

ROBOTICS CHALLENGE

2022/23 evaluation report



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The Robotics Challenge programme is in its final year in 2022/23. During this academic year, participants learned how to build, program and control autonomous LEGO® robots and complete a series of short engineering challenges. Teams then had the option of entering local heats, whose winners competed at the UK final, hosted as part of The Big Bang Fair in Birmingham.

ABOUT THIS REPORT

Over 300 schools took part in the Robotics Challenge programme during the 2022/23 academic year. This report presents feedback from students and teachers who took part this year. Their views were gathered via a combination of online and in person surveys conducted at the Robotics Challenge heats. During these events, we also carried out brief interviews with a small number of teachers to inform EngineeringUK's new programme development.

This report presents feedback from students to enable us to better understand their experiences of Robotics Challenge and any impact they feel the programme has had on their skills, on their interest in taking part in more STEM activities or in engineering careers. Additionally, we want to understand students' interests, views and knowledge of STEM related careers to find out more about who is participating in the programme.

In this report, we share significant associations between student characteristics (e.g., gender, ethnicity, free school meal eligibility, disability status, STEM engagement or whether respondents know a STEM professional) and survey responses. These associations are reported in descending order of significance. Please note that while our analyses identify these significant connections, they don't provide reasons for these differences, which can be influenced by various contextual factors, including program delivery and external variables beyond our control.

Alongside student experiences, feedback from teachers offers insights into what they feel they have gained from the programme, their perspective on the programme's impact for students and any overall reflections of Robotics Challenge.

This information allows us to gain some understanding of the extent to which we are meeting the aims of the programme in terms of informing and inspiring young people into further STEM education and careers. As the programme is in its final year, we are also drawing together learning to inform any future programme development as well as EngineeringUK's wider work on STEM engagement.

KEY FINDINGS

The Robotics Challenge is an engaging and enjoyable programme for students

- 97% of students agreed with the statement "I enjoyed the Robotics Challenge", with 67% strongly agreeing
- 93% of teachers agreed that Robotics Challenge was engaging for their students
- Teachers agreed that Robotics Challenge was engaging for students with varying levels of existing interest in STEM subjects (90%) and that the programme was accessible to students of all abilities in STEM subjects (84%)

After participating in the Robotics Challenge, students were inspired to do more STEM activities and find out more about engineering careers

- 89% of students agreed with the statement "Robotics Challenge has made me want to do more activities related to science, technology, engineering and maths in the future"
- 81% of students agreed with the statement "Robotics Challenge has made me want to find out more about engineering as a career"

Teachers also have a positive experience of the programme and feel more confident to advise students about engineering careers

- 92% of teachers rated their overall experience of Robotics Challenge as 'excellent' (57%) or 'good' (35%)
- 69% of teachers said that they are more likely to suggest to a student that they consider a career in engineering, having taken part in Robotics Challenge
- 59% of teachers said that they feel more confident in speaking to their students about careers in engineering, having taken part in Robotics Challenge

Student and teacher participation in the Robotics Challenge evaluation

ROBOTICS CHALLENGE PARTICIPATION

- **333 schools engaged in the Robotics Challenge programme** overall in the 2022/23 academic year.
- **168 schools took part in a total of 17 Robotics Challenge heats** delivered across the UK between April and June 2023.
- At each heat, **between 4 to 16 teams (one per school) competed across 4 challenges** testing various skills related to programming and designing the robot they created as well as presenting a project and demonstrating teamwork.
- **35 teams from different schools competed in the UK finals** hosted at The Big Bang Fair in Birmingham on 21 June 2023.

STUDENT EVALUATION PARTICIPATION

This report provides findings of 2 surveys conducted with students and teachers both in person at Robotics Challenge heats and via online links.

The surveys aimed to understand students' and teachers' experience of the programme and their attitudes towards STEM careers.

- **588 young people at 75 different schools completed our student survey.** The table to the right shows the demographic characteristics of students who took part in our evaluation.
- Student engagement with in-person data collection was positive, with around 90% of young people attending a heat also taking part in the evaluation. Additionally, we were able to collect an overall higher number of responses compared to last year.

How was data collected?

The student survey was conducted both in person and online. EngineeringUK staff collected data using iPads at 10 of the Robotics Challenge heats that were delivered in England. Students were encouraged to take part in the survey after having competed in at least 2 out of the 4 challenges that make up a heat.

Data was also collected online by sharing survey links with the teams competing virtually after they had completed their heat.

Young people who completed the survey

	No.	%
Total	588	
School type ¹		
Priority	242	41%
Non-priority	328	56%
Missing	18	3%
Year group		
Year 7	194	33%
Year 8	203	35%
Year 9	180	30%
Missing	11	2%
Gender		
Female	198	34%
Male	344	58%
Non-binary or other self-description	19	3%
Prefer not to say	15	3%
Missing	12	2%
Ethnicity		
Asian/Asian British	106	18%
Black/Black British	35	6%
Multiple ethnic groups	39	7%
White	364	62%
Other ethnic identity	12	2%
Prefer not to say	19	3%
Missing	13	2%
Free School Meals		
Yes	49	8%
No	497	85%
I don't know	22	4%
Prefer not to say	8	1%
Missing	12	2%
Disabilities		
Yes	58	10%
No	427	73%
I don't know	65	11%
Prefer not to say	26	4%
Missing	12	2%

¹ EngineeringUK defines as priority schools those who meet our Equity, Diversity and Inclusion (EDI) criteria, based on student population with higher numbers of groups typically underrepresented in engineering. For more details, see EngineeringUK EDI Criteria (tomorrowsengineers.org.uk).

TEACHER EVALUATION PARTICIPATION

Beyond conducting our evaluation with students, we also invited teachers to take part in our feedback survey.

The survey's aim was to understand teachers' experience of the programme and their attitudes towards STEM careers support.

- **130 teachers or technicians at 105 different schools** completed the feedback survey.
- The table to the right shows the school characteristics of those who took part in our evaluation and of all schools who reported engaging in Robotics Challenge in 2022/23.
- The schools of teachers who responded to the survey broadly reflect the characteristics of all the participating schools in terms of UK nation/region. The only exception is for Wales where no teacher responses were collected.

How was data collected?

The teacher survey was conducted between March and June of 2023. All teachers were invited to take part, regardless of whether they were engaged in the competitive elements of the programme. We invited these educators to provide their feedback both through online survey links and via QR codes at the Robotics Challenge heats, where data was collected in-person.

School characteristics		
	All 2022/23 Robotics Challenge schools No. (%)	Schools of teachers responding to the survey No. (%)
Total	333	105
UK nation/region		
England	267 (80%)	89 (85%)
North East	7 (2%)	3 (3%)
North West	66 (20%)	14 (13%)
Yorkshire and the Humber	17 (5%)	4 (4%)
East Midlands	29 (9%)	10 (10%)
West Midlands	22 (7%)	4 (4%)
East of England	20 (6%)	8 (8%)
South East	44 (13%)	14 (13%)
London	36 (11%)	18 (17%)
South West	26 (8%)	14 (13%)
Scotland	33 (10%)	10 (10%)
Wales	10 (3%)	-
Northern Ireland	23 (7%)	6 (6%)
Missing	-	-
School type		
Priority	145 (44%)	43 (41%)
Non-priority	186 (56%)	61 (58%)
Missing	2 (1%)	1 (1%)
Gender		
Single sex: Girls	29 (9%)	11 (10%)
Single sex: Boys	6 (2%)	3 (3%)
Mixed	233 (70%)	88 (84%)
No available data ²	65 (20%)	3 (3%)

² Data related to gender is not always publicly available for all schools in Wales, Scotland and Northern Ireland.

STEM SUBJECTS TAUGHT

As part of our evaluation, we asked teachers about the subject they teach in their school.

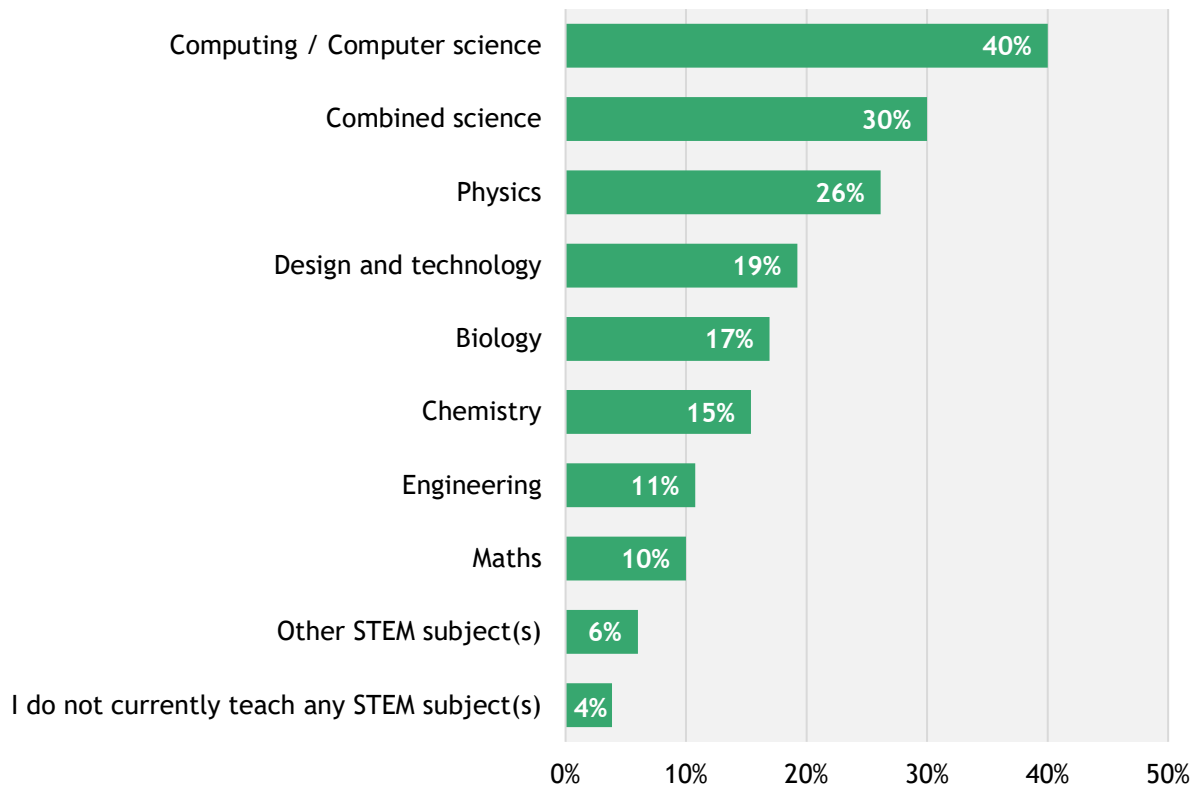
Teachers who took part in the survey mostly taught computing or computer science (40%) or combined science (30%). Just over one quarter (26%) of respondents said they teach physics. Very few teachers reported not teaching a STEM subject at all.

