

## RAPID EVIDENCE REVIEW

Interventions to increase girls' aspirations for engineering and technology careers



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This review brings together the available evidence on interventions that aim to increase girls' aspirations for engineering and technology careers. Through summarising the existing literature, we draw out learning on effective interventions that can be used by STEM outreach providers to improve gender diversity in these careers.

## CONTEXT

Despite some improvements, a significant underrepresentation of women working in engineering and technology careers persists, making up 16.5% of the engineering workforce as compared with 47.7% of the overall workforce.<sup>1</sup>

From an early age girls show less interest in engineering and technology careers than boys do. Only 38.5% of girls aged 11 to 18 said they are interested in a career in engineering compared to 62.5% of boys<sup>2</sup>, and much smaller numbers act on this interest.

As engineering and technology currently has a limited presence in school curriculums, high-quality impactful STEM engagement activities are needed to help inform and inspire young girls towards these careers.

While there are numerous interventions aimed at increasing young people's interest and aspirations in STEM, there are significantly fewer interventions focused specifically on engineering and technology. Furthermore, there is a lack of research on the effectiveness of these interventions, particularly for girls.

While we recognise that gender identity is more nuanced than 'male' and 'female', for this report we will focus on girls and women because of the stark disparity of men and women in the engineering and technology workforce.

## About this review

This paper offers a comprehensive, narrative review of the evidence on what works in engagement interventions to increasing girls' aspirations for engineering and technology careers. It aims to inform programme design and delivery for STEM engagement practitioners and funders, and to highlight gaps where more evidence is needed.

The review summarises the evidence on some key approaches and the learnings drawn from their evaluation. Links are given to the full papers so that interested readers can see full details of the methods used and their findings. Much of the evidence is mixed or inconclusive. The reflections highlighted in this report, which are drawn from the papers directly and from the reviewer's perspective looking across the published studies, are intended to help those looking to explore similar approaches to benefit from the experience of others.

## Research questions

This evidence review focuses on 3 key research questions:

1. What are the characteristics of interventions aimed at increasing girls' aspirations for careers in engineering and technology?
2. What is the evidence that any of the interventions are effective in increasing girls' aspiration?
3. What are the gaps in the evidence?

<sup>1</sup> [Trends in the engineering workforce](#). EngineeringUK (2023)

<sup>2</sup> [Engineering Brand Monitor](#). EngineeringUK (2022)

## Database search

Three databases were searched for relevant papers (ERIC, IEEE Explore, Science Direct). Additional searches were conducted using Google Scholar and by following the references and citations of the studies included.

## Inclusion criteria

To be included in the review, papers must:

- clearly state the aims, participants, and context of the intervention
- evaluate the effectiveness of the intervention using quantitative, qualitative, or mixed methods
- either have a specific focus on girls or conduct differential analyses by gender
- have a specific focus on engineering and technology, rather than science or STEM more broadly

See annex A to see the full methodology.

## Outcomes of interest

An increase in girls aspiring to a career in engineering and technology (including computing) or pursuing options that keep them on a career path including subject choice and next steps after leaving school.

## Screening strategy

A total of 395 papers were identified through the initial search (See Appendix A for the full screening strategy). The titles and abstracts were screened, and irrelevant or duplicate papers were eliminated. The remaining papers were read in their entirety, and those that failed to meet the inclusion criteria or were of poor quality were excluded. Additional relevant studies were discovered by searching the references and citations of the selected papers, leading to a final review of 40 papers.

## Synthesis of key findings

The final papers were read thoroughly to extract useful information about the delivery, evaluation and key findings from each intervention. This data was summarised into a table to facilitate comparison of the interventions and outcomes.

## Reporting findings

Studies were grouped into themes based on the delivery methods of the interventions. The key learnings were distilled to help those planning and delivering similar approaches. Some of these insights are drawn directly from the conclusions of the reviewed papers, while others reflect learning from across the studies as a whole.

Many of the programmes used multiple approaches, such as role models and hands-on activities. It is not possible to attribute the findings in these studies to any one of these approaches. In some cases, studies appear in more than one section of this report to draw on the learning from multiple approaches or components.

Since programmes are rarely replicated in precisely the same way, we have distilled the learning to inform new programmes, rather than to recommend a specific programme approach. Readers who are interested in more detail about any of the papers mentioned in this report should follow the references to read the papers in full.

Ten of the interventions were aimed at primary school children and most involved hands-on activities within the classroom setting.

## OVERVIEW OF FINDINGS

Of the 10 interventions aimed at primary school aged students, all had positive or mixed results. Some of these studies are summarised below.

### Positive findings

**Programming pet robots** (Master, Cheryan and Meltzoff, 2017). In this 20-minute workshop 96 6-year-olds were tasked with using a smartphone to visually programme a toy pet robot to navigate spatial paths. **Findings:** Girls who experienced the robot treatment had significantly higher ‘technology motivation’ compared with girls in the control group, including higher interest in programming and confidence in working with robots.

**Helpful robots** (Sullivan and Bers, 2019). Just over a hundred 6 to 8-year-old children took part in a 7-week robotics curriculum using KIBO robotics kits with the theme of ‘helpful robots’. **Findings:** There was a statistically significant positive change in girls’ desire to be an engineer. After the curriculum, boys and girls no longer significantly differed in their level of agreement that they would enjoy being engineers. Girls in the control group who did not have access to the KIBO curricula did not display this significant increase.

**Techno truck** (Boeve-de Pauw and others, 2022) is a truck that has been designed as an interactive classroom which visits schools. The truck contains workstations and activity resources on various topics focusing on different high-tech aspects of technology. Students spend a whole day with the techno truck activities. Participants were 1,496 male and female students aged 10- to 12-year-olds. **Findings:** Girls’ and boys’ career ambitions developed positively, but girls retain a lower score than the boys after the intervention.

**Cookie-jar alarms** (Mitchell, Lott and Tofel-Grehl, 2022). In sessions over a 2-week period, 15 6- to 7-year-old students learned to programme a robot using a distance sensor to trigger an alarm with customized sounds and flashing lights. **Findings:** They found that girls were more likely than boys to identify as an engineer following the cookie-jar alarm design task. That is, more girls (6 of 8, 75%) than boys (1 of 7, 14%) responded in the affirmative when asked in the post-interview, “Do you think you are an engineer?”. The positive findings were attributed to the design of the curriculum being fun, accessible, gender neutral, collaborative and based around story-telling.

## Mixed findings/no effect

**Sustained career-driven intervention** (Emembolu and others, 2019). The researchers developed a suite of 22 one-hour interventions that focus on increasing children's aspirations towards STEM jobs. Schools could select which and how many of the activities they wanted to do. The interventions included hands-on in-class workshops, whole school activities, informal learning activities and family activities. Seven hundred and eight 8- to 10-year-old boys and girls took part in the evaluation across 2 years. **Findings:** The percentage of girls that 'would like to' be engineers in the comparison and intervention group were similar (20% and 21.8% respectively), but the percentage of girls that 'would not like to do' engineering significantly decreased from 70.6% before the intervention, to 47.1% after the intervention, with the percentage that were 'not sure' increasing from 9.4% to 31%. In contrast, the percentage of boys that would like to be engineers increased from 32.1% in the comparison group to 59.0% in the intervention group, and the percentage that 'would not like to do' engineering decreased from 55.6% to 25.3%. The authors claim that the data supports the suggestion that sustained engagement can lead to impact.

