*What teachers say and how they say it plays a key role in motivating girls as STEM practitioners. Use this toolkit to actively develop positive STEM identities for girls through simple changes to classroom talk.*

GiST Talk Tools

Developing girls’ STEM identities through classroom discourse

# Introduction

Both at and outside of school, girls are exposed to biased views about their place in STEM. Teachers can ‘level the playing field’ by creating gender-inclusive classroom environments, but girls often require active support to imagine themselves as ‘STEM people’.

**Who’s engaged with STEM in your class?**

1. Reflect on your class dynamic or have a colleague observe your class, with a focus on which students typically engage with STEM lessons. What does that look like? Are there any differences in the ways girls and boys engage in STEM lessons?
2. Find out what your students think being ‘STEM-y’ looks like. Have students complete this quick survey(link), then review their responses, considering the following:
   * Do different groups of students see themselves differently or are perceived as more ‘STEM-y’ than others?
   * What kinds of behaviours do your students see as being related to being a ‘STEM person’? Do these align with what you consider the most important behaviours?

Classroom talk is everything a teacher says in the classroom. What we say and how we say it – as well as who we invite to talk and how we listen – communicates our values and beliefs.

With a conscious focus on classroom talk, teachers can ensure that every lesson actively develops each student’s STEM identity and their positive engagement with STEM.

Educators are well versed in the significance of classroom talk. The use of verbal and non-verbal cues of appreciation, re-direction and recognition are key tools in building positive relationships in and around the classroom, and in fostering internal motivation (Webster-Stratton, 2008, quoted in Starr, 2017).

The five GiST Talk approaches:

1. Be interested and enthusiastic about STEM
2. Foster STEM dispositions and skills
3. Value students’ STEM knowledge and experiences
4. Explore the diversity of STEM stories and experiences
5. Demonstrate how STEM knowledges, dispositions and skills are transferable across learning



For each approach, you’ll find activities to reflect on your own practice, tools to develop new approaches, and tips to create classroom talk that’s motivating and inclusive.

You might also like:

* Talk moves – from NSW Department of Education ([link](https://education.nsw.gov.au/teaching-and-learning/curriculum/literacy-and-numeracy/teaching-and-learning-resources/numeracy/talk-moves))
* Related research and references (Link to reference list)
* Who’s into STEM Questionnaire (Link to questionnaire)
* Seven Principles for Inclusive STEM Education (Link)

## 1. Be interested and enthusiastic

How do you feel about STEM? Studies have found that when students perceive their teacher to be enthusiastic and intrinsically motivated about what they are teaching, the students themselves are more motivated and interested. Enthusiastic teachers take genuine and obvious pleasure in the act of teaching. If you want students to be engaged with STEM, the first step is to ensure that you are actively and positively engaged yourself.

We all have our own relationship with STEM, shaped by our own experiences, ideas and perceptions. While you might appreciate the value of STEM, maybe you don’t feel confident to teach it. Within STEM, you might feel differently about each of the disciplines of science, technology, engineering and mathematics.

While negative, ambivalent or fearful attitudes might not stop you from delivering the curriculum, it’s important to recognise that you might be unconsciously transmitting those feelings to your students through the way you engage with each STEM topic.

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**How do you feel about STEM?**

Use the T-STEM [surveys](https://www.fi.ncsu.edu/pages/about-the-teacher-efficacy-and-attitudes-toward-stem-surveys-t-stem) from the Friday Institute for Educational Innovation to give you information about your sense of self-efficacy for – and attitudes about – teaching STEM. These are also useful tools for collecting data if you’re investigating the impact of interventions.

Students see straight through faked enthusiasm; it’s authentic positive emotion that most benefits them. You can’t erase your own experiences, nor change your feelings overnight, but you can find ways to reposition your own relationship with STEM. If you’re feeling like your STEM identity needs some work, here are some strategies to try.