Responses describing in more detail other STEM subjects taught, included construction, electronics and running STEM clubs or academies.

KEY FINDINGS

- Most of the teachers responding taught computing or computer science, combined science or physics
- Over 2 in 5 teachers (42%) indicated they teach 2 or more STEM related subjects

STEM subjects taught (N=130)



Student and teacher experiences of Robotics Challenge

EXPERIENCE OF ROBOTICS CHALLENGE

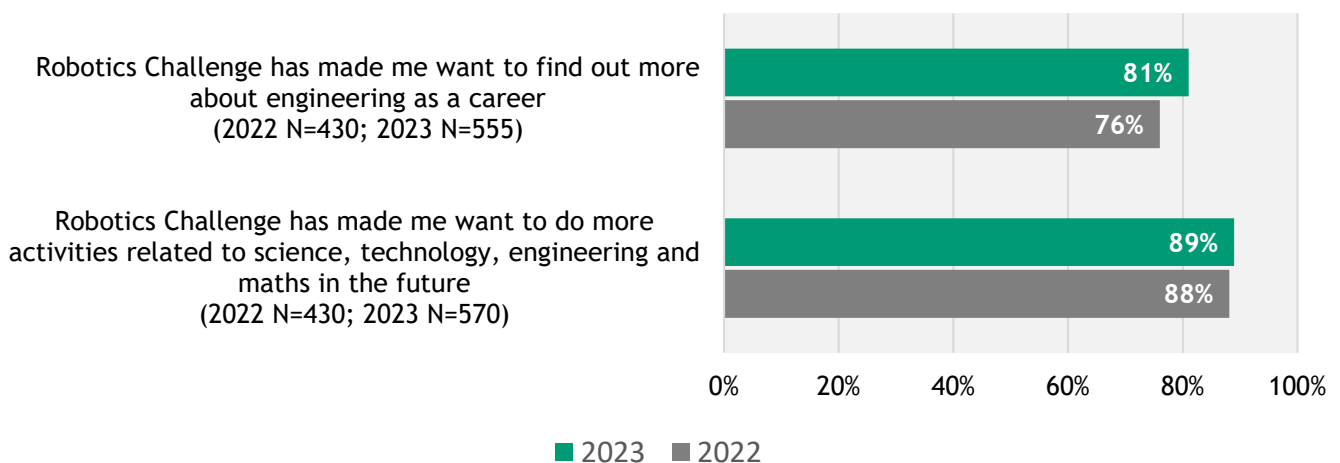
Robotics Challenge's primary goal is to inspire young people to consider or pursue pathways towards STEM education and careers. Providing enjoyable and engaging experiences for young people can be a key step towards achieving this aim in the short-term.

Nearly all young people who took part in our evaluation at the Robotics Challenge heats reported they enjoyed taking part in the programme (67% strongly agree; 30% agree - N=588). A large majority of respondents also reported they wanted to do more STEM activities and find out more about engineering as a career, as a result of their participation.

KEY FINDING

- **97% of students who responded to our survey agreed they enjoyed Robotics Challenge**
- **Over 80% of respondents agreed that Robotics Challenge had made them want to find out more about engineering as a career and do more STEM related activities in the future**

Young people's views on Robotics Challenge in 2022 and 2023



Predictors of students' views of Robotics Challenge

When accounting for all other characteristics³, our analysis of 2023 data found that ethnicity was a predictor of whether students agreed that the programme had made them want to find out more about engineering as a career and whether it encouraged them to do more STEM activities.

- Asian^a students and white^b students were both over 4 times as likely to want to **find out more about engineering as a career** compared to Black students
- White students were about 10 times more likely than Black students to want to **do more activities related to STEM in the future**^c

- Asian^d students were over 5 times as likely to want to **do more activities related to STEM in the future**, compared to Black students

Overall, students' enjoyment of Robotics Challenge was high across the board, but we wanted to understand more about any association between student characteristics and enjoyment. Our analysis found that ethnicity was a predictor of student enjoyment.

- White students were about 8 times more likely than Black students to **agree that they enjoyed Robotics Challenge**^e

³ Logistic regression in this report controlled for student characteristics, including gender, ethnicity, year group, disability, prior STEM engagement, receiving free school meals, whether they attend a priority school and whether they know someone working in STEM. Only significant findings are reported in this document.

Logistic regression outputs: ^a OR=4.28, 95%CI 1.47-12.44, p<0.05; ^b OR=4.14, 95%CI 1.47-12.44, p<0.05; ^c OR=10.07, 95%CI 3.28-30.85, p<0.05; ^d OR=5.24, 95%CI 1.62-16.99, p<0.05; ^e OR=8.04, 95%CI 1.61-40.18, p<0.05

MOTIVATIONS FOR TAKING PART IN THE COMPETITION

The top 3 reasons students reported being motivated to enter the competitive element of Robotics Challenge include to have an experience to include in their CVs (85%), because they want to study computer science in future (75%) and to get feedback on their work by STEM professionals (46%).

There were some differences in the motivations for female and male students to enter the competition. The table to the right shows an overview of motivations by gender. Please note respondents had the possibility to select multiple response options.

Our findings suggest that, compared to boys, girls were just as likely to choose to enter the competition to have something to put on their CV or personal statement and because they wanted to study computer science in future. However, boys were more likely to want to get feedback on their work from scientists and engineers.

This suggests that both girls and boys may be just as likely to link Robotics Challenge with their own future study and career aspirations.

Among students who provided descriptions to why they selected another reason for taking part, the following were mentioned:

- Prior interest in engineering, coding or robotics
- LEGO®
- Previous participation in Robotics Challenge

“I really enjoy [Robotics Challenge] and I was there last year and it was so fun.”
(Student)

“I love engineering and coding and this is a great opportunity.”
(Student)

KEY FINDING

- **85% of students chose to enter the Robotics Challenge competition to have something to put on their CV or personal statement**

Female students (N=198)	Male students (N=344)
1. To have something to put on my CV or personal statement (85%)	1. To have something to put on my CV or personal statement (85%)
2. Because I want to study computer science in future (79%)	2. Because I want to study computer science in future (74%)
3. To have fun (53%)	3. To get feedback on my work from scientists and engineers (50%)
4. To develop skills (51%)	4. To develop skills (42%)
5. To get feedback on my work from scientists and engineers (39%)	5. To have fun (40%)
6. To meet other students who like STEM or Robotics (35%)	6. To meet other students who like STEM or Robotics (35%)
7. To win prizes or awards (35%)	7. Because my friends were talking part (26%)
8. Because my teacher, parent or guardian suggested I should (35%)	8. To present my ideas (24%)
9. Because my friends were talking part (33%)	9. Because my teacher, parent or guardian suggested I should (23%)
10. To present my ideas (26%)	10. To win prizes or awards (23%)
11. Another reason (4%)	11. Another reason (7%)

STUDENTS VIEWS ON THE SKILLS THEY GAINED

Robotics Challenge aims to support young people in developing skills that are important for careers in engineering, including resilience, problem-solving and teamwork. Students who responded to our survey reported learning or improving on a range of different skills.

KEY FINDINGS

The main skills students reported learning or improving by participating in the programme include **‘learning from mistakes or when things go wrong’** (85%), **‘being a good team leader’** (79%) and **‘working as part of a team’** (79%).

Which of the following skills do you think you have learned or improved by taking part in Robotics Challenge? (N=579)



Predictors of students’ views of the skills they gained

When accounting for all other student characteristics, our analysis found that whether students attend a priority school, their year group and gender were significant predictors of whether young people reported that they learned or improved on skills related to resilience and leadership.

- Students from non-priority schools were more likely to report they learned or improved on **‘learning from mistakes or when things go wrong’**, compared to students from priority schools ^a

- Female students were over 3 times more likely than male students to report they learned or improved on **being a good team leader** ^b
- Year 7 ^c and Year 8 ^d students were each about 2 times more likely than Year 9 students to report they learned or improved on **being a good team leader**

Our analysis did not find any associations between student characteristics and whether students reported that they learned or improved on working as part of a team, suggesting students are just as likely to select this skill regardless of their background.

Logistic regression outputs: ^a OR=1.84, 95%CI 1.01-3.38, p<0.05; ^b OR=3.74, 95%CI 1.96-7.13, p<0.05; ^c OR=1.97, 95%CI 1.04-3.74, p<0.05; ^d OR=2.01, 95%CI 1.11-3.65, p<0.05.

EXPERIENCE OF ROBOTICS CHALLENGE

Teachers are overwhelmingly positive about their experience of Robotics Challenge, with 57% rating the programme as ‘excellent’ and 35% as ‘good’. This finding is encouraging, but it may also reflect feedback from teachers who are already highly engaged in the programme ⁴.

The top 3 elements that teachers selected as important in deciding to take part in the programme include: the opportunity to enter the Robotics Challenge competition heats (88%), free kit for activities (77%) and links to information about careers and routes into STEM (63%).