**Computational thinking activities** (del Olmo-Muñoz and others, 2022). Eighty-four 7- to 8-year-old students took part in workshops to improve computational thinking. Some of these activities were on devices (plugged) and others were not (unplugged). **Findings:** The gender gap for technical career aspirations was reduced in the unplugged group, where it decreased from a large effect size before the intervention to a medium-sized effect after the instruction. In this case, although the boys also improved their scores in this dimension, the reduction is due to a greater improvement among girls. However, the gap widens in the plugged group, due to both increased aspirations among the boys and decreased aspirations among the girls.

**Engineering and design-based science** (Capobianco and others, 2015). The study involved a multiweek engineering design-based science curriculum for primary-aged students, including daily lesson objectives, assessments, and engineering design tasks aligned to national science standards. The tasks were designed to be authentic and relatable to students' experiences and integrated ideas and skills from engineering careers and everyday technology. Five hundred and fifty boys and girls aged 6 to 11 took part in the study. **Findings:** The results suggest that when exposed to standards-based engineering learning activities, primary-aged school students demonstrated improved understanding of the work of an engineer, their own abilities to engage in science and maths problem solving, and their aspirations in becoming engineers compared to those in the control group. There was no main effect of gender on these outcomes, however, younger students exposed to the intervention had greater differences in engineering identity development compared to older students.

## LEARNINGS

**Start engaging girls with engineering and technology activities at a young age.** Research suggests that it is easier to influence girls' aspirations towards engineering and technology careers in primary schools compared to secondary school. At a young age, girls' attitudes toward STEM are more malleable. As they get older, societal and cultural influences, as well as peer pressure, can have a negative impact on their confidence and interest in these fields.

**Tailor the activity to the age of the students.** An outreach programme for primary school girls may be more impactful if the focus is on fun and interactive activities that introduce them to different engineering concepts and skills. It is important for engineering tasks to be authentic, relatable, and relevant to students' experiences and interests because it increases their engagement and motivation to learn.

**Include activities that challenge the gender stereotypes around engineering and technology.** Children begin to associate certain careers with gender at a young age, and these associations can shape their attitudes and beliefs about what they are capable of and what career paths are available to them. Providing activities that challenge these stereotypes may help children see that engineering and technology careers are for everyone, regardless of gender.

**Use age-appropriate evaluation methods.** Young children, especially those in primary school, have shorter attention spans, lower levels of comprehension, and may not be able to express themselves verbally or in writing as well as older students. Evaluation methods such as written surveys or focus groups may not be suitable for this age group. Instead, methods such as observation, drawings, and interactive activities may be more appropriate.

**Consider which outcome measures are going to be most insightful for this age group.** Primary students have many years between the time the intervention takes place and when they will start to make subject choices and career decisions. It may be more appropriate to measure intermediate outcomes such as enjoyment and interest in engineering and technology and the extent to which they would like to do more engineering and technology activities.

In 9 of the interventions the content and delivery of the programme was designed specifically for girls to align with girls' interests. In this section we look at whether these 'gendered' approaches had an impact on girls' career aspirations.

## OVERVIEW OF FINDINGS

Of the 9 interventions tailored to girls' interests, 5 found positive short-term effects on girl's engineering and technology career aspirations, one found adverse negative effects and 3 found either mixed results or no changes in girl's aspirations. A selection of the programmes are summarised below.

### Positive findings

**Social robotics** (Barco and others, 2019) investigated whether focusing on the social applications of robotics rather than the mechanical aspects increases girls' engagement with engineering and technology. Twenty-two girls aged 13 to 15 took part in a social robotics workshop where they were shown how robots can be used to help older people and children with disabilities and one mechanical robotics workshop which focused on the applications of mechanical engineering.

**Findings:** Social robotics classes were rated significantly higher than mechanical robotics classes in terms of interest, engagement, desire to take another class and motivation for STEM subjects and careers. The authors suggest emphasising the social applications of robots is a possible way to encourage more girls to study robotics.

**Hello Café** (Goodyer and Ishani, 2017) is a STEM club for girls designed around humanitarian engineering, based on research that women are more motivated to study engineering if they can make a difference to their community. One hundred and four girls aged 10 to 13 took part in the evaluation. **Findings:** There was an increase in the percentage of girls who said they were interested in being an engineer when they leave school, from 21% in the pre-survey to 30% in the post survey. In the post-survey, out of a list of 19 possible careers engineering was listed within the top 3 careers. The authors suggest that promoting engineering as a 'social benefit' can inspire girls to pursue engineering careers.

They also recommend that any outreach activities clearly explain the science principles behind engineering.

**LAUNCHPAD** (DeMatteis and others, 2018) is another programme themed around how engineering and computer science can make the world a better place. The decision for this theme was based on research suggesting that showing how engineering and computer science can be used to improve the environment and help others can have a positive influence on field of study and career choices of women. The activities were based around environmental research and how it is used in civil, mechanical and electrical engineering and computer science. Twenty-eight 16- to 18-year-old girls took part in the evaluation. **Findings:** The students were asked on a sliding scale what the chance was (in %) that they would study engineering or computer science. In the pre-survey the median percentage was 65% and in the post-survey it was 78%. The study found that students' positive responses to the LAUNCHPAD program persisted after 3 months, and the open-ended survey responses reinforced these results. Students reported an increased understanding of engineering and computer science and improved confidence in their abilities.



## Mixed findings/no difference

Solder and wire or needle and thread (Davis, 2016). Twenty participants aged 11 to 14 took part in one of 2 workshops. One involved a 'feminised' activity on the topic of electric fashion using 'Adafruit Flora' kit designed for girls. The second workshop involved a more traditional electronics activity using 'Arduino Leonardo' kit. A control group (n=29) took part in another workshop offered by the school.

**Findings:** There were no significant differences in attitudes from pre-workshop to post-workshop for either the feminised or traditional treatment groups.

## Negative findings

**Digital Divas** (Lang and others, 2014) used a participatory design approach in collaboration between researchers, teachers and students to ensure that the curriculum materials, website and design of the programme were strongly skewed to the interests of female students in lower secondary school. The resulting content was strongly visual and focused on health, diet and body image. **Findings:** After participating, girls disagreed more strongly that they wanted to study computer science in their senior years of secondary schooling or wanted to pursue a career in computing. The lack of short-term attitudinal change may be due to factors such as the availability of choices to high-achieving girls, lack of technical self-efficacy of teachers, or unrealistic expectations from a short intervention program.

