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Final Report

Development of Physics and Engineering Signs in British Sign Language

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September 2012



FINAL REPORT

to the

STEM Disability Committee

Royal Academy of Engineering

on the

Outcomes of the funded project to produce

Physics and Engineering Signs in British Sign Language (BSL)

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Development of Physics and Engineering Signs in British Sign Language (BSL)

Final Report to The Royal Academy of Engineering: Project to create definitions for new BSL Physics and Engineering signs on the Scottish Sensory Centre website

Submitted by the University of Edinburgh acting through its Scottish Sensory Centre, based within the Moray House School of Education in response to the invitation from Royal Academy of Engineering to fund a project to create definitions the SSC proposes to collect, catalogue and develop British Sign Language (BSL) Signs for Physics and Craft, Design and Technology (CD&T) for deaf people.

Final Report Executive Summary

In October 2011, the Royal Academy of Engineering (RAEng), in conjunction with the STEM Disability Committee, agreed a funding proposal by the SSC to carry out a project to expand the Physics vocabulary and definitions in BSL available to deaf students and teachers. In an interim report to RAEng, dated January 2012, SSC reported that since the beginning of the project a further 116 new Physics signs had been created. The interim report stated that the next phase of the project would be to film definitions for the 116 new terms, and to produce film clips for the purpose of demonstrating use of the new signs in practical lab experiments. Following this work the signs would be added to the SSC BSL Glossary website.

1. The project outcomes described in the original proposal document were to:
 - produce a measurable and significant increase in the number of physics and engineering terms captured on the SSC BSL Glossary website, including video definitions;
 - publicise and disseminate information relating to the new terms, including support of an Academy dissemination event at the end of the project;
 - evaluate up take of the new signs;
 - produce written reports to the academy at mid-point and end of project.

2. The project team of six, five of whom are Deaf, used their combined knowledge of physics and sign linguistics in a two-day workshop to create the new signs. The process involved collecting physics and engineering terms from textbooks, past examination papers at various grades. The full list was verified by a Physics Lecturer at the Moray House School of Education. Using features of the productive lexicon in BSL, the team created a new sign and related definition for each term on the list, taking account of the grammar of BSL and the need to ensure the new signs would not be confused with existing BSL signs. In total 117 new signs were created using this process.
3. At this stage it became possible to more accurately assess the amount of work that would be involved to create new signs for all the physics and engineering terms that had been drawn up. It became clear that the full list of terms could not be accomplished within the agreed scope of the project; hence the outcomes achieved were confined to the topics of **movement, universe, light & sound, energy and radiation**.
4. Topics for which more work is required to produce signs are: **electricity, electronics, telecommunications and sounds & waves**. SSC will seek further funding from other sources to enable this work to be completed.
5. The project budget made provision to demonstrate the use of some of the new signs through the provision of video clips of lab experiments, which would help students, teachers and other communicators to better understand the context in which the signs are used. Eighty-three signs were filmed in this manner at a two-day workshop at Durham University.
6. In order to publicise and disseminate the new signs, the RAEng hosted an event in London in June 2012, with help from the Institute of Physics and the Society of Biology on behalf of STEM Disability Committee. The thirty-five people who attended included deaf students, support workers and educators and feedback was overwhelmingly positive. Further opportunities to disseminate and showcase all the science elements of the SSC BSL Glossary were taken through members of the team being asked to do Science Shows in BSL at Newcastle Deaf Club, University of Sheffield's Science Brainwave Summer Lecture and at East Lothian Festival in

Edinburgh. The STEM Disability Committee also greatly helped with the publicity via their contacts. The project was also mentioned in the New Scientist.

7. Provision is now being made to obtain regular evaluation data on the BSL Science Glossary. This will be obtained by creating a BSL/English questionnaire which will be directly linked to the SSC BSL Glossary website. Over time this information will allow users to contribute to a process of continuous improvement and a reduction in the barriers to the study of physics and other science subjects by deaf people.

8. Very encouraging feedback has also been obtained from experienced educators who have been users of the science signs that formed the earlier sections of the SSC BSL Glossary website. This is heartening and motivating to the project team in their quest to obtain more funding to further this vitally important project.

1. Introduction and project aims

The aim of this project was to expand the Physics vocabulary and definitions in British Sign Language (BSL) in the Scottish Sensory Centre (SSC) glossary for deaf students and their teachers. The SSC has a number of development projects in progress and in deaf education the glossary project is currently one of these. The SSC is recognised across the UK and Europe for its pioneering work in this area.¹ The SSC has a track record in this area, having already researched and developed 84 Physics signs and definitions (Appendix 1) on the SSC BSL Science Glossary which has been published on the SSC website in 2007:

<http://www.ssc.education.ed.ac.uk/bsl/physicshome.html>

The researchers involved with this project are:

Dr Audrey Cameron: Deaf chemist and secondary teacher.

Gary Quinn: Deaf linguist based at Heriot-Watt University.

Rachel O'Neill: Lecturer in deaf education at the University of Edinburgh and SSC.

The researchers worked with the BSL vocabulary team to develop new signs for Physics and Engineering.

- John Brownlie (Physics degree).
- Dr Colin Dunlop (Physics researcher at University of Durham).
- Mark McQueen (BSL storyteller and tutor with engineering background).

The SSC Website Manager, Elizabeth Izatt, was responsible for creating the online glossary.

2. Agreed project outcomes

- 2.1** Produce a measurable and significant increase in the number of physics and engineering terms captured on the SSC BSL Glossary website, including video definitions.
- 2.2** Publicise and disseminate information relating to the new terms, including support of an Academy dissemination event at the end of the project.
- 2.3** Evaluate uptake of the new signs.
- 2.4** Produce a written report on progress to the Academy (at mid-point and end of project).

¹ Wade, M (2008) New sign language helps the deaf become hands-on with science (The Times) 19th January.

3. Background information relating to the development of the SSC's BSL glossary project

'I love studying science in school and I have studied Biology and Chemistry from S3 to S5. I like Biology the best. I did Physics in S1 and S2 but I found it very difficult and confusing. That is why I didn't pick it for Standard Grade examination.' a student from Gourrock High School during glossary website evaluation in 2008 (NB: S1-S5 in Scotland = Years 7-11 in England).

