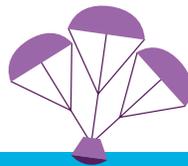




FIRST® LEGO® League Impact Report



Key findings and case studies:
the longer-term impact on
attitudes toward STEM

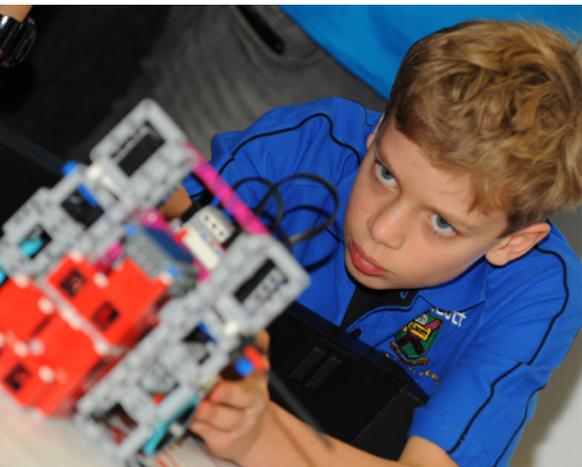
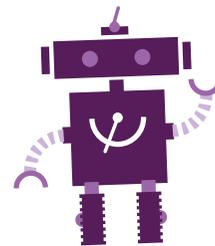


Introduction



To help us understand the longer-term impact on attitudes toward STEM among participants of *FIRST*[®] LEGO[®] League, we carried out two impact studies using qualitative interviews with teachers and surveys with competing students, asking about their past and current experiences of *FIRST*[®] LEGO[®] League.

As a result of this research, we've developed eight theme-based case studies which outline subjective experiences of taking part in the competition, focusing on the benefits of participation and its positive impact on a range of areas.



Case study 1 Benefits for disadvantaged and SEN students	Case study 2 A unique learning experience	Case study 3 Personal and transferable skills	Case study 4 Development of technical skills	Case study 5 Long-term impact	Case study 6 Benefits for girls	Case study 7 Practical experience	Case study 8 Benefits for the wider community
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Key findings



Our findings show that *FIRST*® *LEGO*® League provides:

1. Benefits for disadvantaged students

Participation has demonstrable benefits for struggling or disadvantaged students, particularly Special Educational Needs (SEN) pupils – allowing them to shine. The competition provides a unique outlet for success which they can't always access. It develops skills which motivate students long-term and help them flourish academically and socially, showing them they can pursue a STEM career.

CASE STUDY 1

Benefits for disadvantaged students

2. A unique learning experience

The competition fosters independent, engaging and practical learning that feels like fun and offers quick results in a real-life context. *FIRST*® *LEGO*® League uses a hands-on approach to learning that results in multi-faceted skill development. Many team leaders reported that students thought it was exciting and fun, and sometimes they weren't even aware of how much they were learning from this immersive experience.

CASE STUDY 2

A unique learning experience

3. Improvement of personal and transferable skills

One of the biggest impacts of participating is improvement in various soft skills. Team leaders mentioned students developing personal qualities such as resilience and confidence, as well as transferable skills, such as communication, teamwork and problem solving.

CASE STUDY 3

Improvement of personal and transferable skills

4. Development of technical skills

Participants develop many new technical skills along the way, especially across STEM knowledge, robotics, programming and engineering. For some students (and team leaders) it's their first exposure to programming – helping them learn coding from scratch and motivating them to improve.

CASE STUDY 4

Development of technical skills

5. Long-term impact

Taking part can influence study and life choices – helping more children feel that STEM careers are within their grasp. Students are exposed to practical, real-world STEM application, helping them develop academic aspirations and career choices involving STEM subjects and believing they can become successful STEM professionals.

CASE STUDY 5

Long-term impact

6. Benefits for girls

FIRST® *LEGO*® League can be particularly important for girls, helping address some barriers that hold them back from pursuing STEM activities, studies and jobs. They are encouraged to take on roles and responsibilities that boost their confidence in their skills and knowledge - showing them that it's not only something they can do, but enjoy, excel at and pursue in the future.

CASE STUDY 6

Benefits for girls

7. Practical experience

Students learn that STEM is not just theory in the classroom. By working with inspiring professionals and visiting companies, participants can see how STEM is applied in real context and learn how science and engineering could be used to solve problems in the real world.