## LEARNINGS

**Provide training on gender-inclusive pedagogy** to the facilitators, administrators, and volunteers that will be involved in the programme.

**Learn about the needs, interests, and preferences of girls when designing the outreach programme.** This can be done through conducting surveys, focus groups, or interviews with girls to identify their STEM-related interests, strengths, and challenges.

**Be mindful of the over-use of 'pink tech' in STEM outreach activities for girls.** 'Pink tech' refers to technology products or marketing designed to appeal specifically to girls or women, often by using stereotypically 'feminine' themes, or aesthetics. While the intention may be to make STEM more appealing to girls, this approach can reinforce gender stereotypes and limit girls' exposure to a full range of STEM fields and applications.

**Create a welcoming environment where girls feel comfortable participating.** This can be achieved through fostering a sense of community through teamwork and collaboration, providing positive feedback and encouragement, addressing concerns and questions and using diverse role models.

**Be conscious about how roles are assigned or chosen.** If running an intervention with a mixed-gender group of students and actively try to counter the take up of gendered roles (such as boys coding and girls presenting).

**Understand the limitations gender as a binary concept.** There are practical reasons why programmes categorise students into 'male' or 'female' but gender identity is more nuanced than this. Consider including a wider list of gender identities (for example questioning or non-binary) when collecting gender data.

## EXAMPLE OF A PROGRAMME DESIGNED SPECIFICALLY FOR GIRLS: HELLO CAFÉ

A New Zealand national outreach program-inspiring young girls in humanitarian engineering (Goodyer and Ishani, 2017)

### Purpose

The objective of the program was to raise aspirations of young girls to pursue a career in engineering, by demonstrating the social benefits of engineering and thus develop enthusiasm for STEM subjects applied in the context of humanitarian engineering.

### Participants

104 girls aged between 10 and 13 from underprivileged communities were recruited for the study. The program was marketed in a way that did not initially associate it with engineering or technology, which they called 'engineering education by stealth'. The name 'Hello Café' was deliberately chosen to create a friendly and welcoming environment.

### Delivery model

Hello Café was run as an afterschool club for girls where they meet over 10 weeks to solve problems faced by communities in need. The program consists of 10 practical and hands-on workshops that focus on the social benefits of engineering. The aim is to indirectly introduce engineering and technology to the girls by focusing on 'helping people first' using an engineering education by stealth strategy. The program also aimed to challenge stereotypes and provide long-term mentorship from a woman engineer.

### Evaluation

A survey was used to explore girls' understandings and perceptions of engineering before and on completion of the Hello Café program.

### Findings

In the initial survey, 21% of the girls expressed interest in becoming an engineer, while 16% said they were not interested. After completing the program, the percentage of girls interested in engineering increased to 30% and the percentage not interested decreased to 9%. The survey also asked about career aspirations and showed that science was in the top 3 careers before the program, but dropped to 9th place afterwards. Engineering was listed in the top 3 careers in the post-survey.

### Discussion and lessons learned

This programme was only a pilot and significance testing was not reported which limits interpretation of the findings. The authors attribute the program's success to several factors, including the quality, type, environment, and quantity of workshops. The program's instructional approach emphasised group work and hands-on learning in a supportive and enjoyable atmosphere, which was distinct from the girls' school experiences and may be better suited to their needs and learning styles. The involvement of early-career women engineers in facilitating the workshops was seen as crucial, as their enthusiasm and energy portrayed engineering as a positive career choice. The authors recommended that when conducting engineering activities there should be a clear message conveyed to show how engineers contribute to society and its goals and values. Additionally, they advise that any outreach program should establish a direct link between the scientific principles of engineering and the activities conducted.

Fourteen interventions included female role models and mentors within the programme. Role models contributed by giving talks about their experience of studying and working in the field, answering students' questions about their career journey, supporting students with activities and giving tours of their workplace or campus. Role models included industry professionals, academics, undergraduate students and alumni of programmes from previous years. Some programmes recruited 'near-peer' mentors while others recruited established professionals.

## OVERVIEW OF FINDINGS

Of the 14 interventions involving role models and mentors, 8 found positive short-term effects on girls' engineering and technology career aspirations, 2 found adverse negative effects and 4 found mixed results or no change.

### Positive findings

**FiERCE** (Bayerle and Scanlon, 2017) examined the effect of role-models and mentors on the attitudes and self-confidence of girls towards engineering. Throughout the programme mentors, students and engineers (when available) met bi-weekly to engage in hands-on activities. The programme involved 56 students and 10 mentors. **Findings:** Pre-post surveys found a +12% change in agreement with the statement 'I would consider a career in engineering'. Statistically significant increases were found in considering a career in engineering and confidence of being successful in engineering. The authors attributed the findings to both having a sustained program and the use role-models and mentors.

**CodePlus** (Lawlor and others, 2020), is a 4-day computer science programme for girls that included mentoring. Women from the technology industry and computer science undergraduates were trained in mentoring. Volunteers gave talks about their experience of studying and working in the field and participants were encouraged to ask questions of volunteers throughout the programme. A total of 856 participants were included in the evaluation. **Findings:** Small but

significant increases were found between students' pre and post workshop levels of agreement that they would like to do a computer science degree. The positive findings were attributed to the immersive nature of the programme which provided participants the opportunity to learn coding at an accelerated rate, supported by the mentors.

**LAUNCHPAD** (DeMatteis and others, 2018) is a summer camp which aimed to show girls how engineering and computer science can make the world a better place. Students were introduced to 2 groups of female role-models. The first were early career alumni with positions in local companies. The second were mid-senior level engineers and computer scientists. They discussed the challenges that women face in the workplace, hurdles that they overcame to be successful and benefits of engineering and computer science careers. **Findings:** Students were asked on a sliding scale what the chance was (in %) that they would study engineering or computer science. The pre-survey median percentage was 65% and in the post-survey it was 78%. From open-ended questions students reported a positive impact of panellists who showed them that it was possible to pursue an engineering career as a woman.

## Negative findings

**Girls for Science and Technology** (Bamberger, 2014) was a programme that involved taking 60 14- to 15-year-old girls on visits to a high-tech company and meetings with female role models.

**Findings:** The evaluators found that the interactions with the role models had adverse negative effects. Following the visit students were 'frightened', fewer students had positive perceptions of female engineers, fewer students thought they had the capability or interest to work in STEM and fewer students chose STEM subjects as majors. Possible reasons for this negative change include a cognitive gap between the scientific concepts used by the role models and the students' understanding, a developmental gap where middle-school girls perceive role models as 'too smart,' and a lack of long-term relationships between the girls and the role model women scientists.