This project is crucial because there is a great concern that very few deaf students are undertaking Physics SQA examinations in Scotland (See Table 1 below). The data showing the number of deaf students taking Physics examinations in England is not known.

Table 1: Number of participants taking Physics SQA examinations in BSL (2007 – 2012)

Subject	Level	2007	2008	2009	2010	2011	2012
Physics	Standard Grade	0	1	2	0	0	0
	Intermediate 1	0	0	0	1	0	0

* Data from Scottish Qualifications Authority

We were particularly interested in expanding the number of physics terms in BSL because of reports from parents that some schools, even specialist facilities, were not encouraging deaf children to take Physics at Standard Grade because of a lack of confidence in signing it, as well as a lack of subject knowledge amongst the support staff. This project has enabled us to expand the Physics in BSL vocabulary to ~200 terms. This will help deaf students and their teachers to learn and teach Physics in sign.

3.1 Technical vocabulary in BSL

BSL is a language with a rapidly growing vocabulary. Since 1993 when Disabled Student's Allowance was introduced in the UK, signing deaf students have been able to study at university level and have entered a much wider range of professional jobs than before. Working in new fields either with an interpreter or in deaf work teams, new BSL vocabulary has been coined so that a wide range of work issues could be discussed. Much of this specialist vocabulary is in use only amongst a small group of professionals and interpreters. However, some projects such as the Wolverhampton University's signs websites for Art, Technology and Science (www.sciencesigns.ac.uk) have made this

vocabulary available on the Internet. This has allowed teachers and Communication Support Workers (CSWs) to use technical BSL vocabulary consistently with their students. Previously they often made up a temporary arrangement between pupil and teacher, which would of course vary from school to school. Very often these temporary signs had fingerspelling as their basis, i.e. principles borrowed from English rather than BSL.

For example, the signs for *exothermic* and *endothermic* are both based on the letter E with specific lip patterns. This is particularly difficult for deaf children to cope with – they are being given English words pretending to be BSL. The vocabulary doesn't show the productive features of the BSL lexicon. As deaf children at secondary school go from subject to subject they come across more and more initialised, English influenced vocabulary, e.g. **E** for Evaporation, for Energy, for Effect, etc.

3.2 How the glossary project started

In the 1990's, Dr Mary Brennan, former Reader in Deaf Studies at the University of Edinburgh, worked closely with the Scottish Qualifications Authority (SQA) to develop a new approach to deaf children's assessment in public exams. Dr Brennan was concerned that deaf candidates who use BSL would be disadvantaged if they had to write their answers in English, as deaf pupils who sign usually have very poor access to English. She proposed that SQA should set up a system of centrally translated exams in BSL, distributed on CD ROM to exam centres, and that pupils should be recorded signing their answers. The SQA accepted her recommendations and from 2001, pupils in Scotland, undertaking SQA examinations, have been allowed to sign their responses. A teacher or interpreter translates the exam questions from English to BSL. However, there is a concern because there is not enough specialist vocabulary in BSL to help students to learn and communicate technical details about school subjects in sign. Dr Brennan initiated a BSL glossary project at SSC in 2004 and worked with a Deaf Maths teacher to develop Maths signs and definitions in BSL.

The SSC continued Dr Brennan's work and developed a project called the Scottish Sensory Centre 'Science Signs Glossary' (2007), which established three working groups of deaf scientists and linguists to create and agree signs in BSL for Biology, Chemistry and Physics. Over 750 new science signs and definitions have been collected or created since 2007 (SSC BSL Glossary website).

This Glossary project was initially well received and a further evaluation project was carried out with Learning and Teaching Scotland (now called Education Scotland) in 2008. In the evaluation phase, Dr Audrey Cameron and Gary Quinn interviewed 16 deaf teenagers who had used the site and collected questionnaires from teachers. The results showed that the signs were valued, but that access to the signs was not always easy as it was within the SSC website. The research team found that the definitions and lab movies in particular were valuable for students and teachers because they explain the concept and allowed for self-study. All were enthusiastic about the project but they wanted many more terms.

The SSC's BSL Glossary website received approximately 5,000 hits from UK per month (during 2011-2012), peaking at the start of the school year and during prelims and examinations. We do not know yet the number of hits since June 2012.

3.3 Organisation of the BSL glossary

On the SSC's BSL Glossary website, for each term, there are 3 or 4 video clips online (see next page for examples):

1. A video clip of the SIGN.
2. A DEFINITION video clip where the term is explained in BSL and translated to English (text). There is usually an image too.
3. A video clip for EXAMPLE or LAB movie – also translated to English (text).
4. A video clip for FINGERSPELLING.

Sign for Refracting Telescope

SSC Scottish Sensory Centre

Home BSL Glossary Physics Glossary

Definition
Example
View this clip in Quicktime
Related terms

BSL Physics Glossary - refracting telescope

Scottish Sensory Centre, Murray House School of Education,
University of Edinburgh, Holyrood Road, Edinburgh EH8 8AQ

Done Internet 100%

Definition

SSC Scottish Sensory Centre

Home BSL Glossary Physics Glossary

Example
refracting telescope
View this clip in Quicktime

BSL Physics Glossary - refracting telescope - definition

This type of telescope has an eyepiece lens, near the user. It also has an objective lens at the other end of the tube, which can be moved in and out. This allows the user to change the magnification and focus. A refracting telescope can be used for many different purposes. You can use one to look at stars in space. Or you can use it like a telephoto lens. It's useful for observing wildlife from far off. The telescope magnifies: it makes the image larger.

Scottish Sensory Centre, Murray House School of Education,
University of Edinburgh, Holyrood Road, Edinburgh EH8 8AQ

Done Internet 100%

Example

SSC Scottish Sensory Centre

Home BSL Glossary Physics Glossary

Definition
refracting telescope
refracting telescope
View this clip in Quicktime

BSL Physics Glossary - reflecting telescope/refracting telescope - example

There are two different types of telescope. The first is a tube with a lens at each end: a refracting telescope. The other one has a lens at the far end and a concave mirror at the near end: a reflecting telescope.

Here is the observatory dome. Have a look inside. This is a reflecting telescope. Here is the concave mirror. You can see it better from the top. There's another small mirror which bounces the light back down here. We have a camera in here. The image is relayed to the computer here. We can see the stars on this monitor over here.