* **Work out why you feel the way you do.** What experiences shaped your attitudes? Use [this PowerPoint template](https://stg-www.thegist.edu.au/media/y2enr3nv/gist-talk-tools_stem-journey.pptx) to map the defining moments in your life as you developed your STEM identity. Next, explore what you needed to hear or experience at that stage of your life – how can you embody that positive role model for your students now?
* **Find your own hook.** One of the great things about STEM is that it is a human endeavour. Perhaps you’re excited by the stories of the people who contributed to great STEM advancements, or those whose lives have changed as a result of STEM. Maybe your connection is through representations of STEM in film, stories, poetry or art. For example, check out this article, [‘Black Panther, Vibranium and the Periodic Table](https://pubs.acs.org/doi/epdf/10.1021/acs.jchemed.8b00206)’ – maybe it’s superheroes that bring the periodic table alive for you! Find your hook and indulge your own curiosity and delight.
* **Strap on a parachute**. We’re all nervous about teaching out of field, but there’s an amazing suite of high-quality resources available to scaffold your teaching when you’re outside your comfort zone. Avoid just selecting materials that seem ‘doable’; instead, look for materials that actively support and educate you about the content, the teaching strategies required and students’ possible responses. Some good places to start are the [GiST STEM Lesson Plans,](https://www.thegist.edu.au/educators/stem-lesson-plans/) the [Digital Technologies Hub](https://www.digitaltechnologieshub.edu.au/) and the [Mathematics Hub](https://www.mathematicshub.edu.au/).
* **Bring along a friend.** Invite into your learning space a colleague, friend or parent who can share their enthusiasm for STEM with your students and shape your own enthusiasm around the learning community you’re creating.
* **Create space for your students’ enthusiasm and mirror it.** It’s exciting and motivating when our students love learning. Create opportunities for your students to wonder, ideate, share experiences or instigate their own research and celebrate their agency as learners.

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**How do your attitudes to STEM compare to other educators?**

Check out the [STEM Influencer Report](https://www.industry.gov.au/publications/youth-stem-research-project/stem-influencer-teacher-and-career-advisor-survey-2021-20) (2021), which surveyed almost 800 teachers and career advisors. This report found that teachers with no STEM qualifications rate their own confidence ‘very low’ when it comes teaching most aspects of STEM (mathematics was a notable exception for primary teachers).

You can also see how the enthusiasm of Australian teachers compares to that of teachers in other countries, according to the [PISA analysis](https://www.oecd-ilibrary.org/sites/b9ed2d5d-en/index.html?itemId=/content/component/b9ed2d5d-en) of reading instruction.

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Description automatically generated with medium confidence ***Talk tips***

* Express your own authentic rationale for learning the topic. Avoid justifying the topic with reference to the curriculum or exit requirements.
* Share what interests you, makes you wonder or want to learn more.
* Share personal stories that relate to STEM, including your own fears or anxieties. Use sharing your negative experiences as an opportunity to show that feelings and attitudes aren’t fixed, modelling a growth mindset.
* Encourage students to share ideas and explore concepts. Ask students to justify their opinions and acknowledge when further research is required.
* When a debate takes you out of your comfort zone, acknowledge this and let the discussion continue – model learning **with** your students.
* Recognise and celebrate others’ passion for the topic. Actively break down stereotypes of the types of people who do STEM.

## 2. Foster STEM dispositions

A key contributor to success in STEM is a growth mindset, but studies have shown that many girls hold a fixed mindset (a belief in innate ability) when it comes to STEM.

STEM dispositions are strongly related to having a growth mindset.

STEM dispositions are the attitudes and states of mind that support students to achieve success in STEM education and to pursue STEM career pathways. These dispositions are made visible through demonstrated behaviours. The STEM dispositions are:

* Curiosity and scepticism – students are curious about phenomena; they question ideas and seek evidence
* Collaboration – students value others’ contributions
* Creativity – students generate new ideas and approaches
* Persistence – students overcome obstacles and stay focused
* Problem-solving – students understand the problem from multiple perspectives and consider a range of approaches and solutions
* Intellectual risk-taking – students contribute ideas, questions or creative thoughts, even when they might be perceived as incorrect or naive by others
* Making connections – students search for relationships between ideas, approaches or phenomena

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**Identify dispositions and their supporting behaviours**

Consider how you explicitly or implicitly value the STEM dispositions in your classroom. What evidence would students use to interpret your beliefs and values?