**Digital Divas Club** (Lang and others, 2014) is a curriculum-based coding club for girls with an emphasis on role modelling. The programme had an informal mentoring aspect which linked the schools up with female university students taking computer science degrees (Expert Divas) who visited the club weekly. A group of 199 12- to 15-year-olds took the pre and post survey. **Findings:** Following the programme, girls disagreed more strongly that they wanted to study computer science in their senior years of secondary schooling or wanted to pursue a career in computing. The researchers found the negative results came from specific schools and the culture of the schools, socio-economic status, and technical self-efficacy of the teachers were factors that influenced the results of the programme.

## Mixed/no change findings

**Girl's Day Out** (Deckard and Quarfoot, 2014) is a full day STEM programme for middle school girls and their parents hosted at a university. It featured female STEM speakers, hands-on activities and tours of the college campus and engineering labs by female engineering students. Throughout the day students were encouraged to communicate with the engineering students. Thirty-eight students aged 10 to 14 took part in the evaluation. **Findings:** Interviews with participants revealed increased knowledge that women study engineering and become engineers, and belief that engineering is a suitable career for women. However, pre-post surveys showed no significant change in girls' agreement that they would like to study engineering or be an engineer when they grow up. Parent's beliefs saw more change but there was no correlation between beliefs of parents and their children.

**Girls and Computer Science Camp** (Hur and others, 2017) featured hands-on plugged and un-plugged computer science activities for 27 girls aged 10 to 16. A female computer science graduate who worked at a local IT company talked about her experience and answered participants' questions. Students also had a video call with a female computer scientist researching robotics who demonstrated several robots from her lab and explained how robots support human work. **Findings:** Interview data found that campers were interested in computer science related jobs but it was not their first career choice. Pre-post survey data found no significant differences in measures of computer science career aspirations. Students identified 3 key influences on their career aspirations: the desire to be helpful to others, affinity, and confidence. Girls wanting to study male-dominated fields had concerns about sexism.

## LEARNINGS

**Who role models are can make a difference.** The characteristics and backgrounds of role models can influence how effective they are. Students may relate more to role models who come from similar backgrounds or who have had similar experiences. However, this does not mean that role models need to be the same gender to have an impact.

**Longer-term role model relationships are likely to be more impactful than one-offs.** Longer-term relationships with role models allow for more consistent and in-depth interactions, with the potential for more meaningful long-term impacts on students' career aspirations.

**Role models should be able to interact with students at their level and with age-appropriate language.** Effective role models are able to connect with students on their level, using language and communication that is appropriate for their age and developmental stage.

**The use of near peer role models can help bridge the developmental gap between students and professionals.** Near-peer role models, such as university students or young professionals, can be particularly effective at inspiring and motivating students. These individuals are often closer in age to the students they are mentoring and may be more relatable, making it easier for students to envisage themselves in similar roles.

**Role models should talk about difficulties and challenges, not just successes.** Effective role models are open and honest with students about their struggles and challenges, not just their successes. This can help students understand that setbacks are a normal part of the learning process, and that resilience and perseverance are important qualities to develop.

**Mentoring is a skill and requires support and training.** Effective mentors need to be able to communicate effectively, listen actively, provide guidance and support, and manage expectations. Training and support can help mentors develop these skills and become more effective role models for their students.

**It is important to be aware of the potential negative effects of ineffective mentoring.** If a mentor or role model is not seen as approachable or relatable, they may not be able to effectively connect with young people and may even discourage them from pursuing careers in these fields. If young people feel intimidated or overwhelmed by their mentors or role models, they may start to believe that they are not cut out for careers in engineering or technology.

## EXAMPLE OF A PROGRAMME WITH FEMALE ROLE MODELS: CODEPLUS

‘CodePlus’ – Measuring short-term efficacy in a non-formal, all-female computer science outreach programme (Lawlor and others, 2020)

### Purpose

The purpose of this study was to assess the short-term effectiveness of CodePlus, a non-formal, all-female computer science outreach program aimed at enhancing participants’ perceptions and confidence around computer science and increasing their intention to study computer science at college.

### Participants

The study recruited 865 15- to 16-year-old girls from 30 schools in the Dublin area, specifically from socio-economically disadvantaged areas, through the Trinity Access programme.

### Delivery model

This was an intensive programme which gave an opportunity to engage participants in a number of activities that developed their programming skills and knowledge. The 4-day programme consisted of 3 main components: societal implications of computing, computational thinking, and computer programming. Participants explored technology in various fields, designed and developed prototypes for new technologies, and learned programming languages such as Scratch and Python. They also presented their projects to the group and received mentoring from female volunteers from the technology industry and computer science undergraduates. The volunteers gave talks about their experiences in the field and participants were encouraged to ask questions and seek guidance throughout the programme.

### Evaluation

Surveys were administered to students at the beginning and end of the 4-day programme. The survey asked question about computer self-efficacy, intentions to study undergraduate computer science, perceptions of

the IT profession and undergraduate computer science courses.

### Findings

Statistical analysis showed a small but significant increase in participants’ intention to study computer science and confidence in being accepted to study a related course.

### Limitations

Caution should be taken in interpreting the findings due to the subjective nature of self-reported programming ability and knowledge. The study was only designed to measure short-term effects of the programme, so it is not known how far the programme had an impact on students’ long-term study and career decisions.

### Conclusion

The conclusion highlights the importance of non-formal, all-female computer science outreach programmes in addressing the gender gap in computer science and the need for continued research to understand their long-term impact and effectiveness.

Ten interventions included explicit career elements to inform students about engineering and technology careers and educational pathways. Activities included careers presentations, workshops, visits to companies, tours of university departments, discussions with professionals, careers fairs and QandA sessions with professionals.

## OVERVIEW OF FINDINGS

Evaluation findings of these interventions showed 6 had positive outcomes on girls' career aspirations, 3 had no effects and one had a negative effect. Some examples of these studies are outlined below.

### Positive findings

**POWER summer camp** (McCormick, Tabert-Hatch and Felhaus, 2014) was a weeklong residential camp featuring a range of activities linked to higher education and careers including a visit to an engineering company, a professional roundtable, a hands-on workshop providing an overview of different engineering disciplines, lunch with university faculty and a college information workshop. The participants were 50 high school students. As the programme was voluntary it was assumed that they already had some level of interest in engineering as a possible career choice. **Findings:** There was a positive correlation between attending the POWER Summer Camp and pursuing engineering as a university course. The majority of past participants chose engineering as their major, and even after accounting for those who didn't persist, a significant number remained in engineering.

**Girls Technology Day** (Sabin, Snow and Laturneau, 2015) is run by Georgia Tech's Institute for Computing and Education. Throughout the day interactive workshops demonstrated the collaborative, creative and stimulating nature of computing and allow girls to interact with university faculty and computing and engineering professionals. A college and industry fair was held to give students an opportunity to learn about computing and engineering academic programmes and

careers. Forty-seven matched pairs of pre and post survey responses were used in the evaluation.

**Findings:** Statistically significant gains in girls' attitudes towards computing and engineering were found in the areas of enjoyment, intention to persist, and motivation to succeed, with the largest impact on enjoyment. The effect sizes were small to medium.