Now we will have a look at a refracting telescope. This is a small one. It has two lenses, one at each end. The large objective lens at the far end has a long focal length. The

Done Internet 100%

4. Principles of developing new signs

This section describes the principles we followed in developing new signs.

In any language there are a number of ways in which new words are developed. Usually new words or signs come from the community. People see a need for a new term so new words or signs are spontaneously created and then spread amongst the language users. However, the language of science is not in such everyday use. From the 16th Century onwards, the English language borrowed many technical terms from Latin and Greek because these ideas didn't exist in English. Borrowing is a common way for new words or signs to enter the language. In BSL the sign for *OK* has been borrowed from American Sign Language, for example. Some signs in BSL develop naturally over time as society changes. So, for example, the sign for *TELEPHONE* has changed to show the different technology in use over the past hundred years.



Figs 1 & 2: Signs of *TELEPHONE* over time

Iconicity is an extremely important feature of BSL. All signs are on a continuum of iconicity. So some signs are very much like the thing they represent, e.g. *TREE*, whereas other signs (e.g. *WHY*) are not at all linked to any iconic referent.



Figs 3 & 4: Signs of *TREE* (Iconic) and *WHY* (abstract)

We can expect many of the new signs coined for technical terms to be iconic, to a greater or lesser extent.

Another method of creating new signs in BSL and in signed languages in general is called *synecdoche*. This means when part of an object or person stands in for the whole. In English, for example, the term '*wheels*' is often used in informal speech to denote a car. BSL uses this feature quite often. For example, the sign for CAT is based on the cat's whiskers.



Fig 5: Sign for CAT (whiskers)

Or, some of the signs which use this feature of sign coining from our sign collection weekend are: *MOON*² is an example for synecdoche; we agreed to use a simple concave, representing any type of moon. Another related term is *metonymy*. This is when something closely associated with the term is used as a substitute for it. For example, in English we talk about *Westminster* when we mean the UK government. This occurs in BSL too. The sign for SCOTLAND, for example, is based on bagpipes.



Fig 6: Sign for SCOTLAND (Bagpipes)

² <http://www.ssc.education.ed.ac.uk/bsl/physics/moon.html>

In our new terms developed for physics we have some examples of metonymy: *SPACECRAFT*³ is an example for metonymy as there are a number of different types of spacecraft, however we agreed a standard sign representing a generic rocket-like vehicle moving from land to space.

Both these terms, synecdoche and metonymy, can be seen as sub-classes of metaphor. Metaphor itself is a very productive way in BSL of bringing new terms into the language. We have seen this in our collection of physics signs. For example the sign for *SPEED*⁴ uses a visual metaphor where an object is large when near then rapidly goes into the distance, getting smaller and smaller.



Fig 7: Sign for *SPEED* in steps

Many of the signs we have already coined have metaphorical aspects. For example the sign for *MASS*⁵ is a fist, and the sign for *WEIGHT*⁶ is a fist being pulled down by gravity. This visually reinforces the key distinctions of the related terms.



Fig 8: Sign for *WEIGHT*

³ <http://www.ssc.education.ed.ac.uk/bsl/physics/spacecraft.html>

⁴ <http://www.ssc.education.ed.ac.uk/bsl/physics/speed.html>

⁵ <http://www.ssc.education.ed.ac.uk/bsl/physics/mass.html>

⁶ <http://www.ssc.education.ed.ac.uk/bsl/physics/weight.html>

In BSL there are five features of phonology. These are the smallest units of a sign, which are its central components: handshape, orientation, location, movement and facial expression. The articulators in a signed language like BSL are the hands and the body. It is important that the new sign works when performed in a natural way. So for example at the physics workshop we considered the signs for ORBIT⁷. The sign linguist in the group reminded workshop participants that the sign must be comfortable to make, and the plane of rotation could be tilted because it is easier to sign that way.



Fig 9: Sign for ORBIT

As many other languages do, BSL often uses *compounding* when bringing new terms into the language. In English for example the new term *webinar* is composed of web plus seminar. In BSL the term SPACE SHUTTLE was compounded from the signs for ROCKET plus PLANE being articulated together.



Fig 10: Compounding of PLANE and ROCKET signs to make SPACE SHUTTLE sign

⁷ <http://www.ssc.education.ed.ac.uk/bsl/physics/orbit.html>

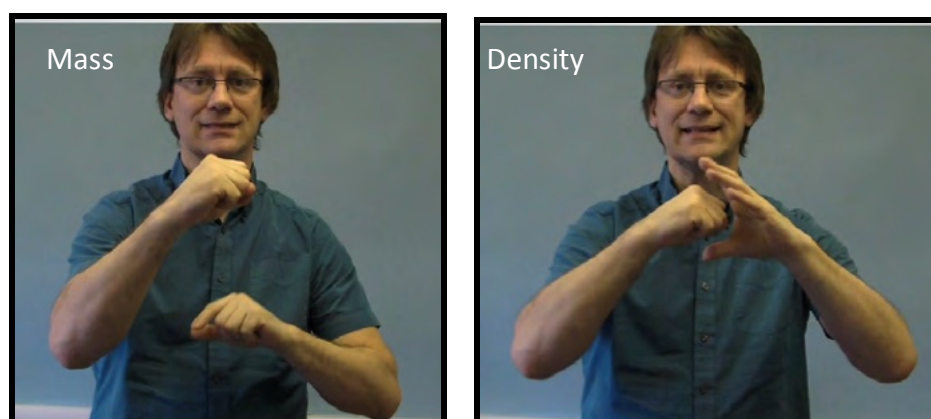
We have noticed a lot of compound signs amongst the newly coined science terms; some of these may well become simplified over time. This has already happened in one area of Biology. Our original sign for AMNIOTIC SAC was BABY + AROUND (articulated in the lower body)⁸. Already in use we have found the sign for BABY has been dropped as the location and handshape of the sign for SAC is self-evidently about a baby.

Some of the new terms we have coined in BSL are morphologically related. That is the structure of a set of new signs is related because the meanings are related. We already had the sign for VELOCITY⁹ agreed before this project started. We used the sign for MASS⁵ and created the sign for MOMENTUM¹⁰ using these elements.



Fig 11: Compounding of VELOCITY and MASS signs to create a new sign for MOMENTUM.