Beyond the competitive element, we see that teachers value the access to free kit and use this resource outside of the programme. In fact, 59% of teachers reported using kit with other students in different ways. For example, they said the kit is used as part of practical components in subject lessons for science, computing or design and technology, as part of demonstration lessons for primary school students on transition and open day events as well as to encourage students to join STEM related extracurricular initiatives.

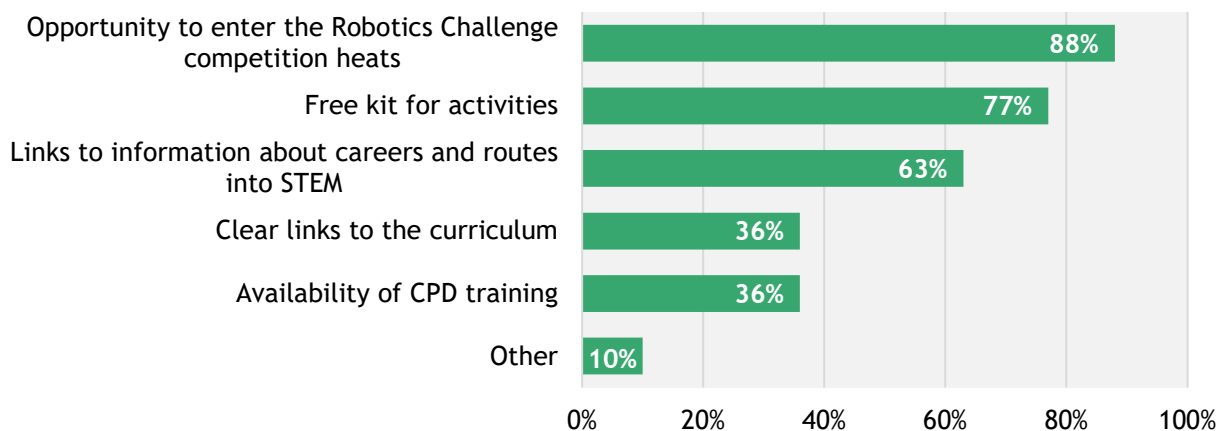
Other aspects teachers mentioned were important to them in deciding to take part included personal development opportunities for students, having resources (staff or kit) available, the flexibility to deliver activities to fit within their curriculum and ‘settling into an annual competition with preliminary heats and a final’.

KEY FINDINGS

- **92% of teachers who responded to our survey rated Robotics Challenge as ‘excellent’ or ‘good’ overall**
- **The competitive aspect of the programme is regarded as an important element of Robotics Challenge**
- **59% of teachers used robotics kits with other students beyond those who participate in the programme**

“I don’t think we should ever underestimate the power of having a competition or event that is annual that students can return to and develop what they learned previously and then have the opportunity to pass on or share those skills with younger students.” (Teacher)

Which of the following are important to you in deciding to take part in Robotics Challenge? (N=120)



4. It is important to keep in mind these findings are based on teachers from 31% of schools who reported participating in Robotics Challenge overall (105 out of 333) and 79% of teachers who responded said their school was planning on entering a team in the heats.

IMPROVING TEACHERS' CONFIDENCE TO TALK ABOUT STEM CAREERS

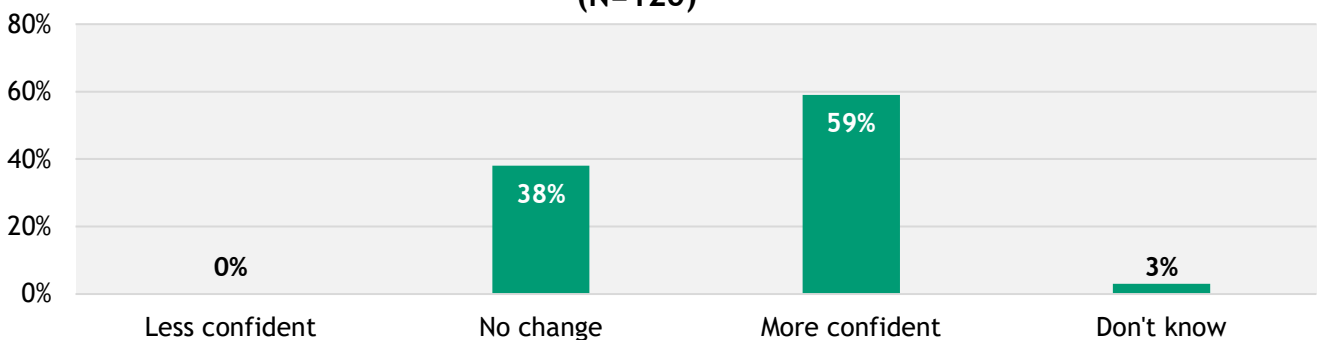
Robotics Challenge includes links to STEM careers to support teachers who provide essential guidance for students on future study and career options. Teachers can play a key role in encouraging students to pursue subjects or career paths related to STEM. However, they can also be a barrier if they do not understand or feel confident in sharing information or advice on STEM career opportunities.

We asked teachers whether they are confident in speaking to students about engineering careers after participating in the programme.

KEY FINDING

59% of teachers said that they felt more confident in speaking to their students about careers in engineering having taken part in Robotics Challenge.

After taking part in Robotics Challenge, do you feel any more or less confident in speaking to your students about careers in engineering? (N=120)



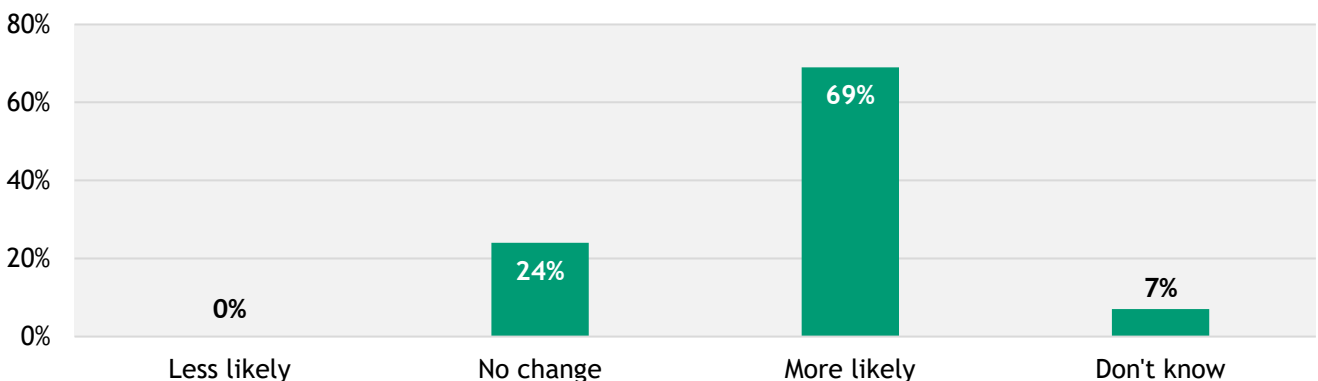
IMPROVING TEACHERS' LIKELIHOOD TO RECOMMEND A STEM CAREER

We asked respondents how likely they are to suggest a career in engineering to a student, following their participation in Robotics Challenge.

KEY FINDING

69% of teachers said that they were more likely to suggest to a student that they consider a career in engineering having taken part in Robotics Challenge.

After taking part in Robotics Challenge, are you more or less likely to suggest to a student that they consider a career in engineering? (N=120)



About the students:

**Their experience with STEM and their
interest in and knowledge of STEM careers**

STUDENTS' PRIOR STEM ENGAGEMENT

As part of our evaluation, we asked young people questions to explore their pre-existing levels of engagement in STEM outside of school.

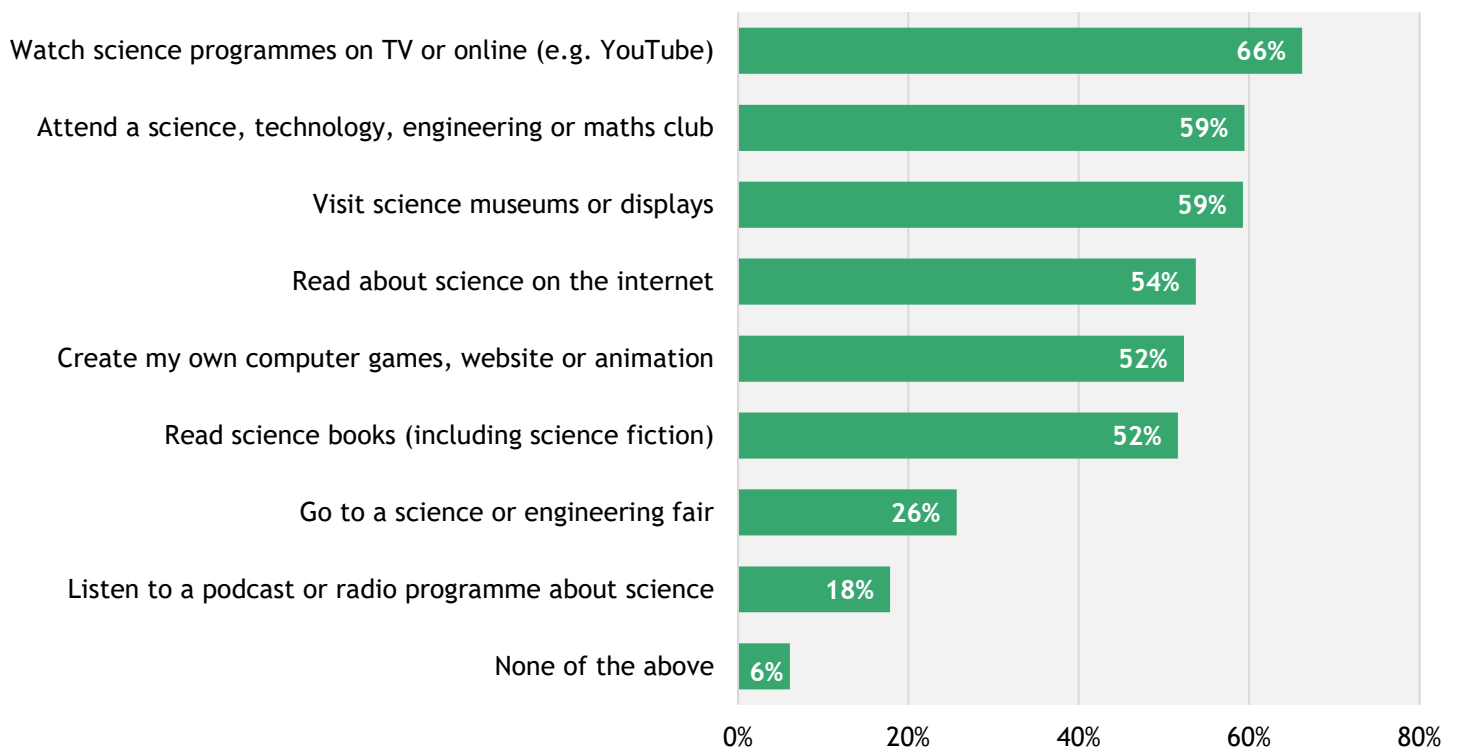
The top 3 ways students engage with STEM outside of school are through watching STEM content online (66%), attending a science, technology, engineering or maths (STEM) club (59%) and visiting museums or displays (59%).