### Mixed/No change findings

**Women in STEM workshop** (Krayem, Kelly, McCauley and Bugallo, 2019) was a one-day workshop hosted by Stony Brook University where 32 pre-university female students interacted with female STEM professionals. Along with hands-on activities, students listened to talks from professionals about their research and career journey and from the university about their courses and curricula. The majority of participants (78%) in the workshop had no prior experience with engineering, and for many of them, this was their first opportunity to engage with an engineering project. **Findings:** The study found overall improvement in attitudes towards engineering, with large effect sizes for both engineering confidence and knowledge about pathways. However, participants' interest in engineering did not show significant improvement.

**GET IT** (Outlay, Platt and Conroy, 2017) is a multi-phase interactive presentation about IT careers. The programme begins by asking participants about their knowledge of technology careers and their preconceptions. The presenter then introduces various IT careers and roles through interactive tasks. Campers receive additional information about IT careers at the end. Thirty girls aged 11 to 14 took part in the study.

**Findings:** At the end of the camp, the campers' interest in IT careers increased, but their interest had decreased when they returned their pre-camp surveys the following year.

### Negative findings

**Girls for Science and Technology** (Bamberger, 2014) is a programme from Israel which involved taking girls to visit a high-tech company and meeting with female scientists who worked there.

**Findings:** When compared to a control group of students from the same classes, fewer students who went on the trips had positive perceptions of female engineers, fewer students thought they had the capability or interest to succeed in STEM and fewer students chose STEM subjects as majors.

## LEARNINGS

**Provide guidance on next steps towards engineering and technology careers.** Resources should be available during the intervention to help students, teachers and parents understand the types of engineering and technology careers available and what education and skills are needed to succeed.

**Let students know that the skills they are learning are essential in engineering and technology careers.** Demonstrate how the hard and soft skills developed in the programme such as problem-solving, collaboration, coding, data analysis, innovation and creativity are applicable to engineering and technology careers.

**Involve local companies.** This could be through site visits, guest speakers, mentors or sponsorship. By partnering with local businesses students get real-world insights into potential career opportunities. Additionally, companies can benefit from developing relationships with future talent.

### **Connect with universities and training providers.**

Events hosted by universities and colleges provide girls with a better idea of what it might be like to study engineering or technology after school, making it seem more accessible to them. Access to laboratories, equipment, and other resources can enhance hands-on learning experiences for students.

**Ensure that careers resources do not reinforce stereotypes.** One way to do this is to showcase examples of diverse role models and success stories. By highlighting the accomplishments of women from different backgrounds and identities, students can see that there are many paths into engineering and technology fields.

**Showcase a range of engineering and technology careers.** Exposure to a variety of roles available in engineering and technology may help students find something that fits with their interests and self-image and may encourage them to consider careers in areas they may not have previously known about.



## **EXAMPLE OF A PROGRAMME WITH LINKS TO HIGHER EDUCATION AND CAREERS: FIERCE**

**FiERCE: Empowering girls in engineering through role-models and mentoring (Bayerle and Scanlon, 2017)**

### **Purpose**

The primary purpose of this study was to examine the effect of role-models and mentors on the attitudes and self-confidence of middle school girls towards engineering.

### **Participants**

The study from the USA involved 56 middle school girls who were paired with 10 female undergraduate engineering students. The participants completed an early assessment of attitudes and confidence level regarding STEM before the activities began.

### **Delivery model**

This was a small-scale programme delivered over multiple weeks. During the programme, mentors, middle school students, and engineers met bi-weekly to engage in hands-on activities designed to provide a structured introduction to engineering in a fun and interactive way. The programme included short lectures before each activity to introduce the content. Mentors were responsible for directing the activity for their group of 3 to 5 students.

The activities were designed to emphasise creativity and problem-solving and ranged from short, one-off activities to complex activities such as 3D modeling and printing which required significant interaction with mentors. Each activity incorporated a testing station, where the students could explore the effects of various relevant variables. The 'introduction to real-world engineering' design problem was introduced as an open-ended problem to solve for a client. The final solutions were showcased in an evening event at Penn State Berks University, where students presented the process and products, demonstrating not only the technical aspects of their work but also the soft skills required in the engineering profession.

### **Evaluation**

The middle school participants were asked to rate their responses to 46 questions on a 7-point Likert scale. The statements included 'I would consider a career in engineering' and 'I believe I can be successful in a career in engineering'. The same surveys were given to the participants before the start of the programme and after its conclusion.

### **Findings**

There were statistically significant increases in consideration of a career in engineering and confidence in succeeding in such a career. Notably, the most significant changes were in perceptions, particularly with regard to their abilities compared to male counterparts, confidence, and opinions of engineers.

### **Discussion and lessons learned**

The authors attributed the positive findings to the sustained programme and the presence of role-models and mentors. They concluded that the success of the programme indicates that exposing young girls to mentors and role-models in the engineering field can foster problem-solving, creative thinking, and real-world engineering skills.

Most of the published evaluations of summer camps comes from the USA, which has a strong culture of providing summer camps to school students. Summer camps provide useful insight into the impact of high intensity interventions. Eight of the interventions were summer programmes that lasted between 3 days and 2 weeks.

## OVERVIEW OF FINDINGS

6 of the summer camps had positive findings and 2 found mixed outcomes.

### Positive findings

**App Camp** (Clarke-Midura, Sun and Pantic, 2020) was a mixed-gender week-long summer camp where mentors teach students to code apps with MIT App Inventor. Overall, 78 girls and 65 boys with an average age of 12 to 13, were recruited either locally or from across the state. They recruited through schools, targeting those serving high numbers of low-income families.

**Findings:** For girl campers, there showed a large effect size for increase in self-efficacy and a medium effect size for increase in interest in computer science.

**GEAR UP** (Mahmoud and others, 2018) is a 7-day mixed-gender summer camp where participants developed and tested engineering research hypotheses and presented results in a poster session. Twenty-one girls and 15 boys aged 13 to 15 took part in the evaluation.

**Findings:** Girls started with lower interest than boys in all STEM subjects except mathematics. At the end of the camp, girls had gained more interest in all the fields and ended the camp with equal or higher interest than boys in all the fields.

**POWER summer camp** (McCormick, Talbert-Hatch and Felhaus, 2014) is a week-long residential camp for high-school girls which included a range of activities (such as visits to an engineering company, team-based projects, hands-on activities, and a lunch with engineering faculty). Fifty girls and women who had previously attended the camp took part in the evaluation.

**Findings:** More alumni from the summer camp went on to study engineering courses compared to other subjects, but the research design does not allow any inference about the effect of the camp on course choice. This may reflect the existing interests of those who chose to attend the camp.

**LAUNCHPAD** (DeMatteis, Allen and Ye, 2018) is a 2-week summer programme for girls exploring how engineering and computer science can make the world better. Each day had sessions on different fields of engineering and technology including civil, electrical and mechanical engineering and computer science. Twenty-eight girls aged 16 to 18 participated in the evaluation. **Findings:** In the pre-survey students said there was a 65% chance they would study computer science or engineering and in the post-survey this increased to 78%.

