



# Transition to higher education for students with visual impairments in STEM subjects

*Disability Practitioner Event: Are we doing it right?*

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This workshop report explores the barriers to Higher Education (HE) in Science, Technology, Engineering and Mathematics (STEM) subjects for students with visual impairment (VI).

## Background

Disabled students with VI are currently under-represented in Science, Technology, Engineering and Mathematics subjects in the UK. The requirements of STEM subjects might represent a major barrier when students with VI are making a decision about higher education and what subject to study. However, there are students with VI who have successfully overcome barriers in delivery and achieved high results (Cliffe & Rowlett 2012).

In order to optimise the process of transition to higher education for learners with VI a collaborative approach across sectors was sought. On 21<sup>st</sup> September 2012 higher education students and staff with VI and staff with experience working with students with VI, including lecturers, disability advisors, needs assessors, teachers and representatives from Sensory Support Services, the RNIB and JISC TechDis came together to consider the transition to HE STEM subjects for students with VI.

## Attendees

We would like to thank all those who gave their time and energy to attend this workshop, especially those who shared their personal experience so generously and openly. Where we report on discussions we have ensured attendees remain anonymous. To assist in understanding the background of attendees we have listed their roles.



This activity was undertaken as a part of the National HE STEM Programme, via the South West Spoke. For more information on South West Spoke projects, please see [www.hestem-sw.org.uk](http://www.hestem-sw.org.uk). For more information on the overall national programme, please see [www.hestem.ac.uk](http://www.hestem.ac.uk).



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## Executive summary

A framework for guiding and optimising the process of transition to higher education for students with visual impairment who wish to study Science, Technology, Engineering or Mathematical (STEM) subjects is presented. This is accompanied by recommendations for further work at national, regional and institutional levels.

This framework was produced as the output of talks and discussions between higher education students and staff with VI and staff with experience working with students with VI. Important aspects of the talks and discussions are presented with appropriate commentary to place the framework and recommendations in context.

The framework presented is detailed in nature, with the student's journey broken into 5 phases: pre-application, pre-entry, transition, later years and career planning. In each phase 4 areas were considered: student's actions, skills development, teaching and learning, and support. The framework is presented as a table (Table 1: Integrated framework) and in a linear format (Appendix: Integrated framework in linear format by rows). It is possible to read this framework, which cannot be summarised, without direct reference to the context which precedes it.

The accompanying recommendations (Key recommendations and areas for further work) capture further work required to realise such a framework. We give brief summaries of each:

1. The various methods of accessing and producing accessible STEM content and of locating expertise in this area should be documented in a centralised resource. This information should be appropriate to different roles and levels and associated training resources may be required.
2. Access to role models including graduates and students with VI currently studying STEM subjects should be facilitated.
3. Learners for whom it is appropriate should have the opportunity to learn Braille and the Braille mathematics code up to GCSE level.
4. Self-advocacy, self-determination and communication skills and the skills required to locate and use information to make choices need to be actively promoted during earlier experiences of STEM study.
5. Students should be encouraged to be flexible and taught to take multiple approaches when working in STEM subjects, starting during sixth form.
6. Institutions should audit STEM courses to quantify the skills and technologies which are required at each level. This information should be used by needs assessors to enable a sound DSA assessment process.

7. Academic departments should be encouraged to form a pre-entry working partnership with applicants and their school or college. Students should be 'up and running' before they reach university in their chosen methods of working with STEM content. Needs assessors should be involved in this partnership to ensure a sound DSA assessment process.
8. Institutions should ensure that they proactively hold all lecture notes in STEM subjects in formats which can be used to create suitable alternative formats.
9. A national database of mathematically fluent support staff able, for instance, to advise on the production of LaTeX resources should be compiled.
10. There is an on-going necessity for improvements to technology. The STEM community should communicate clearly the need for such tools and investment from the public sector may be required.
11. Publishers and providers of STEM materials (e.g. books and journals) should store the source format e.g. LaTeX and make this available on request. Institutions should consider how the education sector may put pressure on publishers to provide STEM content in accessible formats.
12. HE professionals should be aware of issues around progression and transition to higher education for students with VI and proactively communicate with schools regarding these. Positive information should be exchanged by collaboratively developing and delivering aspiration raising activities, workshops and summer schools for students with VI, their parents and teachers.

