having more female lecturers, teaching assistants and interacting with female researchers can improve female students' **sense of belonging in STEM** classrooms



Incorporate real-life examples

- Research has shown that female students are interested in **social implications** of STEM topics (*Ceci et al., 2010*)
- Using a **problem-based approach** centred around real-world problems can **increase the participation** of girls in STEM classes (*Burke et al., 2007*)
- This can be done by designing **hands-on activities** for the classroom, and showing the **relevance** of STEM subjects (*Blanchard et al., 2017*)

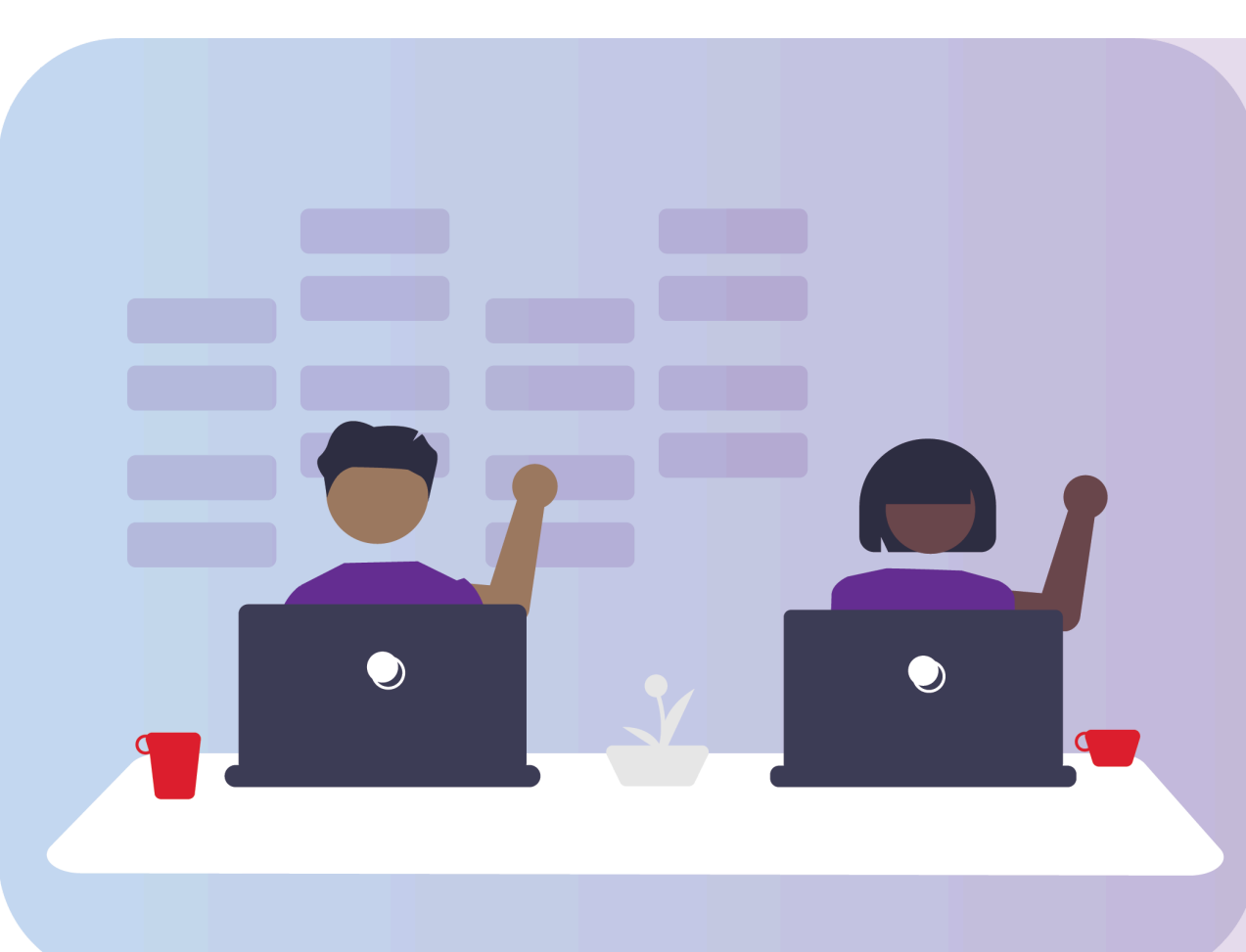


Give positive, specific feedback

- Research has shown that positive feedback is very important for female students to **reinforce** that they **belong** in the field (*Paechter et al., 2020; Skipper et al., 2017*)
- Creating a supportive environment that **acknowledges efforts** can strengthen the sense of belonging in the classroom

Let students work in groups

- Studies have shown that female students prefer interaction and **cooperative learning** over competition (*Burke et al., 2007*)
- However, groups with only 1 female student might risk unequal participation (*Eddy et al., 2014*) – intentionally creating groups with more than 1 female student, or **assigning roles** can encourage participation for everyone



Avoid asking for volunteers

- Research has shown that female students are **less likely** to raise their hands or **participate when asked** (*Eddy et al., 2014*)
- Instead, students can be selected at random or activities redesigned so that they **require everyone's participation**