CASE STUDY 7

Practical experience

8. Benefits for the wider community

The impact of taking part can reverberate well beyond individual teams and schools. Participants can see their work and ideas making a difference in the wider community. The competition fosters a supportive network of enthusiasts eager to encourage and mentor newcomers while core values encourage teams to impact their neighbourhood.

CASE STUDY 8

Benefits for the wider community

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CASE STUDY 1

Benefits for disadvantaged and SEN students

Our research shows the benefits of participation in *FIRST*® *LEGO*® League for struggling or disadvantaged students as well as SEN pupils by allowing them to shine.



Moulton Chapel Primary School, East Midlands, perfectly demonstrates this impact. The school is in a rural area, with fewer than 75 pupils and an above average amount receiving pupil premium. Six out of ten students taking part in 2018-2019 were SEN pupils. The school have taken part for the last five years and include a mix of pupils in their team, particularly those who require extra support in their studies. Years 5 and 6 pupils also take part in the competition. Lisa, the school's *FIRST*® *LEGO*® League team leader, explains how the format ensures her students can access it with just a little support.



Opportunity

Being in a rural, economically disadvantaged area can make it difficult to provide students with exciting extra-curricular activities. But with funding available, and the ability to run *FIRST*® *LEGO*® League internally, the school has access to a unique opportunity.

Access

Lisa found the tasks involved a range of skills, allowing them to shine in different areas.

"SEN children are good at building the models, they follow the instructions well and all have *LEGO*® at home. They were able to contribute as part of the presentation project and research things on the internet. Some of them struggle with getting it down on paper, we can support them with that and make sure they're never excluded."

Skills

The competition draws on a wide range of skills, allowing students to showcase their brilliance technically, creatively and through soft skills.

"Last year, one of our SEN children – who is dyslexic, but very good at drawing – did the design of our prototype. We designed a new type of product which was sent off to industry experts for feedback. The head designer came back and said it was better than some of the design pictures he gets from his teams! It was an incredible boost for the student, she does struggle with writing but has a power in art and was able to utilise that."

Inspiration

Lisa's students worked alongside industry experts and engineers as part of their preparation and tournament participation. This provided them with confidence and inspiration, showing them they can pursue a STEM career if they wish.

"Working with engineers that are really good, they've been able to see that being a SEN pupil doesn't preclude you from getting a job in engineering or technology. They see they can be good at it, experience success within and feel it's not a job that's out of their range or ability."

Success

Participating has provided Lisa's SEN pupils with a unique outlet for success they can't always access. The competition develops skills which motivate students long-term and help them flourish academically and socially.

"SEN children get so much from it because they don't feel under pressure to get everything right every time, because it's not about that, but about how you address where things go wrong, problem solving and resilience and not giving up. The skills they're learning aren't exclusive to science and engineering. They are skills that can be applied throughout the curriculum and their life."



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CASE STUDY 2

A unique learning experience



FIRST® LEGO® League participants describe the competition as an engaging and hands-on approach to learning that offers multi-faceted skill development. Many team leaders reported that students thought it was exciting and fun. Because the experience was so immersive, sometimes students weren't even aware of how much they were learning.

The learning promoted was thought to be different from what's usually achievable.

A student who took part in the 2018-2019 competition described how some of the skills they had gained would be difficult to develop in a classroom:

"The major difference is problem solving ... in **FIRST® LEGO® League** we're creating our own problems and then trying to solve them. So, we're brainstorming that completely independently, whereas at school obviously we've got teachers supporting us and it's more like information-based concept solving solutions."



What makes the experience unique?

The active nature:

"You can hide in a class of 30. You can't hide in a team, because everybody has to take part. I think there's more involvement in the process."

Ilana, leader of a home-educated team

Challenge and competition:

"I think it's the fact that we make it friendly, but we make it a challenge so that they can actually succeed, they can actually achieve something."

Craig, teacher

Curiosity-driven and independent research:

"You hear so many facts about space (that year's theme) like "did you know this?" and, "did you know that?" because they're off looking for a problem to solve and they're learning without realising it."