The sign for MASS was also used to help create the sign for DENSITY¹¹.



Figs 12 & 13: Signs for MASS and DENSITY

⁸ <http://www.ssc.education.ed.ac.uk/bsl/biology/amnioticsac.html>

⁹ <http://www.ssc.education.ed.ac.uk/bsl/physics/velocity.html>

¹⁰ <http://www.ssc.education.ed.ac.uk/bsl/physics/momentum.html>

¹¹ <http://www.ssc.education.ed.ac.uk/bsl/physics/density.html>

One of the principles our team has used, as noted previously, is to not create signs based on the fingerspelt initial letter borrowed from the English term. We have generally been able to do this, but we made some exceptions. The first was for names of units, so the fingerspelt letter N, for example, is Newton. The second example comes from Chemistry where we used fingerspelt letters for chemical elements. Also when we were distinguishing types of enzyme we used initialisation to distinguish *amylase*¹², *catalase*¹³, *invertase*¹⁴ and *pepsin*¹⁵. These terms are all hyponyms of the word *enzyme*¹⁶. Visually, therefore, they are closely related despite the use of initialisation.

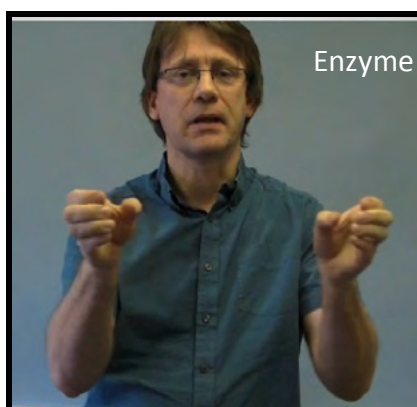


Fig 14: Sign for ENZYME

It will be interesting to see how the terms are taken up and used by the wider community of Deaf people, interpreters and teachers of deaf children. No doubt the terms we have coined will change over time, some will be adopted and others dropped.

4.1 Family of signs

When creating new signs, we tried to make sure that the signs were linked together morphologically and united by a common handshape. In this process, the key concept was identified and an appropriate handshape created. This common handshape is evident in all related terms. Signed examples are provided on the DVD attached to this report and include a range of terms relating to mass (weight, density, momentum, vector, stationary etc. See Figures 12 and 13 for one such example here). Other such terminology families can be found linked to the core concepts of 'lens' and 'angle'.

¹² <http://www.ssc.education.ed.ac.uk/bsl/biology/amylase.html>

¹³ <http://www.ssc.education.ed.ac.uk/bsl/biology/catalase.html>

¹⁴ <http://www.ssc.education.ed.ac.uk/bsl/biology/invertase.htm>

¹⁵ <http://www.ssc.education.ed.ac.uk/bsl/biology/pepsin.html>

¹⁶ <http://www.ssc.education.ed.ac.uk/bsl/biology/enzyme.html>

5. Developing of new Physics/engineering signs

A two-day 'Physics' workshop took place in January 2012 with 6 participants. All participants have different expertise – subject knowledge and linguistic knowledge. The team worked together to collect or create exciting new signs.



Fig 15: BSL Vocabulary Team (from top left): John Brownlie, Audrey Cameron, Colin Dunlop, Mark McQueen, Rachel O'Neill and Gary Quinn.

5.1 Methodology for creating new signs

At the start of the workshop, Gary Quinn explained the principles of BSL linguistics and how the generation of new vocabulary could be achieved. This helped the team to focus on how to develop the new signs properly. The following stages were carried out to create the new signs.

1st stage: Physics & Engineering terms from past Physics examination papers (Standard Grade, Intermediate 1 & 2 and GCSE) and from Physics textbooks were collected. Bob Kibble, a Physics Lecturer at Moray House School of Education based at the University of Edinburgh was consulted to establish a list of terms.

2nd stage: The team collected and listed existing signs from the Sciencesigns.ac.uk website.

3rd stage: The team evaluated the existing signs and discussed how new signs could be created, using features of the productive lexicon in BSL such as iconicity and metaphor. At this stage, the team members were asked if they already used a different sign or signs for this concept.

4th stage: The group worked together on the new signs by looking at the definition of each word and creating draft signs to confirm that the signs could not be mistaken for other signs or did not affect the grammar of BSL. The team made sure that the new signs developed related to the signs developed previously – e.g. a family of signs. The draft signs were filmed and then evaluated by the team members.

From this workshop, 117 new signs were created (see Appendix 2). They were all captured on video and uploaded on the SSC glossary website.

<http://www.ssc.education.ed.ac.uk/bsl/physicshome.html>

This now brings a new total of **201** Physics/engineering terms for the SSC glossary (achieving project outcome 2.1, p8).

Topics covered in 2012 were: **Movement, Universe, Light & Sight, Energy and Radiation**. The team was delighted with the number of new signs developed; however, it is acknowledged that more work is required to develop additional BSL signs for ‘electricity’, ‘electronics’, ‘telecommunications’ and the ‘sounds & waves’ topics and for engineering terms which may be useful for deaf students on more vocational courses at college.

5.2 Definitions and Laboratory movies

After creating the first 250 new signs with definitions and lab movies (for Chemistry only) in 2007, we asked school pupils for their feedback.

‘You should have more examples and lab movies because they will help deaf pupils to understand the definitions better.’ Deaf student, 16 (Evaluation of SSC glossary website, 2008)