Use [this poster](https://globaledstem.wordpress.com/2018/07/20/8-stem-thinking-dispositions/) as a talking point in your classroom or to guide students’ self-reflections on their STEM dispositions and skills.

Use the [STEM dispositions snapshot](http://www.thegist.edu.au/umbraco#/media/media/edit/6167?list=5956&page=1&filter=&orderBy=updateDate&orderDirection=desc) to explore how students rate their own readiness to enact each disposition and provide opportunities for students to journal about their experiences.

Use the STEM dispositions poster as a visual tool in your classroom to highlight examples of students demonstrating high levels of skill or invite students to push themselves to increase their level on the meter.

Work with your students to create group [STEM disposition posters](http://www.thegist.edu.au/umbraco#/media/media/edit/6166?list=5956&page=1&filter=&orderBy=updateDate&orderDirection=desc). Encourage students to create their own images and text. Use these posters to highlight examples of students demonstrating high levels of skill or invite students to push themselves to increase their level on the meter.

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Description automatically generated with medium confidence* **Talk tips**

* Model curiosity by wondering out loud about phenomena or ideas.
* Broaden students’ ideas about what counts in STEM, by valuing and rewarding not just right answers, but student contributions that demonstrate curiosity, scepticism, creativity and intellectual risk-taking.
* Link students’ dispositions to thinking like a relevant STEM practitioner, for example, ‘What a great thing to wonder about, Sam! I love your curiosity; you’re really thinking like an engineer.’
* Actively embrace and celebrate confusion and disagreements as crucial moments in learning, for example, ‘I see that we have a range of ideas about what’s happening here. Excellent! Let’s work through these different perspectives to build our understanding.’
* Talk about failure and setbacks when they occur, honouring the emotions associated with struggle, and the value of persistence in the face of obstacles.
* Notice and acknowledge perseverance and effort in reasoning and sense-making rather than just the outcome, for example, ‘Lisa, I can see all the different ways you’ve tried to solve this and the way you’ve connected these ideas. That shows fantastic thinking and persistence.’
* Explicitly teach students how to respectfully disagree, for example, by modelling sentence stems, such as ‘I respectfully disagree with … because I think …’ or ‘I like your ideas, but…’
* Model and explicitly teach students how to ask questions to understand another person’s perspective, for example, ‘Can you tell me more about …?’ , ‘What do you mean by …?’ or ‘Could you please explain …?

Find out more:

* To learn more about how educators can work with students to understand the concept of a growth mindset, explore the ‘[What’s the context’](https://www.thegist.edu.au/educators/girls-in-stem/whats-the-context/#:~:text=Overview-,Fixed%20mindset,-Gender%20stereotypes) section of the GiST.

## 3. Value students’ STEM knowledge and experiences

Positive recognition of STEM competencies and practices by ‘meaningful others’ is perhaps the most important factor in developing STEM identity. Compared to boys, girls are more likely to undervalue their abilities in STEM and students from diverse backgrounds may find it difficult to see their lived STEM competencies and experiences reflected in the mainstream curriculum.

All students will have STEM-related hobbies or life experiences that can be valued and used in the classroom. Some students will have significant STEM capital and feel more empowered to contribute their STEM knowledges and experiences. For others, having their knowledges and experiences valued and named as ‘STEM’ is a valuable way to support their developing STEM identity.

A child holding a toy

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Source: Alena Darmel/Pexels

Recognising diversity as an asset represents a means of engaging students’ cultural knowledge, experiences, contributions and perspectives. Culturally responsive pedagogy can increase problem-solving and interest in study and careers, particularly for underrepresented groups.