Julie, team leader

Here are three approaches schools have taken to running **FIRST® LEGO® League**, with different benefits:

1. Extra-curricular club

Many teams run as clubs that fit into lunchtime or after school. In some schools, the **FIRST® LEGO® League** club is the only opportunity for the kids to get involved with coding.

Jim, leading a team from an all-girls school, appreciated that it was "a voluntary activity for enthusiasts" and that teachers/students did it for fun.

Ruth, a team leader from Northern Ireland, said it suited her school as they didn't have enough staff to do it during school hours and it catered for a different type of interest than their other activities:

"... not all children want to participate in sport, it's providing for a certain type of child and helping encourage them in that direction of career."

2. Part of the curriculum

FIRST® LEGO® League can be run in timetabled STEM lessons, giving more kids access to robotics and putting less pressure on out-of-hours time.

Lisa, who has led teams for the past five years, has tested it in her very small, rural primary school:

"It can be done without too much difficulty. I wrote the lesson plans and it wasn't difficult linking the objective for computing and design."

3. A flexible approach

Team leaders choose an approach that works best for their school and students.

"We have done it different over years. Run it as an after-school club and part of the curriculum depending on how our topic falls. If science-based then we use the other slot in the timetable to address the programming. So, every two years every child will work on programming. Everyone gets the opportunity in the class".

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CASE STUDY 3

Personal and transferable skills



Previous studies for the IET found one of the biggest impacts of participating in *FIRST*® LEGO® League is improvement in soft skills. Team leaders mentioned students developing various personal qualities, such as resilience and confidence, as well as transferable skills, such as communication, teamwork and problem solving.

90% of students reported their **problem-solving skills** had improved*

89% of students reported their **teamwork skills** had improved*

Time management
Team working
Critical thinking
Confidence
Creativity
Presentation
Problem solving
Ideas brainstorming
Listening
Leadership

Confidence:

Teachers noted positive changes in student self-improvement. Increase in confidence was often mentioned. Jonny, a teacher who's taken part in *FIRST*® LEGO® League Jr. five times with primary school students said presenting to an audience and seeing efforts translating to success gave students a much-needed confidence boost:

"We've had parents coming to us and saying thank you so much for including our child because they've now got more spring in their step and can hold their head higher."

Resilience:

Teachers also reported students building up their resilience by tackling challenges.

"This project gave them a good life lesson that actually, sometimes no matter how hard you try, something's going to go wrong. Failure's not always a bad thing and they've used that as fuel to power them this year."

Shaun (mentored four teams 2018-2019 season)

FIRST® LEGO® League participation is project-based, which encourages students to develop a whole range of transferable skills around collaborative working, managing information and delivering results to deadlines.

Communication: Teamwork:

"They have to make a slideshow and an oral presentation for the judges... and that's a skill that does translate directly to their classwork."

Chris, team leader

"*FIRST*® LEGO® League has given me priceless skills that I would never have come across anywhere else at my age. These skills have massively increased my confidence and belief in myself to know that I am able to program/diagnose/test at a high level, while being able to work efficiently as a team."

Student

Organisation:

"Their ability to take on hard work and organise themselves has certainly improved."

Chris, team leader

"Real-life skills - these are going to be useful to you when you get a job wherever you are in the world. You need to hear other people's contributions. That's real... that's what we learn first, be a team."

Teacher



Note: *Findings from the IET *FIRST*® LEGO® League 2017-2018 Impact Study

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CASE STUDY 4

Development of technical skills

Our IET impact study revealed that students' technical skills had improved since taking part, with feedback from team leaders confirming this. Many described how participants developed in such areas as STEM knowledge, programming, engineering and robotics.



STEM knowledge:

Participants explore a new theme each year. Independent research boosts their knowledge of a variety of STEM topics they may not have come across at school and invites them to follow their curiosity.

"They all know a lot more about space now than they did in September, they've had to study it and find a problem to solve. One of our younger teams came up with, "Could you cook a cake in space?" and they had to get in touch with the science department and interview people about that."



Robotics and engineering:

Students get to explore robotics and engineering – starting with a simple design and gradually building up their skills by overcoming glitches, adding more complex features to their robots and trying out different engineering solutions.

"Some of them have never put LEGO® together but by the end of it they're building complex mechanical structures that do what they want it to do."