It is envisaged that implementation of these recommendations would support practitioners in their roles and ultimately students in accessing STEM subjects in higher education.

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## Programme

The day opened with an introductory talk from Dr Derek Naysmith, Trustee of the British Computer Association of the Blind (BCAB). Dr Naysmith gave an overview of the key findings of his *Science Accessibility Survey* (Naysmith 2011) undertaken for the Open University. This was followed by a talk on *Progressing to HE mathematics – sharing of experience* from Alastair Irving of the Mathematical Institute, University of Oxford and Robin Williams of the College of Engineering, Mathematical and Physical Science, University of Exeter (Williams & Irving 2012). Questions arising from the talks were taken as a panel.

Attendees spent the remainder of the day in two group workshops:

- Workshop 1: Exploring barriers by sharing experience
- Workshop 2: Drafting a framework to assist learners and their teachers to plan for higher education

## Report structure

This report commences with an overview of key points from the opening talks and panel session. These provided a catalyst for the day and hence guide some parts of later discussion.

Discussion in workshop 1 was loosely structured via 5 questions and we report on the discussions in these broad areas.

During workshop 2 attendees were asked to draft a framework for transition to HE STEM subjects. We start this section by introducing the structure of the framework and method of production before presenting further discussion points and an integrated framework formed from the four group outputs.

Finally we conclude with a set of key recommendations and areas for further work. It is envisaged that implementation of these would support practitioners in their roles and ultimately students in accessing STEM subjects in higher education.

# Opening talks

## Science Accessibility Survey

*Dr Derek Naysmith*

Derek surveyed students with visual impairment studying STEM subjects to produce a report of recommendations to the Open University (Naysmith 2011). Ten students responded to the survey which was followed up by contact with the support teams in the students' institutions. Derek summarised some of the findings:

- The attitude of the institution is crucial – a positive looking attitude with an awareness of what is involved is required throughout the entire organisation, not just within the department and the disability services team.
- Students studying STEM subjects require a wide range of technologies, some quite high powered such as talking tactile diagrams and some lower technologies such as German film for diagram production.
- Students require a range of skills such as
  - Ability to read tactile diagrams accurately;
  - Skills to cope with specialist technologies beyond just a screenreader;
  - If the student reads Braille then they will need to be able to read a mathematics Braille code.
- Acquiring these skills and using the technologies places an extra and significant burden on the student. Raising awareness amongst staff of what a student has to do in order to produce work can resolve problems and increase understanding.
- Institutions need to quantify the skills and technologies which a student with VI will require for each qualification they offer and each individual module within those. This would enable students to plan ahead and to gain skills before they need to use them. The process will also uncover issues for course teams so that these can be resolved proactively.
- It is easy for the focus to be on the production of accessible course materials. For students to study to learn and to enjoy their studies they will also need to be able to:
  - Interact with peers and staff in tutorials and practicals and
  - Access materials from third parties.

Students will need to gain skills and have access to technologies which permit this – skills and technologies they can take forward into their professional environment on graduation.

- Students need to be aware of the support available to them e.g. through the Disabled Student's Allowance (DSA) including that this can be used to pay for readers, specialist technology e.g. Optical Character Recognition specifically for mathematics.

- Fellow students are very important to students with VI, often assisting with interaction within tutorials and workshops or acting as a reader (perhaps paid for through the DSA).
- There is a huge diversity of technologies and equipment and there is a need to respond to each student's individual needs. Some students will use all the technologies which are available, will use LaTeX (Lamport & LaTeX3 Project 1985) for mathematics, Braille, tactile diagrams etc. Other students may work in audio alone.
- Students can enjoy STEM subjects and carry on working in that environment if frameworks are put in place and the attitudes are right.