**Future Girls of STEM** (Lawlor, Byrne and Tangney, 2020) was a 4-day event led by an all-female faculty and run with industry partners. It was designed to teach girls about civil, environmental and industrial engineering, robotics, cybersecurity, and leadership. Participants were 856 girls aged 15 to 16.

**Findings:** Before the camp, 69% of campers indicated that they believed being an engineer is interesting, and 48% responded that they wanted to be an engineer. At the end of the camp, 92% of campers thought being an engineer would be interesting, and 64% wanted to be an engineer.

## Mixed/no change findings

WEAVE summer programme (Thompson and Zhang, 2020) was a 4-day summer school that aimed to teach girls about engineering through hands-on problem-solving activities, with a specific focus on biomedical engineering. Activities included the design and construction of a lower limb prosthetic and a bionic robotic hand and hands-on exposure to research-grade instrumentation within the CBRE lab. Twenty girls aged 15 to 16 participated in the evaluation.

**Findings:** Comparing pre- and post- responses, 8 female participants showed a change in scores relating to interest in pursuing engineering. Of these, 6 showed an increase in interest and 2 reported a reduced interest.

## Learnings from summer camps

**Summer programmes can provide more immersive and hands-on experience.** They allow participants to engage in engineering and technology in a more in-depth and meaningful way. Students can participate in experiments, build projects, and explore concepts in a way that is not always possible in a classroom setting.

**Many summer programmes are targeted at students who already have high levels of STEM aspiration and engagement.** This type of programme is high cost and high intensity and largely aimed at those who are already on a pathway to engineering and technology careers. It may be that these interventions are helpful at reinforcing STEM career aspirations rather than generating new ones.

**Be conscious about the inclusivity of summer programmes.** Summer camps can be expensive and inaccessible to many students. It is important to design the programme with mitigations to these barriers such as reserving places for students from groups underrepresented in engineering, offering bursaries, providing travel arrangements etc.

**Summer camps offer a chance for students to meet and collaborate with like-minded peers who share their interests and passions.** This can help to build a sense of community and support, which can be invaluable for girls who may not have many friends with the same interests in STEM within the classroom.

**Summer camps offer opportunities for teamwork and collaboration.** Group work provides students the opportunity to learn how to work effectively with others, which is a crucial skill in all engineering and technology fields. By working in teams, girls can develop communication skills, learn how to delegate tasks, and gain exposure to diverse perspectives, all of which are important in problem-solving and innovation. Additionally, collaborating with others can help girls build confidence, develop leadership skills, and establish a sense of community and support.

The following section outlines the limitations of the evidence included in the review and discusses their potential impact on the conclusions that can be drawn regarding the effectiveness of STEM outreach interventions.

**Variability in the extent and quality of the evaluation methods used to assess the effectiveness of the interventions.** Without rigorous evaluation methods, it is difficult to assess whether the intervention is achieving its intended outcomes, identify which components of the intervention are most effective, or understand how different factors such as the mode of delivery or the target audience can influence the effectiveness of the intervention.

**Most evaluations collected post-event data immediately after the activity.** One problem with this approach is that while participants may report increased interest and engagement in STEM immediately after the event, these effects may not persist over time. Without follow-up data collected weeks, months, or even years after the event, it is difficult to determine whether the programme has had a lasting impact on the participants' attitudes or behavior.

**Interventions use different approaches to recruit participants.** Some studies selected students who were already interested in or perform highly in STEM subjects. Others recruited from a whole class or year groups or from community organisations. It is therefore not always possible to separate the impact of the activity from the pre-existing interest or the wider factors influencing these young people.

**Many evaluations didn't have control groups** which makes it difficult to establish a causal relationship between the intervention and the observed effects. Without a control group, it is challenging to determine whether any changes observed in the treatment group were actually caused by the intervention or whether they might have occurred anyway due to other factors, such as natural variability.

**Most studies relied only on student's self-reported measures about how interested they are in or how likely they are to go onto engineering and technology careers.** Self-reported measures are subjective and may be influenced by various factors, such as social desirability bias, which is when participants respond in a way that makes them look favorable or how they think they should respond.

**Some of the evaluations included had very small numbers of participants.** Small sample sizes reduces the reliability and generalisability of the findings and increases the likelihood of making errors when interpreting findings.

**There is lack of consistency in terminology used to describe interventions.** This leads to ambiguity about what the intervention involves, making it difficult to compare across interventions and draw conclusions about the effectiveness of specific components and methods of the intervention.

While some of these interventions have shown promising results in increasing girls' aspirations for engineering and technology careers, there are still significant gaps in the literature on this topic. This section highlights some of the gaps and provides ideas for future research and practice.

#### Longitudinal studies tracking long-term outcomes of STEM interventions for girls

There are few longitudinal studies tracking students who participate in engineering and technology outreach through their education and careers. Longitudinal studies are crucial for understanding the long-term impact of interventions and identifying the factors that contribute to girls' sustained interest and participation in engineering and technology education and careers.

#### Coordination of a sustained programme of engineering and technology engagement

One-off interventions in isolation are unlikely to be sufficient to increase girls' aspirations for engineering and technology careers long-term. A sustained programme of engagement that begins early in their education and continues throughout their academic and professional careers is likely to be needed to have this impact. A sustained approach should provide girls with a range of opportunities to learn about engineering and technology, explore their interests, and connect with role models and mentors in these fields. It should also address cultural and societal barriers that discourage girls from pursuing careers in STEM. Sustained engagement requires collaboration between educators, industry professionals, policymakers, and parents to create a supportive ecosystem that fosters girls' interests and aspirations in STEM.

#### Greater focus on the differential impact of interventions.

Many intervention evaluations were excluded from this study because they did not measure the differential impact of their interventions by gender. It is crucial that programme deliverers and evaluators consider gender and other target demographic criteria when designing their interventions and collecting and analysing evaluation data.

#### More studies that focus on engineering and technology rather than 'STEM'.

Engineering and technology are distinct fields that pose unique challenges and require specific knowledge and skills. Girls often possess greater knowledge and understanding and more positive perceptions of science than of engineering and technology. The majority of papers in the academic literature use the term STEM making it challenging to distinguish between these individual fields.

#### Publication of evaluations from the UK

More evaluations of engineering and technology interventions from the UK should be published in the academic literature. Publishing evaluations not only helps to share best practice and lessons learned with other practitioners and researchers, but also provides evidence for policymakers and funders to support the development and scaling of effective interventions. Publishing these evaluations can help to ensure that more interventions are tailored to the specific needs and contexts of UK students and can inform policy and practice at the national level.

## DATABASE SEARCH

3 databases of scientific research were searched for relevant papers (ERIC, IEEE Explore, Science Direct). Additional searches were conducted using Google Scholar and through the references and citations of the studies included.

