Engineering in the community
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Abstract
The purpose of this project was to investigate the application of the concept of ‘community engineering’ as a method of engaging girls and black and minority ethnic school children with STEM subjects. The paper describes a community engineering project that was carried out by London South Bank University as part of its outreach programme and shows that the pupils who took part were motivated by the activities and that their awareness of the uses of engineering was expanded. There was also evidence that the student ambassadors who took part benefited from the experience. The project outputs can be transferred to STEM clubs in schools which are fertile ground for project based activity

Keywords: diversity, STEM, engineering, community, student ambassadors, graduate employability

Background
The pupils that were selected to take part in this project were from two schools: Nightingale Academy in the borough of Enfield and Stratford School in Newham. The project was run during after-school STEM clubs. 15 year 11 pupils took part at Nightingale Academy and 25 year 8 pupils took part at Stratford School.

Ten student ambassadors from the Faculty of Engineering, Science and the Built Environment at London South Bank University (LSBU) delivered the project and staff from the faculty helped to develop a brief.

Rationale
The project pilots the application of community engineering projects, similar to those developed in some US universities (such as EPICS at Purdue). In these, colleges and higher education (HE) students develop engineering solutions to small-scale problems identified in the local community. Through problem-based learning, the project intends to encourage school pupils to study science, technology, engineering and mathematics (STEM) subjects at HE level, illustrate career and course options in STEM and demonstrate the importance of engineers and engineering.

The project addresses LSBU’s Faculty of Engineering, Science and the Built Environment’s plans to increase widening participation activity. It also aims to inform groups that are currently under-represented in STEM about the career options available to them in this field.

Student ambassadors were recruited to deliver the project as the involvement of school pupils with university and employers has been shown to enhance their performance and facilitate their progression to HE (Gartland, 2009). It was also expected that student ambassadors would gain transferable skills, as research has shown that leadership and communication skills of HE students are strongly enhanced through working with school pupils (Ylonen, 2010).
Through *Engineering in the Community*, participants receive an enhanced experience of engineering; both student ambassadors and school pupils gain valuable experience of tackling real engineering problems.

**The approach**

*Engineering in the Community* was coordinated by the Schools and Colleges Team at LSBU which falls within the Marketing and UK Student Recruitment department. It was supported by staff and student ambassadors from the university’s Faculty of Engineering, Science and the Built Environment.

The project introduced young people to the concept of community engineering by tasking them with the development of engineering solutions to small-scale problems identified in their community.

Professor John Parkin, Professor of Transportation and Course Director for Transport Engineering and Planning, was initially approached to produce a brief for pupils. He developed a number of ideas. One focused on building a cable car from Greenwich to the Isle of Dogs for the 2012 Olympics and Paralympics. This idea was the basis for the final project brief; pupils were encouraged to think about how the Olympic and Paralympic games will affect their community and how they, as engineers, would develop solutions to potential problems. With the Olympics taking place in London, it was thought that participants would be engaged by an issue that was topical and relevant to them.

According to *Getting Girls into Engineering: a Practical Guide*, “Activities that are put into a societal, environmental or ethical context will instantly engage girls more than ones which are not, without disengaging boys” (The Royal Academy of Engineering, 2010). This project was therefore particularly suited to engagement with female pupils.

Engineering in the community was originally intended for students of the 14–19 Diploma in Engineering; however, it wasn’t possible to recruit pupils from these courses. Many teachers felt that the Diploma already incorporated a sufficient number of activities and also that pupils would be limited in terms of time. Most of the schools with which the LSBU Schools and Colleges Team engage have since dropped the course.

Through the Science, Technology, Engineering and Mathematics Network (STEMNET), the Schools and Colleges Team approached science and engineering clubs in secondary schools to take part in the project. It proved popular, with a number of schools signing up to take part. Club leaders were enthusiastic at the prospect of being able to run a hands-on, five-week project with the support of a university and student ambassadors. The original target group was key stage 4 pupils. The two schools that were selected were Nightingale Academy and Stratford School. Nightingale Academy was selected because the pupils that attend the engineering club are in Year 11 and this offered an opportunity to pilot the project to the intended age group. Although the Stratford School pupils were in year 8, the school is located in Newham, home to the Olympic and Paralympic site.