## Progressing to HE mathematics – sharing of experience

*Alastair Irving and Robin Williams*

Alastair and Robin gave an overview of their progression from a relatively early age to their current PhD studies in mathematics. They felt that perhaps the reason there are not many students with VI studying STEM subjects is because of experience at school. Alastair and Robin both learnt Braille from an early age and gained fluency in the mathematics code as a matter of course. They worked in this format up to GCSE level, using a scribe for their GCSEs. They both felt that this was the best option for them at GCSE and that it was important that they had developed those Braille skills. Even today, while they have both altered their approach since GCSE, they both use Braille on a daily basis as using some form of Braille is the quickest and most accurate way of doing mathematics. They believe that handling any kind of complicated algebraic expressions in audio alone would be near impossible. For this reason, they feel it is very important that children in school do not rely on audio but develop Braille and mathematical Braille skills if appropriate.

However, post-GCSE Alastair and Robin were aware that they hoped to study scientific subjects at university. With their teacher David Spybey (also present in the room) they developed a system of working to permit them to read and produce their own materials without working directly in Braille, using transcription and scribes. They felt that it would not have been possible to enjoy the university experience without such a system as the 'old school' transcription based methods were too time consuming and using a scribe for mathematics 'wasn't ideal'.

Alastair and Robin started to use LaTeX (Lamport & LaTeX3 Project 1985), which is widely used in the mainstream mathematical community to encode documents. They were aware that in many universities lecture notes and problem sheets would be prepared in LaTeX. However, LaTeX is quite unpleasant to read and type e.g. to write  $\frac{1}{2}$  you would type `\frac{1}{2}`. They use the Emacs editor (Stallman & GNU 1984) to assist with writing as this provides keyboard shortcuts and macros for inputting complicated LaTeX and mathematics syntax. Alastair is now able to type quickly enough in this way to take notes in talks and seminars he attends during his

PhD. In order to make the reading of LaTeX easier Alastair wrote scripts (Irving & Williams 2007) which take a line of LaTeX and translate it into English-friendly speech and Braille to be displayed on a Braille display.

By the end of their A levels both Alastair and Robin were able to take their A level mathematics examinations using LaTeX and hence did not require a scribe to produce work which could be read by someone unable to read Braille.

Alastair and Robin spent a lot of time contacting universities to gauge their reaction to an application and found a wide variety in the response. They both chose universities in which the mathematics department specifically was accommodating and positive. Alastair felt that the main requirement he had was to be provided lecture notes in LaTeX and in advance. This enabled him to use his laptop to follow notes in class, to understand what was happening during the lecture (e.g. on the blackboard) and to annotate the notes with additional comments as appropriate.

Robin found it difficult to get lecture notes beforehand for all modules which had a high impact – in fact, Robin's marks correlate with the availability of notes prior to lectures. Robin had assistance from his personal tutor to go through course diagrams – usually just sketched on German film – and his department did occasionally produce tactile diagrams.

It was noted that a key obstacle was that some lecturers appeared not to have lecture notes – in any format! An important recommendation is that all lecturers should have notes, and ideally in LaTeX. If materials are not in LaTeX (e.g. handwritten) then access to a suitable group of people to type lecture notes up in advance is important and something that Robin struggled to find. He was heavily reliant on one or two people and if they had not been available he is not sure how he would have continued. Robin did highlight that these people need not be at the specific institution – he sent some notes to a support worker in Scotland. It was recommended that a national list of people able to do this kind of work for mathematics be kept.

Robin is now a PhD student studying extreme events related to weather forecasts and Alastair is a PhD student studying analytic number theory. LaTeX remains very important to them both. As research students they now need to access a wide range of reading for independent research. They will typically request LaTeX sources from authors of both papers and books. If the LaTeX source cannot be retrieved in this manner then they use InftyReader (InftyReader Group 2002) an Optical Character Recognition package for mathematical and scientific documents which can produce LaTeX. They noted that this technology is expensive and not yet as good as they might like (in terms of error rate) although at this level in their studies they are confident that with a good scan InftyReader is sufficiently accurate for them to understand the text. They recommended that publishers hold the LaTeX of books



and papers but have found that this rarely occurs and in most cases it is necessary to contact the author directly.