While 21% of young people reported not knowing anyone who works in a STEM related career, most respondents said they knew a parent or guardian (33%), another family member (32%), a family friend (28%) or someone else (24%).

KEY FINDINGS

- The top way students engaged with STEM outside of school was watching science programmes on TV or online
- On average, young people said they were already engaging in 4 out of the 8 activities we asked about
- 79% of young people reported they know someone who works in a STEM related career

In the last year, have you done any of these activities outside of school? (N=577)



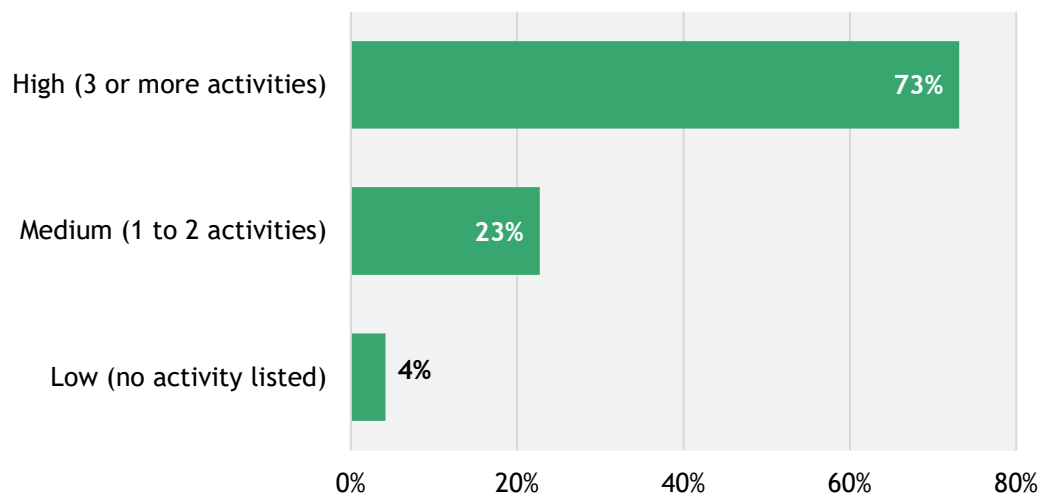
STUDENTS' PRIOR STEM ENGAGEMENT

For the purpose of our analysis, we gave students a STEM engagement score based on how many of the STEM activities mentioned previously they do outside of school: low (none of STEM activities listed), medium (1-2 activities), or high (3 or more activities).

KEY FINDINGS

- **Nearly three quarters (73%) of young people responding to our survey reported a high level of prior STEM engagement**
- **Students who know a STEM professional were more likely to have higher prior STEM engagement**

Students' levels of prior STEM engagement (N=577)



Predictors of students' STEM engagement

Our analysis found that knowing someone who works in STEM was a predictor of young people's prior level of STEM engagement, when all other characteristics are taken into account.

- **Students who know someone who works in STEM are more likely to have higher levels of prior STEM engagement**, compared to those who reported they did not know a STEM professional ^a.

Other student characteristics such as gender, year group, ethnicity, disability, free school meal status or whether they attend a priority school did not show an association with levels of STEM engagement.

Ordinal regression output: ^a Coefficient=0.65, 95%CI 0.13-1.17, p<0.05

STUDENTS' IDEAS OF THEIR FUTURE JOBS

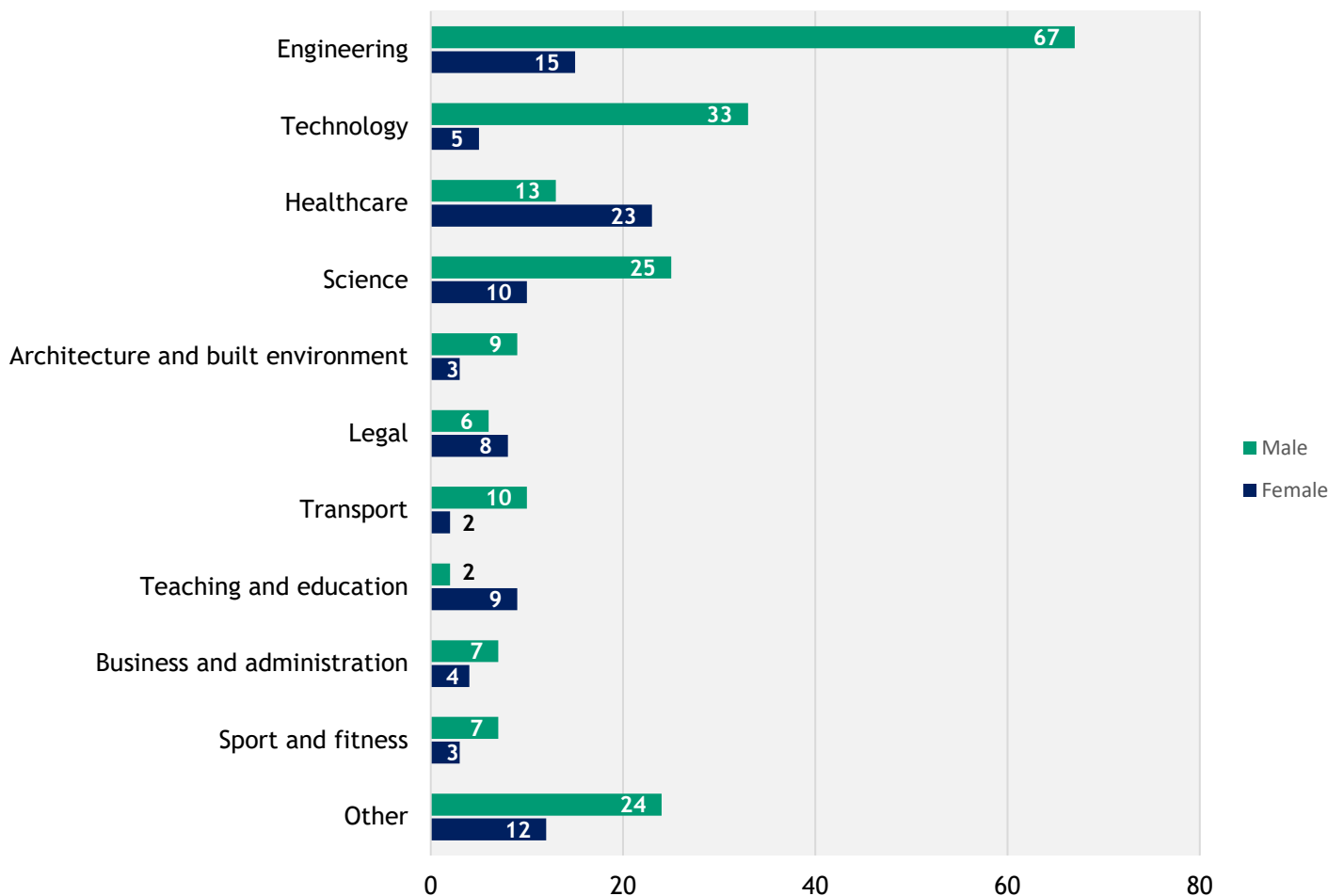
We asked students about their future career aspirations. Those who said they knew what they want to do when they are older were asked to write in the specific job or field. These responses were then categorised in broader occupational areas. The figure illustrates the main jobs shared by female and male students.

- Notably, engineering related occupations emerged as the most popular category overall. Over 4 times the number of boys expressed their interest in engineering, compared to girls.
- Technology related occupations came in second overall, with over 6 times the number of boys sharing interest in these fields than girls.
- Healthcare related occupations were the third most popular, with girls showing an interest in these areas more than boys.

KEY FINDINGS

- 62% of students said that they know what job they want to do in future
- About half of the respondents who said they already know what they want to do shared jobs related to science, technology or engineering, the latter being the most popular overall, especially among male students.