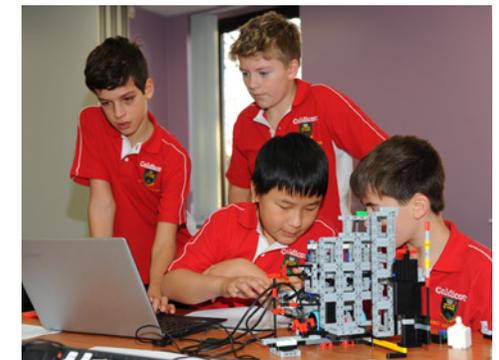
Programming:

While *FIRST*® LEGO® League attracts coding enthusiasts, for some students (and team leaders) it's their first exposure to programming – helping them learn coding from scratch and motivating them to improve step by step.

"The programming skills for all of them have developed massively... in September they knew nothing whatsoever yet between them they managed to produce three robots to compete so it does come on pretty fast."

69% of students reported improvements in **STEM knowledge**

82% of students reported that their **programming skills** had improved since taking part*



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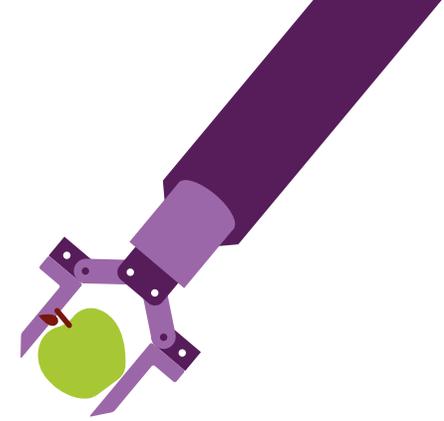
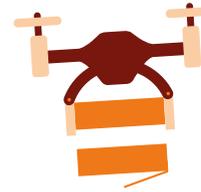
Case study 8

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CASE STUDY 5

Long-term impact

Taking part can influence study and life choices – helping more children feel that STEM careers are within their grasp.



50% of repeat participants reported being **more interested** in having a **job using STEM** since taking part *

FIRST® LEGO® League exposes students to practical, real-world STEM application, increasing their likelihood to agree that they:

- Expect to use science when they leave school.
- Would consider a career in science.
- Can be successful in a career in engineering.

This increase in confidence has also been noticed by some teachers, who felt that FIRST® LEGO® League had played a part in their students' GCSE and A-Level choices:

"I had four girls who joined the team in year 8, they did four years of FIRST® LEGO® League. They hadn't done a lot of programming previously, so they really enjoyed it and because of that they chose the GCSE. Three of them got A*s in the GCSE. At least three of the team have gone on to do computing as an A level. I think that is to do with taking part, at least they told me it was... two of the girls said they want to be engineers and one of the boys is doing an engineering apprenticeship now."

"There's a couple of participants that really embraced it and you can see that their interest in design and technology and computer science has definitely gone up as a result of having done the competition. You can see that they really like the making or the programming and then that's given them more of an interest in the appropriate subject."

Team leaders commented that it also helps to develop career aspirations in a less direct way – by exposing children to inspiring role models and real-world professionals who can encourage them to consider STEM careers:

"When they go to the events, like the first one we went to at Bechtel, where they were talking about engineers and a career path, this was quite eye-opening for some of them because they realised what they were doing was basically a smaller scale version of that."

"STEM may not have been talked about as a career so giving them the opportunity early puts the idea in their head at an early stage."

It is not unusual that students who take part in FIRST® LEGO® League want to learn more about computers, robots, science and technology. Team leaders thought the competition could both boost dedication and ignite interest in STEM subjects and activities – for example, encouraging involvement in coding clubs.

60% reported that **participation** helped them **think about what they needed** to study to become a **scientist** or **engineer***



Note: *Findings from the IET FIRST® LEGO® League 2017-2018 Impact Study

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CASE STUDY 6

Benefits for girls



FIRST® LEGO® League encourages female participants to consider their involvement in STEM more seriously and inspires them to think about the study and career options they need to take.