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**Connect curriculum to students’ STEM knowledges and experiences**

* Find out about your students. Ask them to complete this [student interest page](http://www.thegist.edu.au/media/i5eazpli/gist-talk-tools_student-interest-ppt.pptx) and then collate the data for your class. Student responses will change over time, so this is a great starting point. Be alert to students sharing experiences and add notes throughout the year. This data will help you understand your students and their learning and will be useful when it comes to report time and parent meetings.
* Map student interests to your curriculum, outlining possible links between student experiences and the curriculum content across the year. Check out [this example](http://www.thegist.edu.au/media/2jkkwz1w/talk-tools_student-connection-curriculum-plan-example.docx) for inspiration.
* Revisit the student interest planning tool as you plan specific lessons to ensure you are capitalising on these connections and thinking about how you might elicit these experiences. Will you tell a story that prompts contributions? Ask specific questions? Or provide a contextual phenomena? How do you think students might contribute, and how will you link these contributions back to the curriculum?

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Description automatically generated with medium confidence* **Talk tips**

* Invite and value student contributions drawn from their experiences outside of school, for example, ‘Megan, your aunt is into rewilding, isn’t she? Can you explain how you go about restoring habitat?’
* Share relevant examples from your own personal life experiences as a model, for example, ‘I became interested in probability when I was researching computer models of rainforests, to work out what size rainforest would be required to be sustainable.’
* Ensure all students have opportunities to contribute in ways they feel comfortable, for example, ‘Preemi, I wonder if you could share a screen capture of your latest computer game in action? I think it will show us how you can use a physics engine to create an immersive experience.’
* Highlight the STEM nature of different sorts of contributions, for example, ‘Ruani’s description of her reactions when she’s playing tennis really illustrates the impact of adrenalin on the body system.’
* Provide examples of different types of people who work in STEM-related jobs to elicit stories about friends or families, for example, ‘My friend George is a vet nurse, and they use ratios all the time to work out how much medication to give each pet.’
* Ask students to provide examples of topics as they emerge through the media, family experiences or their knowledge outside of school, for example, ‘Has anyone seen any films that showcase new materials with special properties?’

## 4. Explore diverse STEM experiences

Girls benefit from diverse role models in STEM. Often, these role models represent the most successful and resilient STEM practitioners. However, while aspirational role models are important, it’s also integral to recognise and explore with students the diversity of experience of STEM and the ways in which culture, gender, ethnicity and background can influence and shape each person’s STEM identity. Engaging in this approach is important to validate and support girls’ intersectional experiences as they pursue STEM pathways.

When representing narratives of different STEM practitioners, ensure you acknowledge all aspects of the story in age-appropriate ways. Individuals’ stories can include instances of bias, censorship, frustration, confusion and disappointment, as well as success, recognition, pride, wonder and awe. Balanced representations allow students to connect with those narratives in more powerful ways.

For upper secondary students, it can be important to show students that STEM is vulnerable to social injustice, and that STEM is not always objective and unbiased. For example, in 2021, just under 1.2% of academic staff members at Australian universities had an Indigenous background (Mallapaty, 2022). What factors could explain this lack of diversity in academia?

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Value students’ recounts of their own, family members’ or friends’ challenging STEM experiences, supporting the class to appreciate the range of experiences.

Invite STEM role models from your community to talk to students about their experiences, how they overcame barriers and why they persisted, and encourage students to ask questions.

Model wondering about the lived experiences of STEM role models, for example, ‘I wonder how it felt to be a woman in a workplace that was predominantly male?’

Model wondering about representations of STEM in the media, for example, ‘Do you think that’s an accurate representation of the diversity of STEM practitioners? I wonder how it would feel not to be represented there.’