Category of jobs that female and male students said they want to do when they are older (N=331)



STUDENTS' INTEREST IN STEM CAREERS

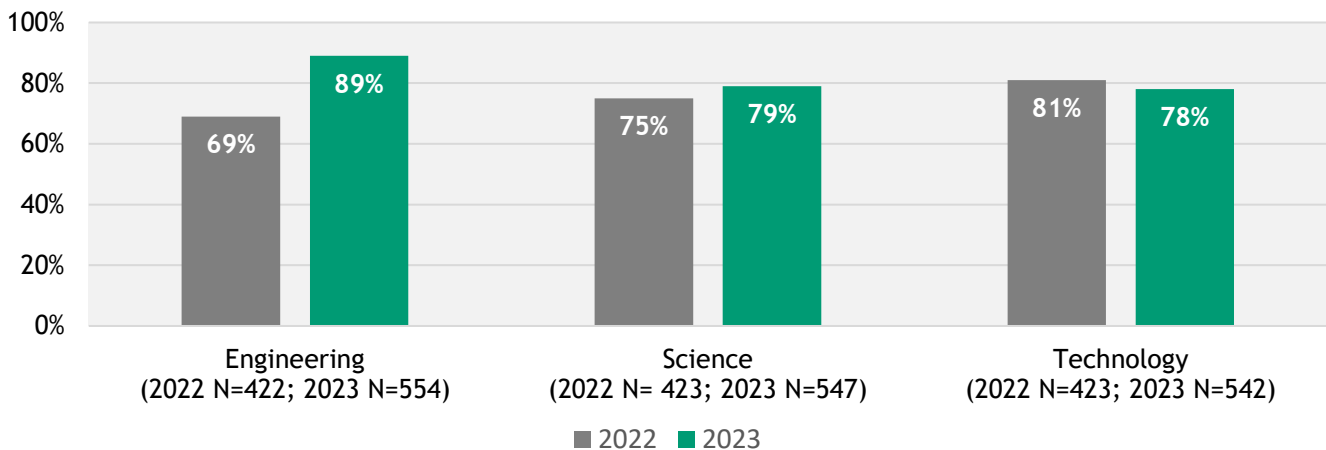
Beyond asking students about their future jobs, we also wanted to learn about how interested they are in a career in science, engineering or technology. In 2023, interest in science and technology careers remained similar to findings from 2022. This year, engineering was the most popular with 89% of students being interested in a career in this field. This could be due to improvements to the programme content, but it could equally be related to the exposure young people may have already had to engineering through STEM related activities or information they engage with beyond Robotics Challenge.

This finding is also not too surprising given that many students who already knew what jobs they want to do in future mentioned wanting to pursue engineering related occupations.

KEY FINDINGS

- **95% of students said they were interested in a career in at least one of science, engineering and technology.**
- **89% of students said they were interested in a career involving engineering**
- **Boys were over twice as likely to say they were interested in a career in engineering, compared to girls.^a**

Proportion of students interested or very interested in a career that involves engineering, science or technology in 2022 and 2023



Predictors of students' interest in careers in engineering, science and technology

Overall, students who took part in our evaluation showed a high interest in STEM careers, with 95% of students saying they were interested in a career that involves engineering, science or technology. Additional analysis highlights the significant predictors of this interest. When accounting for all other student characteristics, we found that:

- Male students were over 2 times more likely than female students to report they were **interested in a career involving engineering**^a
- Students with high STEM engagement were over 4 times as likely to report they were **interested in a career involving technology**, compared to students with low STEM engagement^b
- Male students were over 2 times more likely to report they were **interested in a career involving science**, compared to female students^c
- Students who know a STEM professional were more likely to report they were **interested in a career involving science**, compared to students who did not know someone working in STEM^d

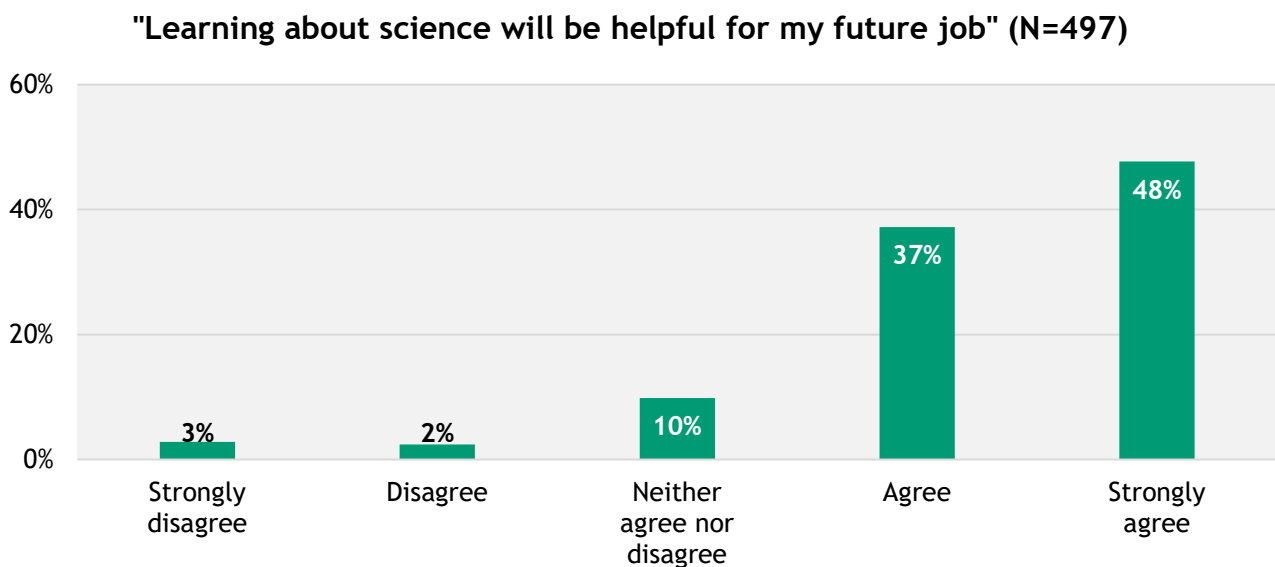
Logistic regression outputs: ^a OR=2.41, 95%CI 1.17-4.90, p<0.05; ^b OR=4.66, 95%CI 1.55-13.99, p<0.05; ^c OR=2.47, 95%CI 1.43-4.25, p<0.05; ^d OR=1.95, 95%CI 1.06-3.60, p<0.05

STUDENTS' VIEWS OF THE FUTURE USE OF SCIENCE

To explore students' views of science and its importance, we asked participants whether they think that learning science will be useful for their future jobs. The large majority of students strongly agreed (48%) or agreed (37%). Only 5% of students disagreed or strongly disagreed with the statement, and 10% neither agreed nor disagreed.

KEY FINDING

Over 4 out of 5 students (84%) agreed or strongly agreed that learning about science will be helpful for their future job.



Predictors of students' views of science

Our analysis shows that ethnicity, year group, disability and whether students attend a priority school were significant predictors of whether young people agreed that learning about science will be helpful for their future job.

- Asian^a and Black^b students as well as young people from Mixed or multiple ethnic groups^c were less likely to agree that learning about science will be helpful for their future jobs, compared to white students.
- Year 9 students were twice as likely to agree that learning about science will be helpful for their future jobs, compared to Year 7 students^d.
- Students who did not report having a disability were over 2 times more likely than those reporting a disability to agree with this statement^d.
- Students attending a priority schools were 2 times more likely than those attending non-priority schools to agree with this statement^e.

Logistic regression outputs: ^a OR=0.37, 95%CI 0.17-0.81, p<0.05; ^b OR=0.22, 95%CI 0.07-0.71, p<0.05; ^c OR=0.25, 95%CI 0.08-0.73, p<0.05; ^d OR=2.54, 95%CI 1.01-6.40, p<0.05; ^e OR=2.24, 95%CI 1.01-4.94, p<0.05.

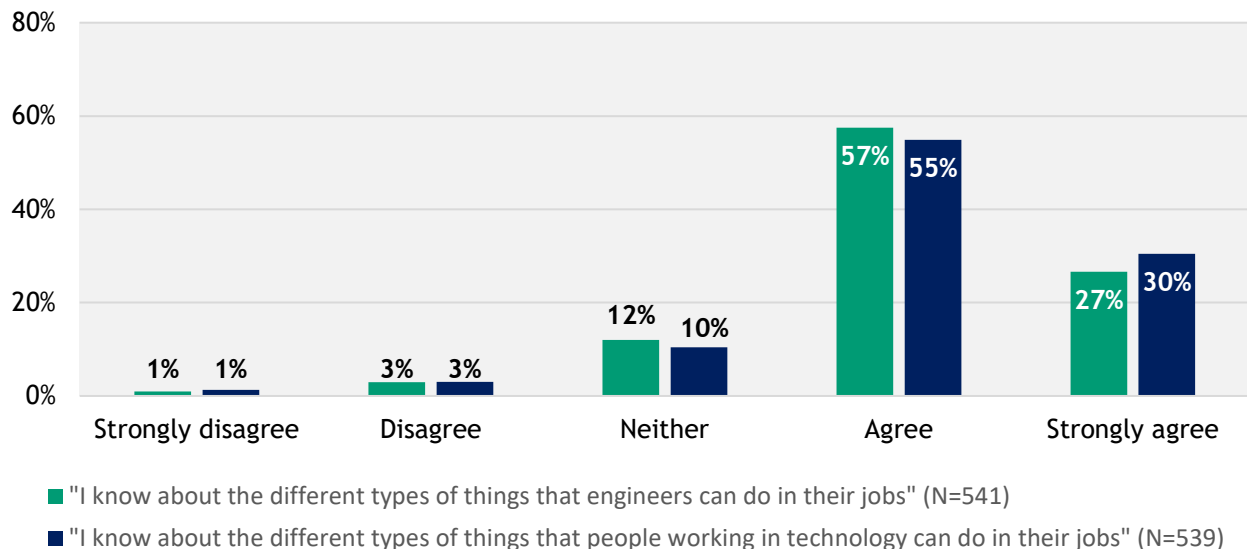
STUDENTS' KNOWLEDGE OF ENGINEERING AND TECHNOLOGY ROLES

As part of our evaluation, we asked 2 questions to students in order to understand their familiarity with STEM related careers. These questions rely on self-reported responses, offering insights into students' perceptions of their knowledge rather than an accurate measure of their actual understanding of what engineers and people working in technology do in their jobs.

KEY FINDINGS

- 84% of students agreed that they know about the different types of things that engineers can do in their jobs
- 85% of students agreed that they know about the different types of things that people working in technology can do in their jobs

Students' knowledge of what engineers and people working in technology can do in their jobs



Predictors of students' knowledge of engineering and technology roles

Our analysis shows that gender and ethnicity are significant predictors of students' reported knowledge of what engineers can do in their jobs, when taking into account all other students characteristics.