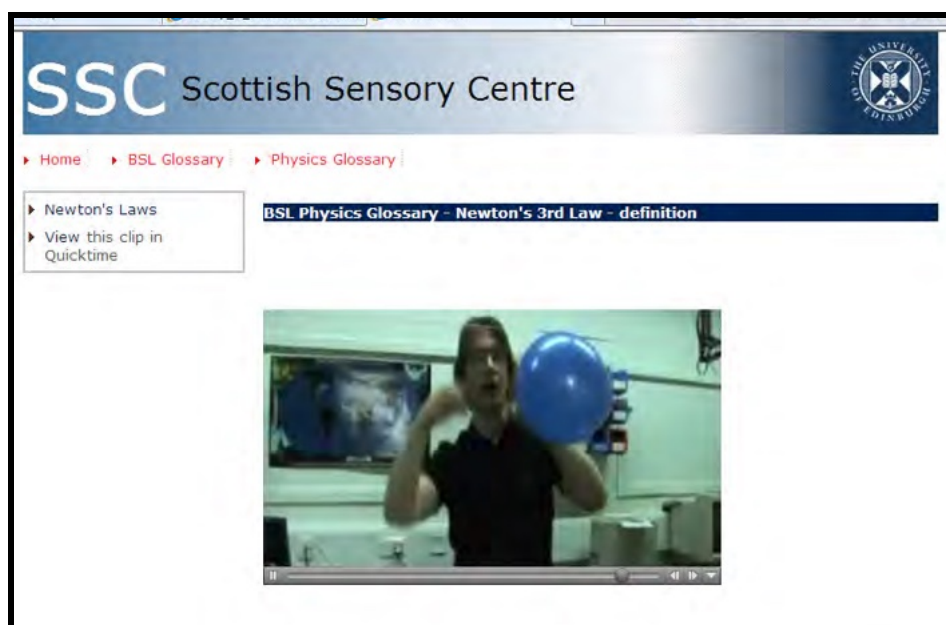
We now believe that it is crucial to provide video clips of demonstrations using the new terminology because it helps the pupils to understand the concepts and it also enables the teachers and communication support workers to communicate science in BSL better.

John Brownlie, Audrey Cameron and Gary Quinn produced BSL definitions for the agreed terms and these were translated into English by Rachel O’Neill. We also carried out

Physics experiments using the new terminology with Colin Dunlop at Durham University. For each experiment, a group of terms was used: e.g. **Light** – ray of light, angle of incidence, angle of reflection, angle of refraction, reflect, refract, normal, angle of emergence, incident ray, reflected ray, emergent ray, principle of reversibility¹⁷



We also tried to include experiments to encourage people to try experiments themselves at home or school e.g. balloon flying along a piece of string (Newton's Third Law)¹⁸.



Graphics or pictures were also added with the video clips.

¹⁷ <http://www.ssc.education.ed.ac.uk/bsl/physics/rayoflightd.html>

¹⁸ <http://www.ssc.education.ed.ac.uk/bsl/physics/Newtonslawsd.html>

6. Project outcome 2.2: Publicise and disseminate information relating to the new terms, including support of an Academy dissemination event at the end of the project.



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6.1 Event at the Academy, London on 19th June 2012

To disseminate and showcase the new Physics signs, the Royal Academy of Engineering volunteered to host an event at the Academy on Tuesday 19th June 2012 on behalf of STEM Disability Committee. The SSC is very grateful for the support from Jenny Young and Bola Fatimilehin of RAEng, Frances Ling and James McNish of IOP and Jackie Caine of Society of Biology for organising this event.

Their planning involved a range of activities including, agreeing elements of the day's programme; design of a flyer; publicity; press release; booking form; distribution list; equipment for experiments; access to communication and venue arrangements; evaluation; and reporting.

The event's programme involved four key sessions. The first session was a keynote address given by Imran Khan who spoke about the work of STEM Disability Committee and the need to make science and engineering more accessible and inclusive to disabled people. The second session was facilitated by Gary Quinn and Rachel O'Neill, who gave background to the project and the principles used to develop the new signs. After lunch, the third session was in the form of an interactive Science Show, facilitated by Audrey Cameron and Gary Quinn. It consisted of a series of ten experiments which gave the

audience an opportunity to see the new signs in use. The fourth session was a plenary discussion on the project and future directions.

Thirty-five people attended including support workers, students (a group from a deaf school), educators and others. Verbal feedback from the day and from reviewing evaluation forms (by Bola Fatimilehin) has been overwhelmingly positive. For instance of the 25 people who completed an evaluation form, 88% rated the event excellent overall, 92% rated the organisation of the day as excellent, 80% rated access to communication as excellent and 88% reported that their expectations were fully or well met (Appendix 3).

The SSC BSL Glossary received a great deal of positive publicity after the event (Appendix 4). Audrey Cameron and Gary Quinn attended three more Science Shows to disseminate and showcase the new Physics signs in other areas of UK:

- Newcastle Deaf Club – ‘Deafinitely Science’ Day – 2nd August 2012
- University of Sheffield – Science Brainwave’s Summer Lecture – 3rd August 2012¹⁹
- Edinburgh – Wish you were there – 4th August 2012

7. Project outcome 2.3: Evaluate uptake of the new signs

The SSC BSL Glossary team is currently creating a short questionnaire in English and BSL which will have a link from the Physics site to help us evaluate its use. A draft of the questionnaire is in Appendix 5. Users will be able to click or write short answer comments in response. With the web statistics this will help us evaluate the use of the Physics part of the Glossary.

7.1 Initial Feedback on new Physics signs developed in 2012

We have asked teachers and colleagues for their feedback about the new signs and definitions.

John Reilly, Teacher of the Deaf – Falkirk Service based at Windsor Park School

“The site is an extremely valuable resource for both teachers and pupils alike.

The site serves as a useful aid to establish key vocabulary in class and will help me greatly in my explanation of Physics concepts in the High School”.

¹⁹ <http://www.sciencebrainwaves.com/uncategorized/science-in-british-sign-language-summer-lecture/>

Marian Grimes, City Lit, London, Co-ordinator of support for deaf students

“It is very heartening to see Mary Brennan's work taken forward by this exciting team of Deaf scientists. The glossary is so much more than lists of new BSL signs; the meanings of complex concepts are made clear and exemplified, making it a vital tool for Deaf students and for a range of educational professionals”.

Kath Clark, Science/Maths teacher, Donaldson’s School for the Deaf, Linlithgow

“When I started teaching deaf students I was quick to notice the lack of science signs, and the absence of standardisation of the limited number. Individual teachers were compelled to make up their own signs with the students or relying heavily on fingerspelling. There is a vast amount of vocabulary within any science syllabus and my level of BSL was not adequate to tackle the creation of new signs, therefore, I was exceptionally pleased to be introduced to the SSC Science Signs Glossary. The science signs make up a valuable part of my lessons, both for my own preparation beforehand and to use as a reference tool during. Using science signs is vital for fluency in explanations and discussions. Also, on a recent placement to another school it was fantastic to be able to discuss science without first having to establish signs. The addition of the definitions will be an excellent resource for teachers and students alike, and I am sure they will feature in class work exercises frequently. The glossary also allows students to access information at home which is a necessity as the language in many science textbooks is not appropriately graded”.