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| These resources are a great start to gain insight into the experiences of diverse STEM practitioners. |
| **For primary students**   * Aussie STEM Stars (<https://www.aussiestemstars.com.au>)   Books for children aged 9 to 13 years that tell the stories of some of Australia’s world-leading researchers and inventors. |
| **For upper secondary students**   * The Leadership (https://homewardboundprojects.com.au/hb-community/projects/film)   This M-rated documentary follows a group of 76 female scientists on an Antarctic voyage focused on developing them as leaders. Issues covered include discrimination and inequality, the gender pay gap, the maternal wall, sexual harassment and abuse in the workplace, imposter syndrome, climate change, and the lack of opportunities for culturally and linguistically diverse and Aboriginal and Torres Strait Islander women. Teaching support materials are also available. |
| * Taking to the Field: A History of Australian Women in Science (<https://publishing.monash.edu/product/taking-to-the-field/)>   This book explores the history and influence of Australian women in science from colonial to contemporary times and shows the outsized influence of these women on the world. |
| * ·Racism: Overcoming science’s toxic legacy   (<https://www.nature.com/immersive/d42859-022-00031-8/index.html>)  This special issue of *Nature* (2022) explores racism in science, including a legacy of excluding people of colour and using research to underpin discriminatory thinking. |

## 5. Demonstrate transferable learning

STEM talk should not be limited to teaching within the STEM learning areas. Making connections across learning areas reinforces the value of STEM for students, shows how STEM careers are often multi-disciplinary, and demonstrates that connecting with their STEM identities empowers students to be successful across all their learning. This can be particularly important for girls who may identify more strongly with other learning areas.

Making connections between STEM dispositions and skills and other learning areas also supports students to leverage their strengths and confidence outside of STEM to build their STEM identities.

A person looking at a camera

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**Make connections across the curriculum**

Use these links to explore skills from a range of Australian Curriculum Version 9.0 learning areas. Note that these filtered examples of the curriculum show Year 6 and Year 8; you can change the target year level to one that is relevant to your classroom.

- [Year 6 example](https://v9.australiancurriculum.edu.au/f-10-curriculum/learning-areas/science_hass-f-6_design-and-technologies_digital-technologies_english/year-6?view=advanced&strand-selections=SCISCI-science-inquiry_HASHAS-skills_TECTDE-processes-and-production-skills_TECTDI-processes-and-production-skills_ARTVIS-developing-practices-and-skills_MATMAT-measurement_MATMAT-statistics_ENGENG-literacy&hide-ccp=0&hide-gc=0&detailed-content-descriptions=0&side-by-side=1&strands-start-index=0&subjects-start-index=2)

- [Year 8 example](https://v9.australiancurriculum.edu.au/f-10-curriculum/learning-areas/science_geography-7-10_history-7-10_digital-technologies_english/year-8?view=advanced&strand-selections=SCISCI-science-inquiry_HASGEO-skills_HASHIS-skills_TECTDI-processes-and-producti)

As you review the curriculum, consider where you see similarities or skills that might reinforce learning across learning areas.

Reflect on relationships between learning areas, such as:

* How does design thinking or problem-solving relate to HASS or the Arts?
* How does developing evidence-based arguments and appreciating multiple perspectives connect to learning in English?
* How does identifying patterns and generalising in mathematics relate to HASS, the structure of English or learning another language?

You can also use the [STEM Dispositions poster](http://www.thegist.edu.au/media/2aqbxjvl/gist-stem-dispositions-meter-posters.pdf) to highlight transferable dispositions and skills as you engage with other learning areas.

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1. Make explicit connections between STEM knowledges when teaching other learning areas, and vice versa, for example, ‘Remember when we worked on procedural texts in English and you had to break down the process into specific steps? That’s a similar type of thinking we use when we’re developing algorithms in Design Technologies.’
2. Reflect on productive struggle in another learning area and compare the experience to students’ STEM challenges, for example, ‘Amara, you couldn’t do a cartwheel at the beginning of the year, but now you can. How were you able to develop that skill?’
3. Leverage students’ strengths in other learning areas to build their STEM dispositions and skills, for example, ‘Luisa, the way you thought about the text from each character’s perspective yesterday was so insightful. As you design your solution, I wonder if you can use that same empathy to think about different users’ needs?’

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