

Science and Engineering Superstars Evaluation Report

1. Description of Project and its aims
2. The 'Superstars'
3. Delivery Report
 - i. Response from schools
 - ii. Number of pupils reached
 - iii. Geographical spread of schools
4. Evaluation Methods
5. Evaluation Results
 - i. Impact on pupils
 - ii. Teachers responses
6. Follow-up Evaluation
7. Changes to be made

1. Description of the project and its aims

Science and Engineering Superstars is a joint project managed by Women into Science and Engineering (WISE), delivered by science made simple limited (sms) and funded by the Welsh Assembly Government (WAG). It is a 45 minute long science show¹ focussing on 6 young scientists and engineers working in Wales, and the exciting work that they do. The show is delivered to Key Stage 2 (KS2) pupils in Welsh schools.

The show consists of:

Six 1 minute video clips of each of the young scientists or engineers ('superstars') in their work environment, talking about what they do and why they enjoy it. Each video clip is shown and briefly discussed. Then the presenter does one or two experiments that demonstrate and help to explain the scientific principle being discussed. These experiments usually include at least one volunteer from the audience, and the children are encouraged to ask and answer questions throughout the show.

The aims of the show are:

- to enthuse children about science and engineering
- to break down the stereotypical image of scientists and engineers among young children, including gender stereotypes.
- to raise awareness of the different sorts of jobs that scientists and engineers do.
- to encourage children to consider a career as a scientist or engineer.

Children in KS2 are aged 7-11, and it is hoped that the show breaks down the stereotypes that may have already been formed before they move on to secondary school where these ideas are often strengthened, and where children begin to make decisions about their future career.

¹ A science show in this case means an interactive presentation delivered live by a presenter (not in character).

The show is delivered by professional science presenters from science made simple, who are all young female physicists.

2. The 'Superstars'

The six young scientists and engineers who volunteered to be 'superstars' have given up many hours of their time and contribute a great deal to the show.

They are:

- i. Haley Gomez. Haley is an astronomer. She studies cosmic dust. She uses an infrared camera to look through the dust to stars and galaxies behind it. Her 'superpower' is x-ray vision, as she can see through solids to what's behind. We explain that infrared light is emitted as heat, and the students guess the object in a series of pictures taken in the infrared spectrum. We then use an infrared thermometer to take the temperature of some students. Haley has provided two pictures of the same area of space, one taken in optical light and one in infrared, which clearly shows that behind the dust visible in the optical frequencies there are many more stars and galaxies visible in infrared.
- ii. Kelly Croke. Kelly is a civil engineer. She designs bridges, and is often out of the office on construction sites. Her 'superpower' is superstrength, as the bridges she designs have to be able to withstand large forces. Using a foam bridge we demonstrate the forces that a bridge has to withstand. We then use Polaroid to look at the forces on different shaped pieces of Perspex, showing that curved shapes spread the forces better than sharp points. Finally we have a pupil and a teacher help to build and walk over an arch bridge, showing what a strong shape the arch is and that it can withstand large forces without any glue or nails.
- iii. Nici Gittens. Nici is a medical engineer. For her PhD research she investigated the way that people fall to understand the forces that cause injuries in playground accidents. Her 'superpower' is saving lives. She designed a new playground surface which absorbs the impact and reduces head injuries in children who fall in playgrounds. We look at the forces in an impact and how to reduce them by having two pupils throw first a tennis ball and then a water balloon between them, spreading out the forces as they catch them. Then we look at how a surface can absorb the force of an impact if the object falling cannot protect itself. We have a pupil drop a raw egg into a tank lined with bubble wrap – it survives. Then we remove the bubble wrap and drop the egg again – it breaks, showing that the surface you fall onto can greatly affect the severity of your injury.
- iv. Katie Brown. Katie is a renewable energy engineer at the centre for alternative technology in Machynlleth. She installs and maintains renewable energy resources around the CAT, including water and wind turbines and solar panels. Her 'superpower' is saving the planet. We discuss the energy crisis and the difference between fossil fuels and renewable energy sources. We use a fan and a model wind turbine

- which lights an led to show that you can create electricity by using wind.
- v. John Thomson. John is a physicist. He is conducting research on communications lasers for use in the internet. His 'superpower' is laser beams. We use a laser which is connected to a CD player or iPod to show that you can transmit information which has been encoded in a laser beam. The music is transmitted by the laser beam to a detector which decodes it and sends it to an amp and speaker system.
 - vi. Sophia, Marcella and Simone – aerospace engineers. This group of young women are working on the wing of the new Airbus 350. Their superpower is 'flight'. We discuss the forces of gravity and lift which act on a plane, and explain the Bernoulli effect using two balloons and blowing between them. The grand finale of the show is using a leaf-blower to lift a beach ball into the air and make it fly over the audience and back to the front. It works because the fast air flowing over the top of the beach ball exerts less pressure than the slow air underneath it, resulting in a net upwards force called lift.