67% of girls said that *FIRST® LEGO® League* helped them to think about what they needed to study to become a **STEM professional**.*

Participating in *FIRST® LEGO® League* can also help to challenge some gender stereotypes by:

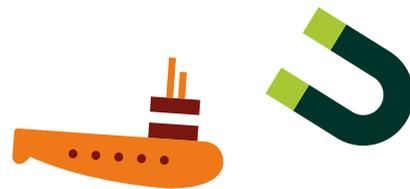
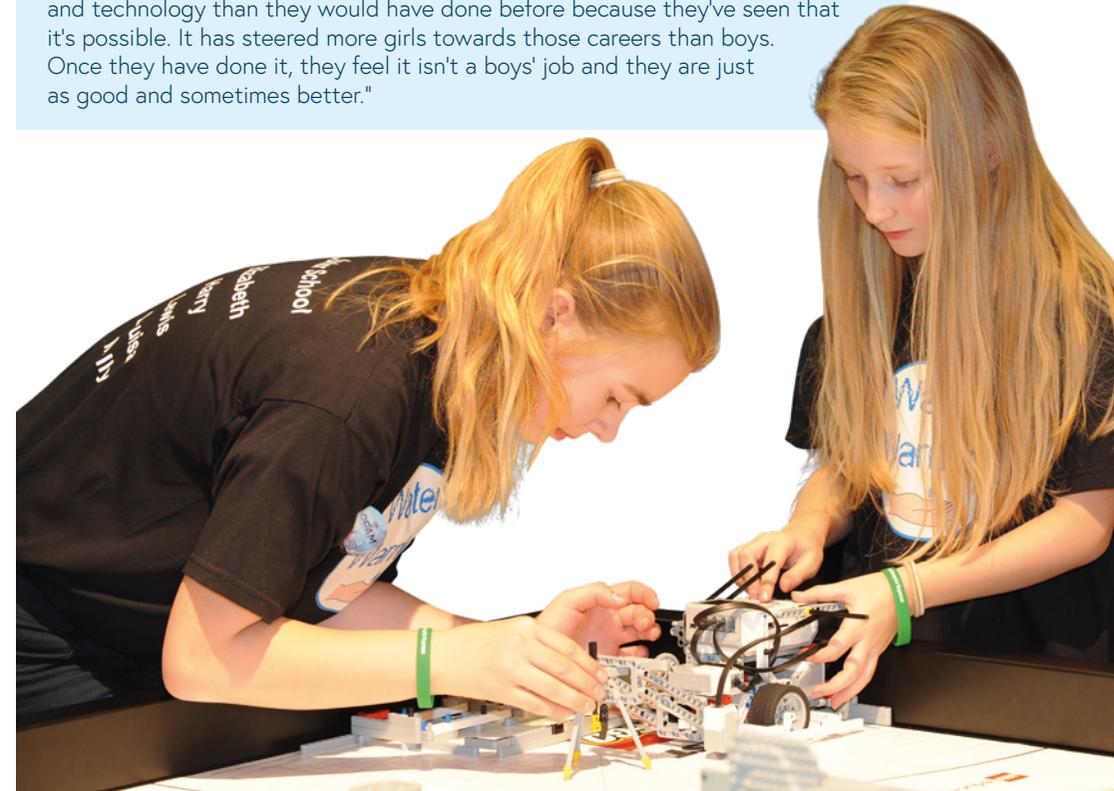
- Encouraging girls to take on roles and responsibilities that might be seen as 'for boys'.
- Showing engineering is a cutting-edge and exciting career option.
- Exposing students to female role models/STEM professionals.

"Someone is engaging and switching the light bulb on in their head about engineering and science."

Girls in particular were more likely to believe that they were good at maths and problem solving following taking part.*

"We've made a big effort to recruit girls into the programme to make sure we have female mentors helping the teams and this year we have an all-girls team, which was just year 6 girls and they did really well."

"There are students from previous years who have gone more towards science and technology than they would have done before because they've seen that it's possible. It has steered more girls towards those careers than boys. Once they have done it, they feel it isn't a boys' job and they are just as good and sometimes better."



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CASE STUDY 7

Practical experience

Students learn that STEM is not just theory in the classroom. By working with inspiring STEM professionals and visiting companies, participants can see how STEM is applied in real context and learn how science and engineering could be used to solve problems in the real world.