- Asian students were over twice as likely to say they **know what engineers do in their jobs**, compared to white students. ^a
- Male students were twice as likely to say they **know what engineers do in their jobs**, compared to female students. ^b

We also found that gender and knowing a STEM professional are significant predictors of students' reported knowledge of what people working in technology can do in their jobs, when taking into account all other students characteristics.

- Students who know a STEM professional were nearly 3 times as likely to say they **know what people working in technology can do in their jobs**, compared to students who do not know someone working in STEM. ^c
- Male students were twice as likely to say they **know what people working in technology can do in their jobs**, compared to female students. ^d

Logistic regression outputs: ^a OR=2.44, 95%CI 1.04-5.73, p<0.05; ^b OR=2.10, 95%CI 1.13-3.89, p<0.05; ^c OR=2.90, 95%CI 1.46-5.76, p<0.05; ^d OR=2.38, 95%CI 1.21-4.65, p<0.05;

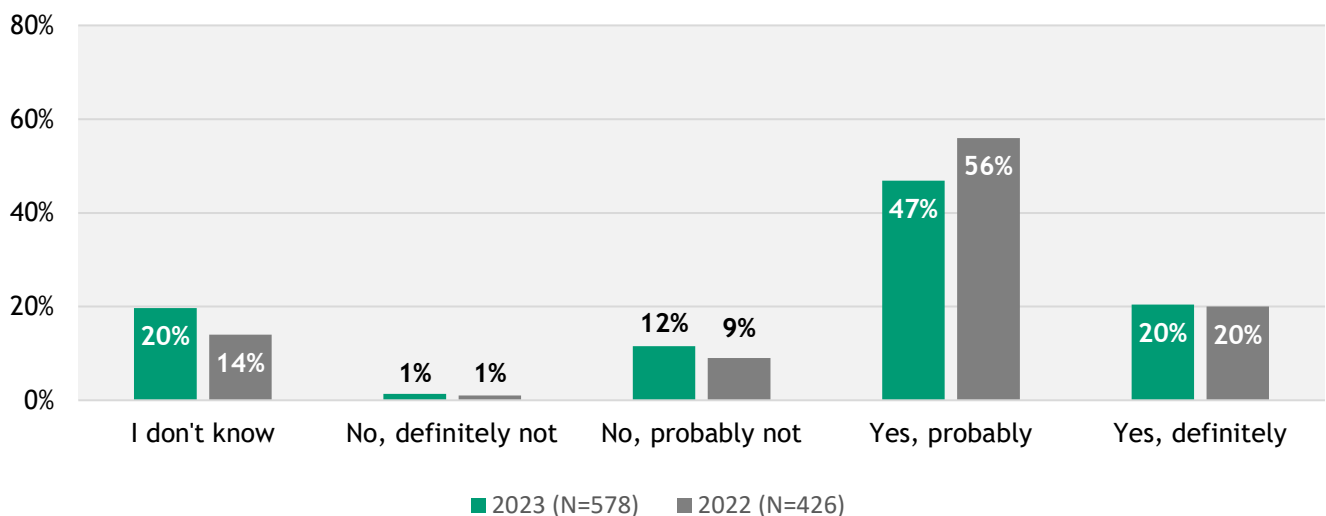
STUDENTS' CONFIDENCE IN THEIR ABILITY TO BECOME AN ENGINEER

For students to consider pursuing an engineering career, it is important that young people believe that such a career is accessible to them. Thus, we asked students whether they believed they could pursue a pathway towards an engineering career, if they wished to do so.

KEY FINDINGS

- In 2023, about two-thirds (67%) of students thought that they could become an engineer, if they wanted to
- Male students and those who know a STEM professional were more likely to think that they could become an engineer, if they wanted to

Whether students think they could become an engineer, if they wanted to, in 2023 and 2022



Predictors of students' confidence in their ability to become an engineer

Our analysis shows that gender and knowing a STEM professional are significant predictors of whether students believe they could become an engineer.

- Students who know a STEM professional were 3 times as likely to say they **could become an engineer if they wanted to**, compared to students who do not know someone working in STEM. ^a
- Male students were over twice as likely to say they **could become an engineer if they wanted to**, compared to female students. ^b

Logistic regression outputs: ^a OR=3.27, 95%CI 1.56-8.82, p<0.05; ^b OR=2.47, 95%CI 1.24-4.89, p<0.05

STUDENTS' PERCEIVED BARRIERS TO BECOMING AN ENGINEER

We asked students who said they did not think they could become engineers to tell us what would stop them from pursuing this career.

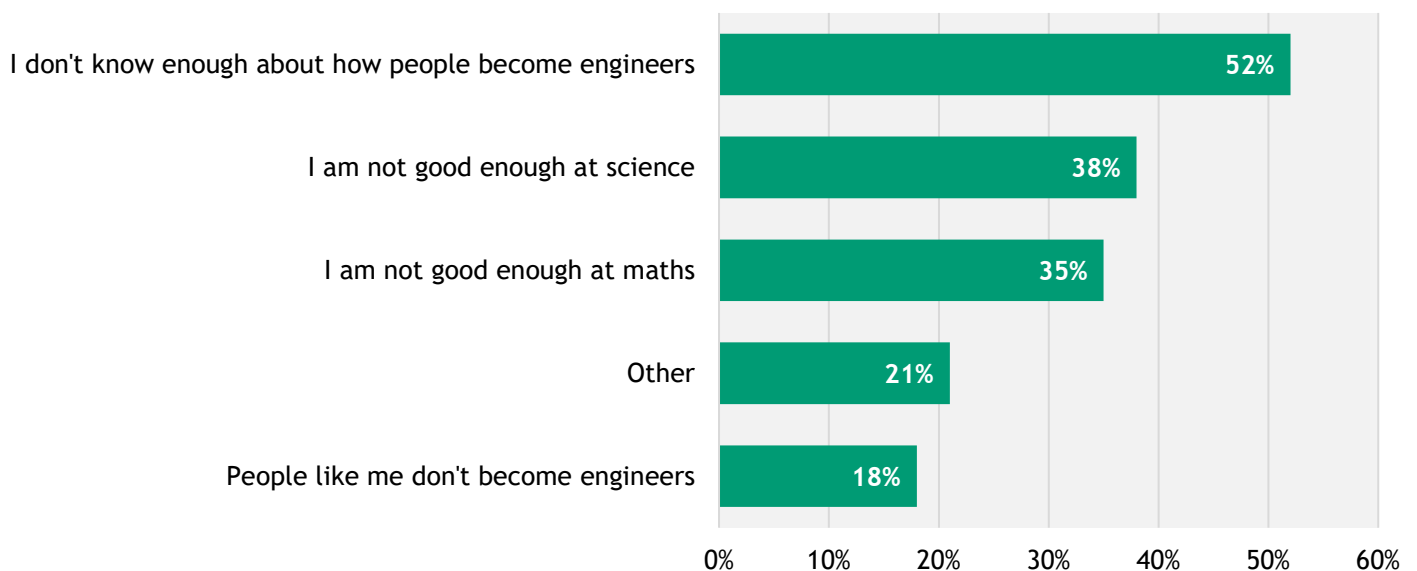
Half of students (52%) said it was because they don't know enough about how people become engineers. Roughly similar proportions of students said it was because they are not good at science (38%) and they are not good at maths (35%).

Nearly one in 5 students (18%) indicated that it was because people like them don't become engineers.

KEY FINDING

52% of students who do not think that they could become an engineer said that they do not know enough about how people become engineers

What do you think would stop you from becoming an engineer, if that was what you wanted to do? (N=71)



Other reasons that would stop students from becoming engineers

Students who selected other as an option were asked to specify any additional reason for what would stop them from becoming an engineer. Their responses included:

- Lack of interest or enjoyment in engineering
- Interest in other careers (e.g., healthcare or creative occupations)
- Self-doubt in one's capabilities

**“I’ve always wanted to be a doctor hence I’ve devoted my aim towards becoming one.”
(Student)**

Learning for future programme development

WHAT TEACHERS LIKE ABOUT ROBOTICS CHALLENGE

The 2022/23 academic year is likely the last year that Robotics Challenge will be running across the UK. However, there is learning that can be drawn from teachers' experiences to inform future programme development.

We asked teachers to let us know what they liked about Robotics Challenge. A total of 116 respondents shared their views. Emerging themes ranged from the design of the programme, engagement with staff and opportunities for students to develop their skills.

Engaging and challenging activities

One of the main aspects that teachers liked about Robotics Challenge was the range and level of activities that make up the programme, as mentioned in over 45 responses. The variety of the activities (e.g., combination of coding, programming, design and robot building) was highlighted as beneficial in engaging students with different interests and abilities.

Learning and skill development

Teachers reported that students learned valuable STEM related skills, problem-solving skills, teamwork and communication through Robotics Challenge (as mentioned in 44 responses). Teachers mentioned that students had the opportunity to build their confidence by taking part through a structured programme that encourages a trial-and-error approach to solving challenges. In their opinion, the programme encouraged students to try something new, learn through exploration and in a different setting, outside of typical classroom lessons.

Staff and organisation of the programme

Another aspect teachers liked was the overall organisation of the programme and staff engagement (as mentioned in 40 responses). Respondents highlighted the team was approachable and supportive on the administrative level as well as during in-person interactions. The organisation of the event, including communication, support and logistics, was reassuring for teachers and fostered an encouraging environment for students, particularly at the heats.

Robotics Challenge Resources

Other responses highlighted the importance of the resources provided, including free LEGO® kit, support in setting up a school-based group, step-by-step guides for the challenges and teacher CPD training (as mentioned in 38 responses).