3. Delivery Report

WAG had provided funds for 20 performances of the show. Each of the 1557 primary schools in Wales was offered a free performance of Science and Engineering Superstars on a first come first served basis. The country was divided into 4 geographical areas; North Wales, Mid Wales, West Wales and South Wales. Each area was allocated a week to have 5 performances delivered in 5 different schools, making 20 performances in total.

Science made simple received 271 requests for the show – close to a 20% return which is high for a cold mail-out. Some schools may not have replied as the dates provided for the shows did not fit into their timetable. This is particularly true in North Wales where the week of touring the show clashed with the Llangollen Eisteddford, and also with many year six secondary transfer days.

Twenty schools were chosen on a first come first served basis in each area, bearing in mind that some areas were in school holidays when the letter was sent out. Appendix 1 is a list of the successful schools. The schools chosen represent both large urban schools and smaller schools in rural Wales which usually have less money as they have fewer pupils, and correspondingly tend to have fewer extra-curricular events. In total, 1684 pupils have seen the show.

3. Evaluation Methods

Both qualitative and quantitative summative evaluation was conducted. Three evaluation forms (appendix 2) were used. Immediately after seeing the show, both pupils and teachers filled in different evaluation forms. Teachers were also given a long-term evaluation form to fill in asking whether they had

noticed an increased interest in science, engineering and construction amongst their pupils, and whether they had used aspects of the show in their teaching.

Responses from the immediate evaluation were compiled, and the results are discussed in the following section of this report. We looked at the numbers of pupils reached, which 'superstar' boys and girls related to the most, how much they enjoyed and understood about the show, what they learned and whether they wanted to be a scientist or engineer when they grew up. Appendix 2 gives a full table of the results of the evaluation.

From this we have drawn out the strengths of the show, things that need changing or improving, and the impact of the show – i.e. pupils' attitude to science and engineering, and whether they would like to be a scientist or engineer when they grow up. Many of the suggested changes from earlier performances of the show

A very poor return is expected on the long-term evaluation, and if any forms are returned it is likely to be in the autumn term when the pupils are back in normal lessons. However, as year six pupils will have moved on to secondary schools, and the majority of the other pupils will have moved to a different teacher's class, the teachers will be unlikely to be able to observe long-term effects even if they remember to watch for them and to fill in and return the form. No long-term evaluation forms have been received at the time of writing this report.

5. Evaluation Results

1. Pupils' evaluation forms. Evaluation forms were given to nearly every pupil, but many schools opted to return the forms by post. Of those that chose this, not all of them have returned the forms, therefore 652 completed evaluation forms were used in this evaluation.

The quantitative 'closed questions' used to evaluate the initial reactions to the show produced overwhelmingly positive results.

68% of pupils rated the show as excellent, and 21% rated it as very good. 10.5% rated it as OK, and only 0.5% said they didn't like it. This 0.5% corresponds to 4 pupils, three of whom were from Tynywedd School where there were significant visibility problems due to the sun shining on the screen.

90% of pupils found the show easy to understand. Of the 10% who said the show was not easy to understand, 40% were Welsh medium schools, and many of the pupils were first language Welsh speakers. This undoubtedly affected their ability to understand the show, as they were also concentrating on the language. Some schools have requested that the show be available in Welsh, but as yet science made simple does not employ a Welsh speaker. If this project is to be continued, particularly in north and west Wales, it would be greatly enhanced by being presented in Welsh in Welsh medium schools.

81% of pupils thought that the length of the show was just right, 12% thought it was too long, and 7% thought that it was too short. Although the intended length of the show is 45 minutes, by the time the pupils have been brought in and sat down, the teacher has introduced the event, the show has been performed and often the teacher has debriefed the students afterwards, the total time is closer to one hour, especially if evaluation forms are filled in on the spot. This is a long time for younger children to sit down without being allowed to move, even during a fast-moving show where they feel involved. It would be difficult to make the show shorter without removing one of the sections altogether, which is undesirable, and with 81% of pupils feeling the length was just right, removing a section would be unjustifiable.