82% said taking part taught them how **science and engineering** could be used to **solve real-world problems**

Completing practical tasks with tangible results

FIRST® LEGO® League involves tasks that:

- Have goals (solving missions).
- Encourage experimenting.
- Show practical application of ideas.

Andrea, whose students have taken part six times so far, highlighted the benefits:

"There are lots of little missions... so they have a lot of intermediate goals, which works quite well. Saying, "let's do one mission," so they have something small, they can finish and complete. They are happy to have little steps where they can feel like they've accomplished something."



Working with professionals

Teams can collaborate with experts who come into schools as volunteers. Craig, a team leader for eight years, particularly appreciated this support:

"Our engineer is phenomenal. He instils a lot of the engineering principles into the work he does with the kids."

Teams are also encouraged to contact STEM professionals. Jonny, who led a primary-school team of first-time entrants, pointed out the importance of that:

"This year, they were encouraged to speak to different engineers or astronauts as well. You might google your homework, but you actually have to find an engineer and talk to them and learn those interview skills and research skills and things like that, so it's hugely beneficial to them."

Solving real-life problems

Participants not only get a chance to see how professionals work, but also try to solve real problems affecting the world – from mental health in space to water shortages in developing countries.

Sion, whose team from a rural Welsh school qualified for the finals in Detroit (US), talked about their project:

"The idea from the project last year was to have plants in dry places in Africa that could pump water into chambers and then use concave mirrors to desalinate the water. We worked with a local company to help get the theory behind that. We had a site visit with them."



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CASE STUDY 8

Benefits for the wider community



The impact of taking part can reverberate well beyond individual teams and schools. Participants can see their work and ideas making a difference in the wider community. The competition fosters a supportive network of enthusiasts eager to encourage and mentor newcomers while core values encourage teams to impact their neighbourhood.

Benefits stated were:

- Raising the profile of STEM within the school.
- Raising the school's profile within community and even nationally.
- Building supportive networks between schools.
- Collaborating with local universities and businesses.
- Promoting the competition among parents and siblings.
- Meeting other enthusiasts and STEM professionals in different cities and abroad.
- Leaving a mark and making a difference in the local community.

"They encourage you to share your project with relevant companies, organisations etc. In schools, they often do this by standing up in assembly. Because we don't have that opportunity, I reach out to companies and we go and visit them. Last season they went to Microsoft and talked to a whole room full of adults and they also went to a university to do this 'sharing'."

Ilana, leader of a home-educated team

Local schools

FIRST® LEGO® League fosters competitive spirit and, in turn, a supportive network of enthusiasts – eager to encourage and mentor newcomers. Shaun is based in a rural community and, despite funding restraints, manages to share his resources and expertise:

"We entered two teams last year and... we've got three teams in it this year plus we're sponsoring and working alongside a primary school and getting them involved as well."

Families

Some team leaders, like Julie, saw how building robots sends a message to younger siblings that STEM is cool:

"Parents come to pick up the children so we say they're welcome to pop in and generally the younger brothers and sisters with them are like, 'can we do this when we come up?'"

And Liz, a coach, adds that parents might be impressed too:

"I like to have the parents helping because then they see what their child is doing they think, 'wow' and they're blown away because they think, 'this is so complicated, how does my child get around this problem?'"

Businesses

Being a small, rural or under-funded school shouldn't be a barrier to STEM involvement. Taking part in *FIRST*® LEGO® League has allowed students to visit companies like Microsoft, Caterpillar or Qualcomm.

Julie, from Buxton Community School in the Peak District, said:

"We took 10 students and got some quite nice sponsorships from local engineering companies and we did a lot of fundraising ourselves."

Communities

The competition is not only about STEM. Core values are a crucial aspect and encourage teams to make a difference in their communities.

Jonny, a primary school team leader, talked about their two latest projects: mental health in space and plastic pollution:

"We went and talked to a care home down the road, about how loneliness affects them and we had a fantastic time playing bingo down there."

"It's that awareness which *FIRST*® LEGO® League brings that you're passing on to another generation... we went around the coffee shops by the school and gave them some information about plastic pollution in the sea, because we're a coastal school. They now offer a discount to people if they bring their own cup. So, for the children to see their own work and own ideas in the bigger community, it's enormous."

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