“The programme was fantastic, the best aspect for me was the resources that came with signing up. The robotics kit give my pupils the opportunity to see how you can take an idea, design it, build it, programme it and modify it.” (Teacher)

“The nature of the programme allowed pupils to be independent in their thinking and learn from their mistakes which is often something time strapped curriculums are not able to do.” (Teacher)

“The students all really gained in confidence over the course of the program and learnt new skills, the level of challenge was just right and the robots are really fun to build and work with.” (Teacher)

WHAT TEACHERS WOULD IMPROVE ABOUT ROBOTICS CHALLENGE

Beyond asking teachers what they liked about the Robotics Challenge, we also wanted to find out what could be done to improve the programme in their opinion. A total of 92 respondents shared their views, with 80 teachers providing specific suggestions. Emerging themes ranged from having additional technical support, practical suggestions as well as overall continuing the programme.

Technical support and guidance

While teachers appreciate the training and support received, one of the main themes that emerged from their responses is the need to have updated resources, offering more tutorials and videos that align with recent software updates as well as in-school visits (16 responses). This was especially highlighted by teachers who did not have prior experience with coding, programming or using robotics kits. Some suggestions also referred to having more in-person training or opportunities to engage with judges ahead of the competitive element of the programme. A few teachers noted they faced technical challenges with the software, hub connectivity and parts that were not functioning as expected.

Logistics and practical improvements

Several suggestions were specifically related to the logistics and scheduling of the heats and finals (16 responses). For example, elements important to consider about the venue include access to Wi-Fi for real-time coding and problem-solving, having flat surfaces for consistency in the challenge mat and charging points for laptops. Knowing the event dates as far in advance as possible and avoiding conflicts with exam periods was also highlighted as important.

Continuation or extension of the programme

Some teachers expressed their views for the programme to continue (15 responses), with an additional 12 responses highlighting they would not want to change anything. Several responses included proposals for the programme to be extended, offering more complex components for older students or introducing more challenging activities for participants who had taken part before.

Communication and guidance on competition

Clear communication about the heats and transparency of judging criteria and results were other themes that emerged (15 responses). Teachers want more clarity on what they need to do to prepare for the heats, such as explanations of tasks, rules that all teams will be held to and clear criteria on how their teams will be evaluated. Several responses also suggested creating a feedback loop where judges could provide tailored feedback for a team to improve year on year.

Other suggestions

Beyond previous suggestions, teachers also proposed changing the themes of the challenges to maintain student interest and motivation, which can be challenging when other school activities are also competing for attention. Some teachers proposed including opportunities for young people to interact with other teams and showcase their own work beyond the competition.

Costs for materials are also a consideration in some school, whose teachers highlighted that funding would enable the programme to remain accessible.

SUPPORT FOR TEACHERS IN PROVIDING STEM CAREERS ADVICE

Robotics Challenge also offers information and links to STEM careers, aiming to assist teachers who play a pivotal role in guiding students in their future educational and professional choices. We asked teachers what additional support they feel they need when speaking to students about careers in engineering. A total of 61 respondents shared their views, emerging themes are presented below.

External engagement

An area that teachers would find helpful is support on engaging with external STEM employers or volunteers (30 responses). Most of these responses highlighted how they would benefit from engaging directly with more STEM ambassadors, hosting in-person STEM professional visits at their school, or arranging site visits at local companies. Teachers mentioned how they felt it would be beneficial for their students to engage directly with external STEM professionals, specifically to talk about their roles and careers. Other teachers suggested supporting opportunities for these volunteers to be mentors for students throughout the year.

Up to date careers information

Another theme that emerged through the responses was around teachers wanting access to clear and up to date information on engineering careers, particularly for educators with limited experience or knowledge of the field (20 responses). Examples of some suggestions include having a catalogue of current engineering careers with information on pathways, roles and salaries, offering interactive guides for students and any details on opportunities for students with different learning abilities. Other teachers also suggested that having access to case studies, videos of 'engineers in action' or examples that showcase the variety of engineering discipline would be helpful.

Teacher resources

Other suggestions were focused on practical resources that teachers felt they could benefit from (8 responses). Some examples included having access to resources that provide explicit links between Robotics Challenge activities and engineering careers. Several teachers suggested videos to introduce the programme, challenges and careers that can be played in their classrooms. While others would find helpful to have a careers component in the teacher CPD or even having practical demonstrations from STEM professionals embedded in the programme activities.

“On the day I spoke to a few experts who were happy to come and do talks at the school. If there was a way that this could be very easily organised and there [was] a platform that provided easy communication with the experts, this would be a great way to get them into schools and talking directly to the students.” (Teacher)

“Up to date information on roles in [the] area and areas of growth, pathways from entry level roles up [would be helpful]. Clear explanations on what engineering is in all its various roles...Everyone says be an engineer, but if you ask them, no one actually knows how to describe it.” (Teacher)

TEACHERS' VIEWS ON STUDENT ENGAGEMENT

Teachers were asked to what extent they agreed that Robotics Challenge had met some of its key objectives:

- To be an engaging activity for students across all levels of existing interest in STEM subjects
- To be accessible to students across a range of abilities

Survey respondents agreed that the programme is engaging for their students overall (93%) and engaging for students with varying levels of existing interest in STEM subjects (90%). There was a slightly lower agreement among respondents that Robotics Challenge was accessible to students of all abilities in STEM subjects.

Which activities were particularly engaging?

A total of 68 teachers shared the Robotics Challenge activities they felt were particularly engaging for their students. Free text responses were categorised to show which aspects were commonly mentioned:

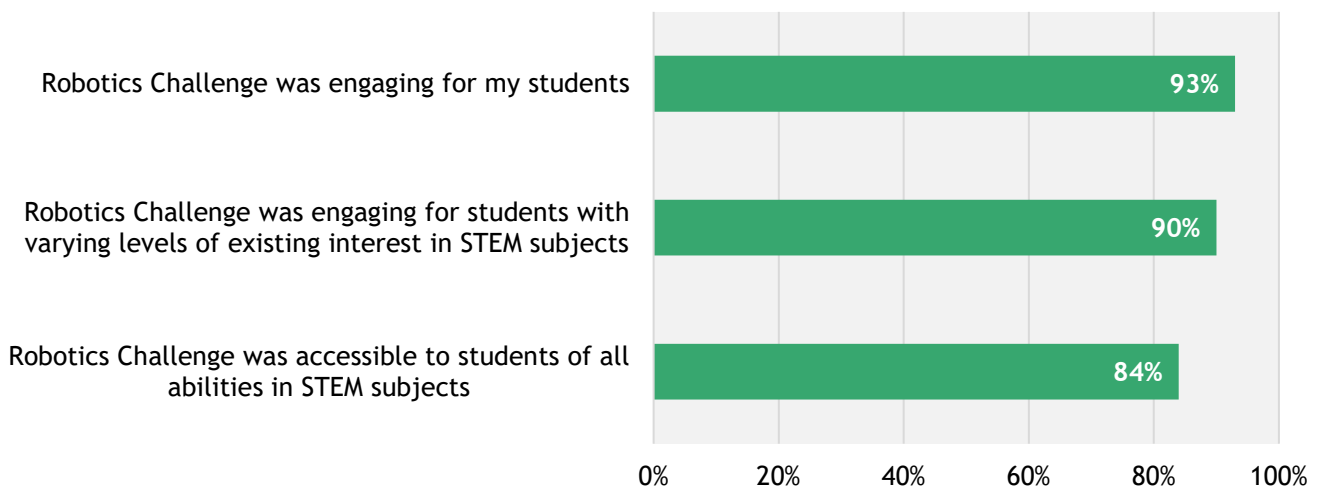
- **Competition activities** (38 mentions), specifically the challenge mat and speed and control challenge (both receiving 17 mentions)
- The overall **range of activities** that can be flexible to students' interests or skills (8 mentions)
- Some responses also highlighted **designing, building and programming robots** as engaging aspects of the programme (6 mentions each)

KEY FINDINGS

- **93% of teachers who responded to our survey agreed or strongly agreed that Robotics Challenge was engaging for their students**
- **The Challenge Mat and the Speed and Control challenges were mentioned by teachers as particularly engaging for students**
- **The range of activities and skills needed were also seen as engaging for students with different interested in research, design, build or programming elements**

“The lovely thing about this programme is that there is something for everyone. Whether your interest is creative, theoretical or hands on building and programming there is something for everyone’s interest.” (Teacher)

Proportion of teachers who agree that Robotics Challenge is engaging and accessible for students (N=120)



ENGAGING STUDENTS FROM GROUPS UNDER-REPRESENTED IN STEM

Robotics Challenge aims to engage all young people in engineering and technology related activities. This includes young people from groups under-represented in STEM, such as girls, students from UK minority ethnic groups, students from low-income households or students with disabilities.

Therefore, teachers were asked about whether they felt the programme was less effective at engaging young people from any of these groups. A total of 68 teachers shared their feedback. Responses highlighted a range of teachers' experiences, from those who said their teams were already diverse to others highlighting challenges they faced in engaging young people from groups under-represented in STEM or students less interested in or aware of engineering.

All young people engaged

Several teachers felt that no particular group was less engaged in Robotics Challenge activities (24 mentions). Others shared that their teams were diverse or said the programme was effective at engaging young people from groups under-represented in STEM. Some teachers specified in their responses that their constraints to engagement are related to students' ability to remain for after-school clubs, limited kit available.

“We are a multi-ethnic, all girls school and all of our students get the opportunity to get involved.” (Teacher)

“[I] tried to get more girls involved with the robotics challenge but they lost interest - also timings to when the club runs often clashes with other clubs.” (Teacher)

Girls

Some teachers reported that the programme was less effective at engaging girls (15 mentions). In some cases, teachers reported girls' participation had increased compared to previous years but remained low. However, other teachers mentioned that this year they were able to engage fewer or no girls at all.

Beyond girls, fewer responses highlighted other under-represented groups the programme was less effective at engaging with, such as: young people from low-income households (4 mentions), students with special educational needs (3 mentions) or young people from UK minority ethnic groups (1 mention). However, it's important to keep in mind that this is from teachers' perspectives.