Teachers were briefed on the aims and benefits of the project and asked to encourage girls to attend the club. At Nightingale Academy there were 15 participants, 11 female and four male. At Stratford School there were 25 participants, 20 male and five female. One of the target groups for the project was black and minority ethnic (BME) pupils and schools were chosen in areas where there are high numbers of pupils from these groups. Over 70% of the participants at Nightingale Academy were from BME groups and at Stratford School all of the participants were from BME groups.

Student ambassadors from the Faculty of Engineering, Science and the Built Environment were recruited to deliver the project. Working with student ambassadors gave pupils the opportunity to ask general questions about university and student life as well as engineering courses. Ten student ambassadors, of which half were female, were recruited to take part in the activity. All of the ambassadors had been through a recruitment and selection process and had attended the LSBU student ambassador training (this included sessions on communication, diversity
awareness, creating a rapport, health and safety and child protection). In addition, these ambassadors attended STEM outreach training (which covered gender and diversity awareness and how to run STEM activities). All student ambassadors had previous experience of working with young people. The ambassadors were paid for their involvement in the project.

All ambassadors attended a one-hour training session. They were given the project brief and information on the clubs. They were provided with facts and articles on how the Olympics may affect Londoners and commuters to the Olympic site and were also encouraged to do their own research prior to the first session. Two ambassadors were selected as ‘lead ambassadors’ to deliver the project and act as the main point of contact between the school club leaders and the Schools and Colleges Team.

Engineering in the Community aimed to equip student ambassadors with transferable skills that would make them more employable. It was hoped that, through leading and delivering the project, ambassadors would develop their interpersonal, leadership and teamwork skills. The practical approach of the project and the research involved meant that it also gave the students experience of tackling real engineering problems.

The project ran over five weeks as follows:

**Week 1:**
- Ambassadors introduce themselves. Lead ambassadors introduce project brief (including information on how the Olympics will affect the pupils' community and visitors to London during 2012).
- Groups split into teams of four/five. Groups assigned an ambassador. Ambassadors work with groups to brainstorm ideas and identify an issue affecting their local community with a focus on the Olympics. Ambassadors help teams to develop their ideas into their own specific project brief.
- Groups produce detailed project plans (e.g. what they will do in sessions, what each team member is responsible for, etc.).

**Week 2:**
- Ambassadors work with pupils to design a solution to the issue that they have identified.
- Ambassadors provide pupils with a materials list (this included a variety of items such as pipe cleaners, string, straws, buzzers, motors, LED lights, plastic sheets, small light bulbs, wheels of different sizes, felt and pipe cleaners, etc.) and pupils produce a ‘shopping list’ of materials. Pupils are shown examples of these items so that they know what they are and how they work.

**One week break**
- Ambassadors spend time preparing a list of additional materials that pupils would need.
- Lead ambassadors research how project designs will be put into practice.

**Weeks 3 and 4:**
- Teams receive materials and make models.
- Teams begin posters and presentations to showcase their designs.

**Week 5:**
- Teams present their ideas to guest student engineers.
- Pupils awarded prizes for taking part.

Teachers were responsible for encouraging pupils to work on their projects outside of club sessions; however, one of the limitations of the project was the time period. The pupils were able to complete a project, but some groups would have benefited from more sessions.
LSBU provided materials for the project, but teachers were asked to provide an appropriate work space and tools for the pupils (such as pens, scissors, cutting instruments, drills, etc.).

**Evaluation**

*Engineering in the Community* gave pupils an opportunity to tackle real-life engineering problems that affect their community. As the project was practical, pupils were able to see that engineering is a hands-on and creative career.

Student ambassadors had the opportunity to develop their employability skills. All of the ambassadors involved were responsible for presenting to the groups, working with pupils on a one-to-one basis and leading their teams, which helped them to develop their communication and interpersonal skills as well as their leadership skills.

Evaluation for *Engineering in the Community* was focused on the outcomes and benefits to the student ambassadors and school pupils.

**Student ambassadors:**

Student ambassadors were interviewed about their role in the project to find out how their employability skills had been improved. All of the ambassadors stated that their employability skills had been improved (see below).