### Inclusion criteria

To be included in the review, papers must:

- clearly state the aims, participants, and context of the intervention
- evaluate the effectiveness of the intervention using quantitative, qualitative, or mixed methods
- either have a specific focus on girls or conduct differential analyses by gender
- have a specific focus on engineering and technology, rather than science or STEM more broadly

### Scoping criteria

Search results were narrowed down based on the following scoping criteria

Scope	
Location	OECD countries
Language	English
Date	2012 onwards
Setting	In and out of school settings
Outcomes measured	An increase in girls aspiring to a career in engineering and technology (including computing) or pursuing options that keep them on a career path including subject choice and next steps after leaving school
Population	Female students of school age (5-18)

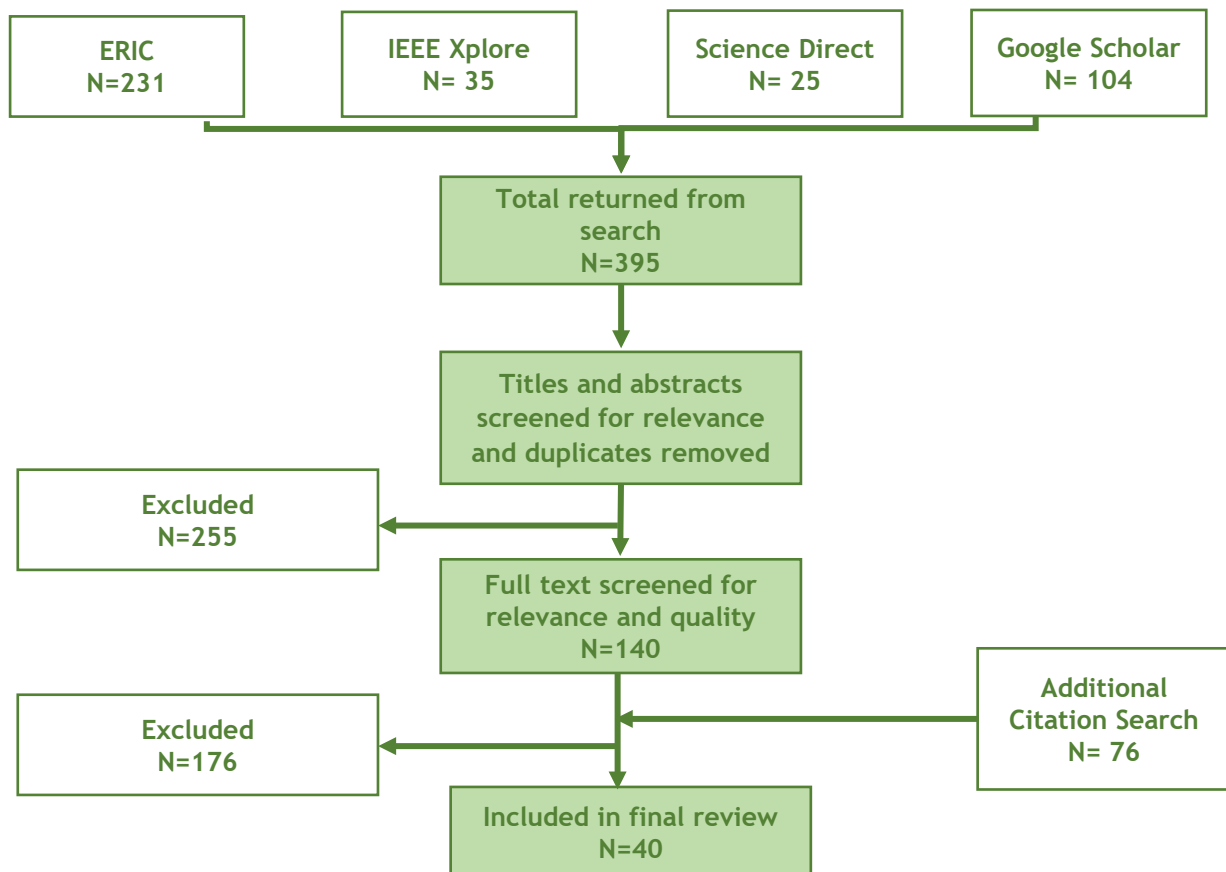
### Search terms

The databases were searched using the following search terms.

Concept	Search terms
Intervention	(Program* OR Interven* OR Workshop* OR Session* OR Club* OR Activit* OR Approach* OR "Extracurricular" OR Project)
Field	(Engineer* OR Tech* OR "Computer Science" or Coding)
Positive outcomes	(Aspir* OR Interest* OR Motivat* OR Choice* OR Choos* OR Selection OR Ambition) AND
Gender	(Gender OR Girl* OR Female*)
Career	(Job OR Career OR Study)
Context	(School OR Student*)

## SEARCH STRATEGY

The search strategy outlined in the diagram below was used to identify relevant papers for the evidence review. After an initial screening of abstracts, papers that did not meet the inclusion criteria were excluded. Further scrutiny of the remaining papers was conducted to ensure they were relevant and of reasonable quality. Finally, the papers that met both the inclusion and quality criteria were synthesised and analysed. A summary of all the papers included in the final review can be found in Annex B.



## Synthesis of final papers

The key features of the methodology and evaluation of the intervention in the final papers, as well as the key findings and discussion points, were extracted and summarised. This information was synthesised into a table, which allowed the different interventions and their outcomes to be compared and contrasted. The key learnings from the discussion sections of the papers were summarised to provide insights into the practical implications of the evaluations. These insights are summarised in the 'Learnings' throughout the report.

## Location

The majority of the published literature on STEM interventions comes from the USA, with a few studies coming from Europe, Australia and Asia. We found very few relevant UK evaluation papers published in academic journals.

Country	Number of papers
USA	27
Australia	3
Belgium	2
New Zealand	2
Ireland	1
Israel	1
Japan	1
Spain	1
Turkey	1
UK	1

## Type of interventions

Nearly half the interventions were delivered as classroom or school-based activities (20). Other types of interventions included summer camps (8), STEM clubs and workshops held in external venues (5), site visits/field trips (2) and competitions (2).

Context	Count
School/classroom	20
Summer camp	8
University	5
External venue	5
Competition	2
Site visit	2

## Gender and age

A little over half of the interventions were mixed gender (22) and the rest were for girls only (18). The majority of interventions were for students of secondary school age (25), with 10 aimed at primary aged students and 5 spanning both phases of education.

## Disciplines

As shown in the table below, there was overlap between disciplines covered in the interventions.