Young people's previous experience

Several teachers offered additional insights in their responses, elaborating on factors that might contribute to limited interest or participation of young people in the programme. In these instances, they emphasised the potential challenge of limited access to prior opportunities to learn about programming or engineering (3 mentions). Some also suggested young people who were not already interested in STEM, those who had not used LEGO® before or students who find STEM difficult were less engaged (3 mentions).

“I think students who haven't been exposed to coding / engineering before were more reluctant as soon as they knew you needed to code the robot yourself. If I had more equipment, I would do a lesson in class to show students how easy it was.” (Teacher)

TEACHER VIEWS ON NEW PROGRAMMES

Alongside the teacher survey, we conducted in-person vox pops with 10 educators at Robotics Challenge heats. The aim of these brief interviews was to explore their views on computer science or robotics activities to inform EngineeringUK's new programme development.

Motivations for joining Robotics Challenge

Teachers said they decided to get involved in the programme for a variety of reasons, including:

- To enable students to engage in something different from a classroom lesson
- To offer extracurricular STEM activities for students who tend not to have access to these opportunities
- To encourage students to get involved in computer science or computing in future
- Because the content of the programme ties well with the computer science curriculum
- Because LEGO® is familiar for young people and can be an accessible way to practice STEM activities

Aspects teachers value of Robotics Challenge

Teachers shared the elements they liked the most about Robotics Challenge. For example, they liked the heats and view them as a platform for recognising student efforts and achievements. These events offer young people the chance to receive a variety of awards and showcase their work. Students can also learn from other teams' projects on the day.

Additionally, the variety of the challenges was mentioned as an aspect teachers liked about the programme. They shared that the variety can suit a diverse range of young people. One teacher highlighted that Robotics Challenge is a unique programme as activities integrate both programming and engineering, demonstrating the links between these 2 areas.

Another aspect they liked is that the program encourages creativity by letting students solve challenges iteratively. They felt the guidance provides accessible information, enabling students to advance with minimal teacher direction.

Some teachers liked that there was a clear outline of what the programme entails and its various phase, progressing from school activities to the Robotics Challenge competition. Other teachers highlighted that having a physical kit was valuable. They felt it was accessible to students who do not have experience in computer science or computing, allowing for activities to be more engaging and fun for a broader audience.

Imagining new programmes

We also asked teachers for their opinions on what a new programme could look like and what gaps they feel exist in current STEM engagement provision. The elements below highlight what they would look for in a new programme:

- Hands on, engaging and practical activities - they have to 'wow' young people and enable them to see the effect of their work
- Modular activities that build skills enabling a young person to work on an overarching project over time by learning and applying skills in new settings
- Clear links to the curriculum
- Clear links between programme activities and real-world contexts
- A competitive element where students can see where they have succeeded
- Awareness and consideration of the time and funding constraints teachers face.

In terms of the latter point, some teachers shared examples to achieve this by ensuring that resources and activities are accessible and achievable for staff who might not be a subject area specialist, by making the most of kit schools already have, or by including financial support and free resources.

Teachers also shared some themes where they see a gap for new programmes to possibly address:

- Artificial Intelligence - what is it and why can it be exciting? There is limited presence in curriculum and extra-curriculum activities
- Ethical considerations in engineering - "rather than just can we, actually, should we? And if we should, how should we?"
- Robotics and coding activities linked with Python
- Programmes that include design and technology components rather than a primary focus on science
- Aircraft or aerospace

Conclusions and recommendations

The objective of Robotics Challenge is to provide engaging hands-on activities for students and offer support for educators on STEM careers. We can see that the programme has predominantly succeeded in attaining its immediate outcomes as teachers and students share a positive view of the programme. However, findings also suggest that students involved in the competition are for the most part already highly engaged in STEM and interested in engineering careers.

Positive experiences of Robotics Challenge

Students as well as teachers had positive experiences of the programme, overall reporting that they enjoyed participating in Robotics Challenge and rating it highly. Encouragingly, there were no differences in student enjoyment based on gender, year group, disability, receiving free school meals, or whether participants attended a priority school. However, our findings do suggest that ethnicity can be a predictor for enjoyment.

According to teachers, it's the variety and range of activities that makes the challenges appealing for students of different interests and abilities. Teachers also greatly value the competitive element of the programme as an add on to school-based activities.

Students primarily chose to enter the competition to have something to put on their CV or personal statement. Our findings suggest that girls are just as likely to enter the competition for this reason or because they want to study computer science in future. This highlights that students may already have a clear sense of how Robotics Challenge links to their own future career aspirations.

Inspiring students to consider a career in engineering

More than 4 out of 5 respondents agreed that the programme made them want to do more STEM activities and find out more about engineering careers. This was particularly true for Asian and white students. Students also reported learning a range of different skills, including skills related to resilience, leadership and teamwork.

However, we also found that a majority of young people already know what job they want to do in future. And about half of these respondents shared they wanted to do jobs related to science, technology or engineering. Engineering related jobs were the most popular, particularly among male students. Therefore, the programme might be more effective at fostering interest in these careers, rather than inspiring.

Widening participation

Teachers reported that the variety of activities and the hands-on aspects of the programme were particularly engaging for their students. Teachers tended to agree that Robotics Challenge was engaging to students with a range of abilities in STEM subjects and existing interest in STEM subjects. However, considering their feedback, engaging girls in the programme may still be a challenge for some schools.

Findings from the student evaluation suggest that the programme might not be as engaging or enjoyable for young people from UK minority backgrounds, particularly Black students. It would be useful to explore activities or initiatives that may be more engaging for students from these groups. While the evaluation does not provide specific insights into the content that might be more engaging, learning from other organisations who are successful in doing this might be helpful to widen participation in future programmes.

In October 2022, EngineeringUK launched the 'Introducing Robotics' stand-alone lesson for teachers to deliver in classrooms as an optional session to familiarise students with robotics and promote awareness of career opportunities in robotics and engineering. The aim of this lesson was also to widen participation in the programme. Based on our Robotics Challenge evaluation, we found that 62% of teachers used this additional resource. Findings from our pre and post evaluation of the lesson and its impact for young people are available at: <https://www.engineeringuk.com/research-policy/evaluation/>.

Teacher feedback

Teachers highlighted they liked having a clear structure to the programme and the overall organisation from school-based activities to heats and finals events. They also shared that programme staff and resources available were helpful for their participation in Robotics Challenge. Teachers found particularly helpful the access to free kit, activity guides and CPD training.

In their opinion, aspects that could be improved about the programme include having access to technical support and guidance, logistical improvements at in-person heat events, clear guidance and communication about the competition. Some teachers also mentioned they would like the programme to continue or even extend to different age groups and abilities.

STEM careers advice

Robotics Challenge includes information related to STEM careers to support teachers in offering guidance to students about future education and job prospects. Most teachers reported that they felt more confident in speaking to their students about engineering careers and that they were more likely to suggest students to consider these. However, some also suggested additional support that they would find helpful, including facilitated engagement with STEM professionals for their students, up to date careers information and additional resources linking programme activities to STEM careers.

Students reported high levels of knowledge of STEM careers overall as well as self-confidence in becoming engineers if they so choose. However, among those who did not think they could become engineers, the main reason they highlighted that would stop them is their limited knowledge of how people become engineers. This suggests that additional support related to careers advice from teachers could help students learn more about different pathways into engineering.

Limitations

As shown in this report, the students who took part in our evaluation, in large part, skewed towards having a high level of prior STEM engagement, knowing a STEM professional and more likely to be already interested in engineering, technology and science related jobs.

The data does not allow us to compare student views before and after taking part in the competition, so we cannot conclude that the findings related to students' views, interest or knowledge of STEM careers are the result of students' experience at the heats.

Similarly, the teachers who took part in our evaluation were likely among the most engaged in all aspects of the programme, including its competitive element. Further, the responses we received were from nearly one third of all schools who participated in the programme overall.

LEARNING FOR NEW PROGRAMMES

The past academic year, 2022/23, was likely the final year of Robotics Challenge delivery in its current form. However, based on findings from our evaluation, the following are suggestions to consider for those designing new programmes like Robotics Challenge.

Student experience

- Offer opportunities for young people to showcase their progress, for example at competitions or via presentations
- Embed opportunities for students from different schools to meet and learn from one another
- Embed opportunities for students to meet with STEM professionals
- Consider ways to ensure students receive feedback and recognition for their work
- Foster a supportive environment for young people, where they feel encouraged to try new things and learn from their mistakes

Programme activities

- Design challenges that are both aligned to the programmes objectives and encourage independent learning, problem-solving and creativity
- Create a mix of activities from simple to more complex challenges, to cater for different levels of skill or interest among young people
- Ensure activities have a hands-on component for young people to apply their knowledge in practice
- Include activities that build on one another and enable young people to progress gradually over time
- Explore content that may be more engaging for students from UK minority ethnic groups
- Consider activities or programmes that focus on the following themes: Artificial Intelligence, Ethics, Robotics, Aerospace

Teacher resources

- Provide a central location for teacher resources, such as activity manuals or details of the programme structure and stages
- Provide resources that support schools to integrate a STEM engagement programme into existing educational opportunities for their students
- Include clear signposting to existing STEM careers information, interactive careers resources or videos and case studies used across EngineeringUK programmes or available on Neon

Organisation and communication

- Ensure staff are well-trained on the structure and organisation of the programme, enabling them to support schools where needed
- Provide clear communication with schools about the programme, its structure and stages, offering opportunities for them to contact staff for support
- If a competitive element is included, provide comprehensive rules and clear judging criteria

Logistics and cost

- Explore ways to minimize costs for schools, especially for those who might not have access to additional support or resources
- If in person activities are conducted in a location other than participants' schools, reflect on whether any specific equipment or materials are needed as well as any logistical and accessibility considerations

Evaluation and learning

Especially in the case of new programmes:

- Monitor delivery to assess feasibility and understand how schools engage with the programme
- Establish ways to collect feedback from participants throughout the duration of the programme to understand their experiences and identify improvements for the intervention
- Set up a system to incorporate lessons learned from the pilot phases of the programme to inform subsequent development