All of the ambassadors agreed that presenting to the groups and working with the pupils one-to-one had improved their communication skills. One lead ambassador stated that the project had allowed him to practice communicating with individuals at different levels (i.e. teachers, project coordinators, young people and fellow ambassadors) and that this had helped him to improve his interpersonal skills. Another ambassador stated that in order for the pupils to understand and engage with the project he had to ensure that he provided clear instructions and avoided using technical jargon. This had made him more aware of how he communicates information.

Each ambassador was responsible for a team of pupils and often had to take charge of the groups and motivate them. Many of the ambassadors said that their leadership and teamwork skills had improved as a result. Again, the lead ambassador particularly benefited from having additional responsibilities: “I realised that there has been a marked improvement in the way I worked with my teammates”, he states, “I had to delegate tasks to my fellow ambassadors and assign support to the teams. I made sure that roles were shared in such a way that no one felt left out of important tasks, which I believe helped to develop their abilities and promoted good team spirit.”

Some of the ambassadors felt that they had benefited by practising their engineering skills: “As well as allowing me to use my people skills I had the opportunity to put my scientific knowledge to good use. It may have been for this project but these skills are transferable and will be useful in other places where I will be working in the future.”

Some of the ambassadors felt that they had already developed good employability skills through other student ambassador projects and activities, but felt that this project had been another opportunity to practice and strengthen these skills further.

One of the unexpected benefits of the projects was that some of the ambassadors believed that it had helped them to improve their timekeeping and organisational skills.

**Pupils:**

Pupils were given evaluation forms at the beginning and at the end of the project. Only pupils that completed evaluation forms at the end of the project were counted in the surveys. 13 pupils from Nightingale Academy and 15 pupils from Stratford School completed evaluations. Teachers and ambassadors were also interviewed about how they felt the project had benefited the pupils.

At the beginning and the end of the project pupils were asked if they were good at maths, science and design and technology. This was in order to see if the project had improved the pupils’ self-perceived skills in these areas. The changes in this area were minimal, with a maximum of only three pupils changing their answers to ‘yes’ in any subject. However, a large proportion of pupils
had answered ‘yes’ to these questions at the beginning of the project and no student had answered ‘no’ to more than one of these questions.

The pupils were asked at the beginning and end of the project what they understood by the term ‘community engineering’. A few participants had not developed a good understanding, many of the pupils already had an understanding but, overall, pupils in both schools had a better understanding of the concept at the end of the project. This is illustrated by some of the answers to the question ‘What do you understand by the term ‘community engineering’?’:

**Participant A** Answer 1: “I understand that it is a community of engineers.” Answer 2: “A group of engineers working together to make a community a better place.”

**Participant B** Answer 1: “Engineering for our community and the public.” Answer 2: “It means trying to work out solutions to help the community through engineering.”

**Participant C** Answer 1: “Fixing computers.” Answer 2: “Engineering solutions to problems within the community.”

All of the pupils were asked if they enjoyed the project. 100% of the pupils answered ‘yes’ to this question.

The pupils were asked what they enjoyed most about the project. A large number of pupils in both schools answered that they enjoyed working in teams – this was an unexpected outcome. A large number of pupils said that they had enjoyed making the project and putting their ideas into action. Many of the ambassadors and both teachers felt that the pupils had really benefited from being able to explore their creativity and build a model: “The thing that really interested the pupils was just being able to design something and see it come to life”, said one ambassador. Mr James Benson (Nightingale Academy) agrees: “It makes the pupils more enthusiastic about school […] some of them can be deflated by sitting in lessons.”

When asked what they would change about the project, most of the pupils answered that they would have liked more time to complete it. The ambassadors also felt that the project should have been longer. Some of the pupils said that they would have liked more materials to work with.

Both of the teachers agreed that the pupils particularly benefited from working with student ambassadors: “The ambassadors bring energy and enthusiasm into the classroom and are able to deliver projects in new and exciting ways”, states Mr Daniel Ligget (Stratford School). Mr Benson adds: “My pupils have benefited massively from this project, particularly working with the student ambassadors.”