Bob Kibble, Physics Lecturer, Moray House School of Education, University of Edinburgh

“The glossary of terms provides learners with empowerment to learn about, think about and talk about physics and science. It is liberating and a resource which should find value across the globe. The definitions are presented without the barrier of culture or language and their beauty is in their simplicity.

The physics video clips are a great teaching and learning resource. The presenters engage in a dialogue with learners, blending signing, symbolising and explaining processes as they go. I found the explanations of how lenses help us to see and how light behaves as it passes through a glass block to be as good as any I could have mustered as a teacher.

This work breaks new ground and provides an invaluable set of resources for deaf learners. Well done to you and the team”.

8. Next Steps

The project group believes the SSC BSL Glossary Project will give deaf pupils who sign better access to the Physics curriculum. In the longer term it is intended to expand the range of subjects, available on the glossary, including geography, history, art and media, CDT, ICT and computing, using the same method for finding signs from Deaf experts.

The immediate aim of the project is to continue with work to be done in the STEM area to improve access for BSL users. This will include:

- The production of a simple **linked questionnaire** in BSL and English which provide feedback from both deaf and hearing users about the SSC BSL Glossary website (See Appendix 5 for draft).
- An update of the introduction of the SSC BSL Glossary to the website to reflect its current rationale and to report on presentations the team has given recently.
- Investigate any possible funding sources to continue the high standard of work initiated by this project.

9. Conclusions

The funding provided to the Scottish Sensory Centre by the Royal Academy of Engineering, Institute of Physics, Institute of Physics and Engineering in Medicine and the Royal Society to undertake this project has resulted in the Physics signs in the SSC BSL Glossary being increased from 84 to 201. This significant increase of 140% will give deaf pupils and students who sign much improved access to the Physics curriculum.

Achievement of this key outcome of the project has also given the project team an accurate measure of how much work is needed and the likely time requirement to create the remaining signs and definitions to complete the full list of Physics and Engineering terms which was identified at the outset of the project. The collaboration between the project team, RAEng and STEM Disability Committee representatives resulting in the successful Academy event in London, and the positive publicity it attracted, produced the desired outcome of publicising and dissemination information about the new Physics signs that have been added to the SSC BSL Science Glossary website. The work that is now underway to add an evaluation questionnaire to the website for use of those who use the

glossary, will in time offer the means to fully evaluate the effectiveness and usefulness of the full signs glossary.

This project has given further impetus to SSC to obtain funding and develop partnerships that will not only allow for completion of the STEM subject signs in Physics and Engineering, but will also allow work to be undertaken to enhance the website and organise events that will offer help to teachers and interpreters to improve the quality of their explanations to BSL users.

The SSC and the BSL science signs project team are extremely grateful to the Royal Academy of Engineering, Institute of Physics, Institute of Physics and Engineering in Medicine and the Royal Society for funding this successful project. We feel confident that the work of producing the BSL Signs Glossary will lead, in future, to more deaf people achieving success in their study of science subjects. We also look forward to the possibility of working with STEM Disability Committee in the future to help ensure that this aim is achieved.

10. Acknowledgements

Thanks to the following people who helped during the project

- Deaf Scientists and BSL linguists: Dr Colin Dunlop, Mark MacQueen, John Brownlie
- University of Edinburgh: Bob Kibble, Christine Smithers, Douglas Buchanan, Linda Hayne, Valerie Gordon
- Scottish Sensory Centre: Janis Sugden, Elizabeth Izatt, Sheila Mackenzie, Ruth Simpson
- Institute of Physics: Frances Ling, James McNish
- Institute of Physics and Engineering in Medicine
- Royal Academy of Engineering: Jenny Young, Bola Fatimilehin
- Society of Biology: Jackie Caine
- STEM (Science, Technology, Engineering and Maths) Disability Committee
- The Royal Society, London.

Appendix 1: Signs for Physics & Engineering on SSC's BSL glossary website (84) before this project.

Universe

Galaxy
Milky Way
Solar System
Universe
Vacuum

Movement & Force

Acceleration
Average Speed
Constant Speed
Deceleration
Instantaneous speed
Uniform acceleration
Velocity
Air resistance
Balanced forces
Compression
Force
Friction
Gravity
Resultant force
Tension
Thrust
Unbalanced forces
Weight
Attract
Magnet
Magnetic
Magnetic field
Repel
Mass
Density
Newton

Electricity & Electronics

Alternating current
Ammeter
Amp
Capacitor
Circuit
Conductor
Current
Direct current
Earth
Electricity
Live
Multimeter
Neutral
Parallel circuit
Resistance
Sensor
Series circuit
Voltmeter

Insulator
Volt
Voltage

Sound & Waves

Amplitude
Frequency
Pitch
Wavelength

Telecommunications

Analogue
Digital

Light & Sight

Angle of incidence
Angle of reflection
Angle of refraction
Concave lens
Convex lens
Diffraction
Laser
Lens
Optical fibre
Reflection
Refraction
Speed of light
Telescope
Total internal reflection

Energy

Energy transfer
Geothermal
Heat conduction
Heat convection
Joule
Kinetic energy
Potential energy
Power
Radiation
Renewable
Temperature

Appendix 2: New signs for Physics & Engineering developed in 2012 (117)

Electromagnetic Spectrum

- 1 Electromagnetic spectrum
- 2 Gamma ray
- 3 Infrared radiation
- 4 Line emission spectrum
- 5 Microwave radiation
- 6 Radio waves

- 7 Ultraviolet
- 8 Ultraviolet radiation
- 9 Visible light
- 10 Visible spectrum
- 11 White light
- 12 X-ray

Electronics

- 13 Heat sensor
- 14 Light sensor
- 15 Pressure sensor
- 16 Smoke/ gas sensor
- 17 Vibration sensor

Energy

- 18 Efficiency
- 19 Energy change/ transfer
- 20 Engine
- 21 Light energy
- 22 Non-renewable energy
- 23 Renewable energy
- 24 Specific heat capacity
- 25 Specific latent heat of fusion
- 26 Specific latent heat of vaporisation
- 27 Thermometer

Forces

- 28 Air friction
- 29 Friction
- 30 Momentum
- 31 Newton balance
- 32 Newton's Laws
- 33 Vector (force)
- 34 Water friction