Open questions were used to find out which were pupils' favourite and least favourite parts of the show. Interestingly, the same few parts of the show produced strong positive and negative reactions, with the leaf blower and beach ball, laser demonstrations, building the bridge, the egg and the water balloon coming high up on the list of both favourite and least favourite parts of the show.

The leaf blower and beach ball demo was by far the most popular demonstration with 43% of pupils who wrote something for question 2 including it in their favourite part of the show. 4% of respondents said that the leaf-blower was their least favourite part of the show, mainly citing the noise as the reason (many referred to it as the loud noise, or the noisy thing), and a further 4% said that the aeroplanes part was their least favourite part of the show. The second most popular part of the show was the laser demonstration, with 17% listing it. 4% said that the laser was their least favourite part. Building the bridge was popular with 9% of the vote, but 12% of respondents listed it as their least favourite part. This is perhaps because it takes a couple of minutes which is a fairly long time for a demonstration, and although it involves a volunteer and a teacher (or three volunteers depending on how it is done), pupils who are not involved, or whose friends are not involved, probably find it quite boring. Those who listed it as their favourite were probably in the majority those who's friend or teacher was building the bridge. 8% of respondents listed the egg as their favourite part, and 5% the water balloon, but 9% said the egg was their least favourite part, and 3% the water balloon. The egg and the water balloon demonstrations can be thought of as 'high-tension' demonstrations, where the atmosphere is built up for example by using a countdown as is the case with dropping the egg, or by overacting on the part of the presenter, as with the water balloon. Children generally either love or hate high-tension experiments, and the majority love them. However, those who don't like sudden shocks might be scared of the water balloon bursting, or might not like the tension leading up to breaking the egg. It could even be for a completely different reason, as was the case with one ??? year old ??? – "I didn't like it when you dropped the egg because I felt sorry for the baby chicken."

Reassuringly, 7% of respondents said that everything was their favourite part of the show, and 45% said that they didn't have a least favourite bit. A further

3% said their least favourite bit was when it ended, which presumably meant they were enjoying it and didn't want it to be over!

Pupils were also asked to write down something they had learnt from the show. These answers have been divided into different sections and all answers relating to these sections have been grouped together. The 6 topic areas – space and infrared radiation, building bridges, saving lives, saving the planet, lasers and flight, and also more generally comments about science and engineering, jobs or scientists and engineers.

Good Quotes:

"I learned if you want to do something do it." 9 year old girl Ysgol Manod

"What scientists and engineers can do". 9 year old girl Ysgol Manod

"Science is fascinating" 10 year old boy Llandudno

"I learnt that there are all kinds of science". 9 year old girl, Llandudno

" I learnt about forces I have never looked into – even though I like science." 11 year old girl, Bodfari

"Science can be made easy, fun, interesting." 9 year old girl, Mid-Wales

"Science is very easier (sic) now because I understand." 8 year old girl, Tynywedd

"Scientists can be fun." 10 year old girl, Tynywedd

"I learnt that science is a brilliant job and is also fun because you can do lots of things." 8 year old girl, Tynywedd

"That an engineer will have lots of jobs." 8 year old girl, Tynywedd

"That there can be really really fun jobs to do with science." 10 year old girl, Tynywedd

"I learnt that there are different types of scientist." 8 year old girl, Tynywedd

"I have learnt that science isn't only for school, it can be fun and a job." 8 year old girl, Tynywedd

"That it can be fun to be a scientist." 8 year old girl, Porth Tywyn

"I learnt that science isn't always just experiments and that science is fun." 10 year old girl Bronington

"It is fun to be a scientist." 10 year old boy, Bronington

"I learnt how interesting science is." 10 year old boy, Llansawel

"How interesting scientist jobs are." 11 year old boy, Llansawel

"How interesting science jobs can be." 11 year old girl, Llansawel.

"I learnt that it would be brill being a scientist." 11 year old girl, Llansawel.

"There is all different jobs." 10 year old girl, Llansawel.

"It would be good to be a scientist and discover ways to help that planet." 11 year old girl, Llansawel.

"That being a scientist you can do cool stuff." 8 year old boy, Aberdare

"I've learnt that science is now interesting." 9 year old girl, Aberdare

"I learnt that science is a fun activity and I think it is easy to learn." Aberdare.

"I learnt I wish I could be a scientist." 7 year old girl, Aberdare.

"Engineering I thought was to do with machines and I thought it would be a boring job but now I think I might be one." 10 year old girl, Aberdare.