Mr Benson felt that the project helped pupils to become more engaged in design and technology and careers in this area: “It makes them realise that there are people who do engineering jobs and things don't just appear. It also helps our pupils to realise what paths they are able to follow in order to pursue a career in engineering. I signed the club up to help promote STEM within the school and encourage pupils into design and technology in key stage 4 and 5. Trying to promote with pupils, parents and some staff that design and technology isn’t just cooking and woodwork but is key to developing pupils who are successful in engineering careers in the future, and design and technology is an important aspect of STEM, not merely an add on.”

All of the ambassadors interviewed felt that the pupils had enjoyed the project and that they had benefited in some way. Most of the ambassadors agreed that the focus on ‘community engineering’ taught the pupils how engineering was applied in an everyday situation, which made it more relevant. They also felt that the theme of the Olympics was topical and therefore of interest. One ambassador said: “It really made them think about the world around them and the engineering that went into things they use every day like escalators and planning for the Olympics.”

An unexpected benefit of the project was that some ambassadors felt that the pupils’ self-confidence had been boosted as a result of seeing their designs come to life. One ambassador stated that even the pupils who had been quieter and less confident in sessions were proud of their work and had wanted to present their ideas in final sessions.
Overall the ambassadors found that girls were very engaged in the project, particularly at Nightingale Academy where there were a large number of female pupils participating.

Another positive outcome of the project was that it had also encouraged the pupils to consider sustainability. One ambassador stated: "I am sure the brainstorming session that preceded the development of the model has helped them to be more proactive, not just thinking about a model that can work, but a model that will be environmentally friendly, [have] post-Olympic functionality and very importantly its energy source dependence with regards to renewable and non-renewable."

Discussion, summary

The evaluations showed that all of the pupils had enjoyed participating in *Engineering in the Community*, particularly as it had given them the opportunity to complete a practical project and work as team with others. Many pupils developed a better understanding of ‘community engineering’ and engineering in general. The pupils also benefited in terms of gaining confidence from seeing their ideas come to life and from having the opportunity to tackle real-life engineering problems while working with ambassadors. The theme of the Olympics proved a good way to engage the pupils because it was relevant to them.

Evaluations of the project did not show that pupils felt that they had improved in science, maths and design and technology. However, when asked at the beginning of the project, many pupils had stated that they were ‘good’ at these subjects. A drawback of the evaluation form was that it only asked for a simple ‘yes’ or ‘no’ answer to this question. If pupils had been asked to provide an answer on a scale of one to ten, or if they could have provided further details, then any changes might have been clearer to see.

One of the key aims of the project was to engage with girls and black and minority ethnic pupils in order to inform them about options available in STEM. This was achieved. Although only a third of the participants overall were female, at Nightingale Academy most were girls. Over 90% of the pupils involved were from BME groups.

One of the original aims of *Engineering in the Community* was to engage with industry, but unfortunately STEMNET was unable to recruit ambassadors to work on this project for the dates required. If this project was to run again in the future, involvement from industry would be beneficial, particularly as it would allow pupils to engage with different types of engineers.

*Engineering in the Community* was originally intended for students of the 14–19 Diploma in Engineering, with the intention of raising awareness of the different STEM careers and courses for pupils who had already shown an interest in engineering through the selection of the Diploma. It wasn’t possible to recruit from these courses for the reasons outlined in the first part of this report. However, recruiting STEM clubs to take part in this project was very successful, as many club leaders were actively seeking opportunities to take part in practical projects and the original intention of engaging with pupils that had demonstrated an interest in STEM was achieved.

If the project was going to run again it should run over a longer time period.

All of the ambassadors that were involved in the project felt that their employability skills had improved as a result, particularly in terms of leadership and communication, and this was a very positive outcome. Given the fact that this project proved popular with STEM club teachers, we would like to use the ambassadors’ expertise and offer to run this project in STEM clubs next year as part of the university’s outreach programme which serves to build partnerships with local schools and colleges. Student ambassadors are central to this programme and they are funded by the budget of Marketing and UK Recruitment.

One of the aims of *Engineering in the Community* was for the project to fit into LSBU’s undergraduate engineering courses. It is yet to be seen if this will be achieved.

The Schools and Colleges Team at LSBU will remain in contact with pupils that took part in this project and any progression onto LSBU courses will be recorded.
Further development

Engineering in the Community is scalable and portable to other science and engineering clubs. In the future, the project could fit into the second or third year of undergraduate engineering courses.

References


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