Health Physics

- 35 Endoscope
- 36 Image guide (endoscope)
- 37 Light guide (endoscope)

Light

- 38 Angle of emergence
- 39 Bulb
- 40 Critical angle
- 41 Dimmed lighting
- 42 Emerge
- 43 Emit
- 44 Fluoresce
- 45 Glass
- 46 Image
- 47 Image retention
- 48 Incident ray
- 49 Normal (e.g. angle of incidence)
- 50 Path of rays of light
- 51 Principle of reversibility
- 52 Ray of light
- 53 Reflected ray

Telescopes

- 54 Eyepiece lens
- 55 Focused
- 56 Objective lens
- 57 Reflecting telescope
- 58 Refracting telescope

Measurement

- 59 Depth
- 60 Depth (under surface)
- 61 Distance
- 62 Distance travelled
- 63 Height
- 64 Horizontal
- 65 Length
- 66 Metres/ second
- 67 Time
- 68 Time delay
- 69 Time interval
- 70 Timer
- 71 Vertical
- 72 Width
- 73 Maximum speed
- 74 Speed
- 75 Stationary
- 76 Streamlined

Nuclear Physics

- 77 Chain reaction (nuclear)
- 78 Nuclear energy
- 79 Nuclear power station

Radiation

- 80 Absorbing material (radiation)
- 81 Alpha particle
- 82 Alpha radiation
- 83 Background radiation
- 84 Becquerel, Bq
- 85 Beta particle
- 86 Beta radiation
- 87 Gamma radiation
- 88 Gamma ray
- 89 Sievert, Sv

Sight

- 90 Blurred vision
- 91 Correct (vision)
- 92 Dioptre (power of the lens)
- 93 Eye defect
- 94 Focal length
- 95 Focus point/ Focus
- 96 Lens
- 97 Long sight
- 98 Parallel rays of light
- 99 Rays converge
- 100 Short sight
- 101 Spectacles

Space physics

- 102 Earth's pull
- 103 Gravitational field strength
- 104 Launch vehicle
- 105 Light year
- 106 Moon
- 107 Orbit
- 108 Period (of orbit)
- 109 Planet
- 110 Space
- 111 Spacecraft
- 112 Star
- 113 Sun
- 114 Universe
- 115 Weightlessness

Waves

- 116 Peak value
- 117 Wave

Appendix 3: BSL Evaluation – Aggregated Forms – prepared by Bola Fatimilehin of RAEng

Evaluation forms were handed out to all 35 people who registered to attend the event of which 23 were fully completed and 2 were completed on one side only. The form contained 11 questions - aggregated responses are detailed below.

Questions	Aggregated Response
1. Overall rating of the event (Excellent, Good, Satisfactory, Poor?)	22 Excellent; 3 Good
2. Pre-event Organisation (same rating as above)	16 Excellent; 7 Good; 2 Satisfactory
3. Organisation of the day	23 Excellent; 2 Good
4. Meals/Refreshments (same rating as above)	11 Excellent; 12 Good; 1 Satisfactory; 1 N/A
5. Meeting rooms/facilities (same rating as above)	21 Excellent; 4 Good
6. Access to Communication (same rating as above)	20 Excellent; 4 Good; 1 Satisfactory

<p>7. What did you hope to achieve by attending this event</p>	<p>Comments – each bullet represents verbatim comments from a single form:</p> <ul style="list-style-type: none"> • Exceeded my expectations. • Awareness and build links with BSL/STEM disability advocates. • To achieve good knowledge. • Learn science signs, about the organisation who did this and make contacts. • To learn scientific signs as well as useful seeing useful non-hazardous experiment taking place – it was worth the trip. • Excellent day – informative & entertaining. I worked hard to find out more about BSL science signs and their derivations. • Better understanding of the issues surrounding use of BSL & development of signs for STEM – more new contacts to work with in future. • Discover new signs are being developed for science (specific interest in chemistry). To see the cutting edge of possibilities to support deaf people to access education. Discuss future areas/directions project will take. Offer my experiences as a deaf chemist (PhD student). • Better knowledge of BSL signs for science. • To learn about the signing resources available to support our secondary deaf students in science • Understanding of the new sign project and how to integrate it into the events and projects we do • Access more information about communicating science through BSL. • To apply more BSL to my teaching. To learn how deaf education is progressing in the area of science and technology. • Enlightenment of how to sign iconically for science and engineering. The event was excellent – I will use the resources. It has put me on track. • Networking, meeting new people, gathering information. • I did hope to achieve more scientist things. • Learn about the new signs and how to select/create. • I'd love to see again when the event is appropriate to show to children. • To learn more about the project and teaching deaf students. • An understanding of how the SSC has designed the new signs. • Had no expectations but loved the SSC. • I was hoping this event was good and improve my knowledge too.
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<p>8. To what extent were your expectations met? (Fully met, well met, satisfactory, Not well met)</p>	<p>16 Fully met; 6 Well met; 3 did not complete the question</p>
<p>9. What was the most useful or meaningful thing you learnt?</p>	<ul style="list-style-type: none"> • I learnt useful thing make of firework, cloud, custard. • I would say all really, really useful because it simply and good show! • There is support out there to get science vocab. • Useful visual gestures VG3 – I like that. • Stick to one sign – family sign. • SSC ongoing partnership with STEM (brilliant initiative) to deliver in BSL – was not fully aware of this • The use of hand shapes in communicating/translating specific science signs, for example the lens hand shape and the maths hand shape used in context. It gave me a useful insight into the development of these signs and the grouping of them and would make a lot of translation clearer in the context of science lesson for e.g. • Where to get access to resources using the new signs. The process behind the development of these signs. • Access to the signs at work – the consistency of hand shapes – families of signs. • The concept of establishing signs. • I was interested about that and I have now learnt for everything. • The specific signs were useful and meaningful. • When developing signs, concept is more important that any connection to the words in English. • Video BSL exam questions is something I can pass onto The New Eccles Hall School (an independent school experiencing an influx of deaf since deaf school closure). The Linguistics of signs. Just a wonderful experience to FINALLY have some science in BSL, without the barriers to inclusion. • The signs e.g. solid, liquid, gas. • How good BSL cab be at explaining science. • The most useful/meaning thing I almost love everything. But especially exploding pop rockets and dry ice. It seemed fun. • I found everything useful, but predominantly thinking visually in context. The website will be very useful. • The extent of the website. Learnt new signs.