Disciplines	Count
Coding or computer science	6
Engineering	10
Engineering and design	1
Engineering and science	3
Engineering and technology	1
Engineering and coding	2
Engineering, computer science and robotics	1
Engineering, robotics and cyber security	1
Engineering, technology and robotics	1
Environmental engineering and computer science	1
Robotics	5
STEM/STEAM	4
Technology	3
Technology, computing and engineering	1
<b>Grand Total</b>	<b>40</b>



Authors	Country	Discipline	Simplified delivery model	Length of intervention	Gender	Phase of education	Sample	Relevant outcome measures	Overall findings
Johnsona and others (2012)	USA	Engineering	Careers materials	Less than 1 day	Mixed	Both	565	I would be interested in working as an engineer	Positive
Bamberger (2014)	Israel	STEM	Visit to an engineering/tech company	Mutli-week	Girls	Secondary	60	Future career choices	Negative
Deckard and Quarfoot (2014)	USA	Engineering	Full day programme	1 day	Girls	Secondary	38	Engineering awareness and pathways	No change for girls
DiDonato and others (2014)	USA	Engineering	Careers materials	Less than 1 day	Mixed	Primary	100	Interest in engineering career	No change for girls
McCormick and others (2014)	USA	Engineering	Summer camp	1 week	Girls	Secondary	50	College enrolment and chosen college major	Positive
Ardies and others (2015)	Belgium	Technology	Workshops	Mixed	Mixed	Secondary	2228	Technological career aspirations, interest in technology	Mixed
Bishop (2015)	USA	STEM	Sustained programme of engagement	Multiple years	Mixed	Both	46	Engineering career aspirations	Unsure
Capobianco and others (2015)	USA	Engineering, science	Engineering lessons and activities	Multi-week	Mixed	Primary	550	engineering aspirations	No effect
Lang and others (2015)	Aus	Computing; Engineering	STEM club for girls	Mixed	Girls	Secondary	199	Would you choose IT as a subject to study in VCE?; I would like a job working with computers when I finish studying	Negative
Robinson and others (2015)	USA	Computer science	Workshops	1 hour for 5 days	Girls	Secondary	37	Future plans in computer science	Positive
Sabin and others (2015)	USA	Technology, computing, engineering	A full day of a range of workshops	1 day	Girls	Secondary	47	I can see myself working in a technology field; I intend to take courses related to computing and engineering.	Positive
Ward and others (2015)	Aus	Engineering, physics, biology	Workshops	6 hours over 4 weeks	Mixed	Secondary	57	Interest in engineering career	Positive
Master and others (2016)	USA	Computer science	Experiment based on classroom design and setup	Less than one day	Mixed	Secondary	165	Enrolment interest	Positive

Authors	Country	Discipline	Simplified delivery model	Length of intervention	Gender	Phase or education	Sample	Relevant outcome measures	Overall findings
Sullivan (2016)	USA	Engineering, technology, robotics	Robotics classes	7 weeks - 1hr per week	Mixed	Primary	105	Would enjoy being an engineer	Positive
Witherspoon and others (2016)	USA	Robotics	Competition	Mixed	Mixed	Both	502	Motivation to do more	Negative
Bayerle and Scanlon (2017)	USA	Engineering		Bi-weekly	Girls	Secondary	56	I would consider a career in engineering	Positive
Davis and others (2017)	USA	Computing; engineering	Workshops	1 week	Girls	Secondary	49	Future career and educational goals	Neutral
Goodyer and Soysa (2017)	NZ	Engineering	STEM club	10 x 1.5 hour workshops	Girls	Both	104	Interest in being an engineer	Positive
Hur and others (2017)	USA	Computer science	Summer camp, hands-on activities, mentors	3 days	Girls	Secondary	27	Higher education and career aspirations	No difference
Master and others (2017)	USA	Robotics	Robotics session	20 minutes	Mixed	Primary	96	Programming interest, robot interest	Positive
Outlay and others (2016)	USA	IT	Interactive careers presentation	1 hour	Girls	Secondary	30	Interest in IT careers	Mixed
DeMatteis and others (2018)	USA	Engineering, computer science	Engineering summer camp	2 weeks	Girls	Secondary	28	College and Engineering Intent	Positive
Mahmoud and others (2018)	USA	Engineering	Summer camp	1 week	Mixed	Secondary	33	I am interested in careers that involve engineering/technology	Positive
Miller and others (2018)	USA	STEM	STEM competitions	Long term	Mixed	Secondary	15,847	Interest in a career in engineering	Positive
Barco and others (2019)	NZ	Robotics	Workshop	2x0.5 hour workshops	Girls	Secondary	22	Motivation for STEM subjects and careers	Positive
Krayem and others (2019)	USA	STEM, engineering	Activities, talks and careers advice	1 day	Girls	Secondary	32	I am interested in engineering and science careers	No effect
Ozogul and others (2019)	USA	Engineering	Workshop	1 day	Mixed	Both	3344	I would like to learn more about engineering (interest)	Negative

Authors	Country	Discipline	Simplified delivery model	Length of intervention	Gender	Phase of education	Participants	Relevant outcomes	Overall findings
Sullivan and Bers (2019)	USA	Engineering, technology, robotics	Robotics sessions	1 hour for 7 weeks	Mixed	Primary	105	Desire to be an engineer	Positive
Clarke-Midura and others (2020)	USA	Computer science	Summer camp	1 week	Mixed	Secondary	78	Interest in CS	Positive
Emembolu and others (2020)	UK	STEM	Series of workshops	Several workshops 1 hour each	Mixed	Primary	700 (350 each year)	Jobs I would like to do	Mixed
Essig and others (2020)	USA	Engineering	Summer camp	4 half days	Girls	Primary	19	I want to be an engineer	Positive
Lawlor and others (2020)	Ireland	Computer science	Project work, female mentors, speakers	4 days	Girls	Secondary	856	I intend to do a degree in computer science and I would like to do a degree in computer science.	Positive
Ng and Fergusson (2020)	Aus	STEAM	Project work	Mixed	Girls	Secondary	352	I would consider studying these subjects at university	Neutral
Thompson and Zhang (2020)	USA	Biomedical engineering	Summer school	4 days	Mixed	Secondary	24	Interest in pursuing engineering	Mixed
Kijima and others (2021)	Japan	STEAM	Workshop, mentors, site visit	4.5 days	Girls	Secondary	97	Interest in engineering	Positive
Stanberry and others (2021)	USA	STEM, engineering, coding, robotics	Series of STEM enrichment classes	Unknown	Mixed	Secondary	100	Subsequent enrolment in future STEM courses	Negative
Boeve-de Pauw and others (2022)	Belgium	Technology	Series of workshops	1 day	Mixed	Primary	1496	Technological career aspirations	Positive
del Olmo-Muñoz et. Al (2022)	Spain	Computer science	Series of workshops	3 x 45 minute sessions	Mixed	Primary	84	I will probably choose a job in technology; I would enjoy a job in technology; I would like a career in technology later on; Working in technology would be interesting	Positive
Mitchell and others (2022)	USA	Engineering, coding	Series of workshops	2 weeks	Mixed	Primary	15	Interest and engineering identity	Positive
Tekbiyik and others (2022)	Turkey	Robotics	Robotics camp	6 days	Mixed	Secondary	32	Engineering and technology career interest	Mixed

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