	<ul style="list-style-type: none"> About the development of concept 'families' in BSL and their potential application to education for hearing students too.
10. What aspect did you find least useful?	<ul style="list-style-type: none"> N/A I would benefit from more training. This would make a good training course. None. Would have been useful to have computers so we could access SSC website. None. The show was great fun but as a PhD it wasn't why I attended as have seen it before in Newcastle. None. N/A Nothing. As a CSW parts of the practical experiment wasn't hugely useful – but as an audience member it was fantastic, very entertaining and I did <u>love</u> it – that is no <u>criticism</u> of the show I thought it was <u>BRILLIANT</u>. <u>Show and more time.</u> <u>Notetakers.</u> <u>No.</u> <u>N/A.</u>
11. What future actions will you take as a result of attending this event?	<ul style="list-style-type: none"> Look at online glossary. Inform SENCO of the website/project. Network with 'Secret Lab' and 'The hub'. Set up workshop the future for deaf kids, parents too. Pass to CSWs and teachers of deaf at Eastbury. Networking more closely. Using the website as a hugely valuable resource for science signs. Using science signs in practice as/when useful if working as a CSW in a science context. Adjusting our science events to link with and reinforce signs developed here. Promotion of the website in improving deaf student access to science. Look up online glossary. I would be involved more. Engaging with Dr Audrey Cameron to join/advise RSC Diversity Working Group. Work with colleagues to review accessibility of RSC resources. Will offer to assist Audrey, Gary (and STEM team) in any way please contact me!! I am a chemist at Newcastle and can sign BSL. I would love to be involved in the project. I can see how it would enable deaf people to enter science professions with confidence – instead of apprehension.

	<ul style="list-style-type: none"> • Encourage them to visit Oak Lodge to encourage the pupils? Visit website, use the signs I have learnt. • Look at websites for these organisations. • None. • Inform the team of CSWs at city Lit. Friends working in education.
<p>12. Please suggest one thing which could improve similar events</p>	<ul style="list-style-type: none"> • Advertising the event I would suggest advertising via Deaf Jobs UK; NDC; City Lit Noticeboards and requesting email is sent out to the college; REMARK/BSLBT (??) advertising who may be interested in playing a part in the event. This could make a great TV show. • More time for discussion. • Unsure. • None I think it is fine. • More discussion time. • Videos to show other experiments. • Need more training courses for vocabulary to ensure it is rolled out to wider community. Module for interpreters and interested signers. • None. • N/A • More workshops. • More discussion about sign language. • Breaking down the day into smaller segments. • I thought it was fantastic and hugely important and valuable day. It was a shame that there were so few people there, particularly CSWs. Perhaps it could be better advertised/publicised in future. • Show and more names on what chemicals been used for reactions and why. • More training for science teachers, parents, interpreters, CSW too and kids. • Get better note takers... Stage text perhaps. • N/A • Nothing.

Appendix 4: Online publicity SSC received after event on 19th June at the Academy

Aus Inst of Physics on Twitter

<http://en.twitter.com/ausphysics/status/215648474576850946>

At the Rim

<http://attherimmm.blogspot.co.uk/2012/06/new-signs-for-physics.html>

Boing Boing

<http://boingboing.net/2012/06/22/two-interesting-forays-into-sp.html>

Deaf Parents Deaf Children

<http://deafparentsdeafchildren.co.uk/give-me-bsl/>

I, Science Magazine

<http://www.isciencemag.co.uk/news/news-round-up-space-age-china-in-utero-surgery-signing-physics-sexist-science-published-flu/>

IChemE website

<http://www.tcetoday.com/latest%20news/2012/june/science%20sign%20language%20help%20deaf%20students.aspx>

IOP

http://www.iop.org/news/12/june/page_56379.html

IPEM

<http://www.ipem.ac.uk/newsandmedia/latestnews/Pages/Newphysicssignsfordeafstudents.aspx>

New Scientist

<http://www.newscientist.com/article/dn21967-obscure-physics-words-get-sign-language-equivalents.html?DCMP=OTC-rss&nsref=online-news>

Peterborough and District Deaf Children Society

<http://www.pddcs.co.uk/2012/06/physic-words-get-sign-language.html>

<http://www.pddcs.co.uk/2012/06/physics-in-bsl-event-in-london-tuesday.html>

Royal Academy of Engineering

<http://www.raeng.org.uk/news/releases/shownews.htm?NewsID=767>

Smart Planet

<http://www.smartplanet.com/blog/rethinking-healthcare/learn-x-ray-endoscope-and-other-physics-terms-in-sign-language/9325>

Society of Biology

<http://www.societyofbiology.org/newsandevents/news/view/436>

The Royal Society

<http://royalsociety.org/about-us/equality/activities/>

<http://blogs.royalsociety.org/education-resources/2012/06/25/new-signs-for-deaf-physics-students/>

Appendix 5: Draft of online bilingual (English and BSL) questionnaire for Physics part of BSL Glossary website

Questionnaire

We would like to know how you use the Physics site and your views on the glossary. Please spend 5 minutes answering these questions. The results will help us to expand the glossary further.

1. What is your role?

- Deaf student / pupil
- Teacher of deaf children
- Parent of a deaf child
- Interpreter
- CSW
- Other. Please explain

2. What do you think of the BSL Glossary on a scale of 1 to 5?

- 1 Is very poor
- 5 Is excellent

3. What do you think about the Physics webpages on a scale of 1 to 5?

- 1 Is very poor
- 5 Is excellent

4. Why do you use the Physics webpages? Please choose all that apply:

- To prepare for giving explanations in class / tutorial
- To prepare for interpreting assignments
- To help with homework
- To understand physics better
- To increase my BSL vocabulary
- Other, please explain

5. How could the Scottish Sensory Centre improve the BSL glossary site?

- More physics / engineering signs and definitions
- More signs for other subjects (please explain what)
- Improve the website (please give your ideas)
- Other – please explain in the box

We are also happy to receive BSL comments on video. Please upload to YouTube or Drop box and email Rachel.oneill@ed.ac.uk with the link.

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