Both Alastair and Robin use some mathematics/statistics software including R, Matlab, Maple and Sage. They noted that these pieces of software can all be accessed by working with the command line interface (text based terminal) to the software rather than the standard graphical interface (where this exists).

David Spybey (Spybey 2012), Alastair and Robin's A-level teacher was present and asked to comment. He noted that he has not, until this year, tried to use LaTeX and the above described system with another student. Now that he has he found it can be difficult to remember the specifics. He felt that fuller documentation of the approach would be beneficial. There was some concern that documenting a specific method might be construed as stating that this was the definitive method to read and write mathematics. Alastair and Robin felt it was important that students have choice and the flexibility to find the method which works for them in their context.

The session concluded with Alastair and Robin highlighting that they feel there is an element of responsibility on the part of the student themselves to learn the appropriate skills and to communicate with staff well regarding their process for working. They noted that this works as a partnership, the student knowing what they want and need and staff having the tools to provide this.

## Question and answer session

Questions to the panel, answers and points to the room are summarised in this section.

### **Question: Have you used NVDA (screenreader)?**

Yes, it does not yet work with the LaTeX-access scripts (the scripts for working with LaTeX and the JAWS screenreader) but it would be feasible. NVDA is free and open source and a viable alternative to JAWS. It can be carried around on a USB stick and used with any computer if a screenreader is not available.

### **Question: Do you feel that other students were key to supporting you?**

All of panel had used help from friends or colleagues. It was noted that sometimes just a single equation needed to be read, for instance, or a document visually checked and that relying on staff involves a waiting time which is not always feasible. It was noted that it was important for a reader to have a comparable skill level to read mathematics appropriately – peers on a module are most likely to have this.

### **Question: Only 10 students responded to the survey – do we know there were more e.g. from university responses?**

The institutional response rate was lower than that of the student survey so it is not clear. It was noted that the attitude of schools is crucial – that if a student is discouraged at school from the ‘harder’ options they are unlikely to study a STEM subject at university. However, a school’s ability to encourage a student is reliant on appropriately skilled staff. This was also considered to be an issue in HE as disability resource centres seemed relatively far more aware of how to support students with VI in ‘text based’, rather than science subjects.

**Question: Does it have to be LaTeX?**

An attendee had chosen to use mathematical Braille at university and had not foreseen the difficulty there would be in obtaining notes in the appropriate Braille format, which while possible has transcription challenges (Whapples 2007; Maddox 2007). However, while the attendee did learn LaTeX he always felt that using the full LaTeX system was not the most appropriate solution. He preferred to use MathType (Design Science 2009) with Word and input LaTeX codes only for the equations (that is, type LaTeX mathematics commands into MathType but not use LaTeX for the full document). It was concluded that there are multiple options and that students may need to try out different approaches. However, it was also noted that trying to learn LaTeX (or even just the LaTeX required for use with MathType) once at university is difficult as you are trying to learn a complete new language while studying.

**Question: How important are soft skills such as the ability to self-advocate, self-determine and evaluate information to make choices?**

It was agreed that these skills were particularly important in STEM at higher education level as students may need to educate staff on how they can best be enabled and that this requires a level of self-confidence. For instance, all panel members had themselves fully informed their DSA Needs Assessor regarding what was required agreeing that the Needs Assessor did not themselves hold the requisite STEM specific knowledge. Both Alastair and Robin focus on communicating with the academic school rather than with the disability resource centre. The academic school has greater STEM literacy than the disability resource centre so they found this to be more effective – however, this requires robust self-advocacy skills.

**Question: To enable staff to provide choice should all available methods be documented? How should we feed experience back to disability resource centres? Could LaTeX skills be learnt pre-arrival?**

It was acknowledged that documenting an individual experience might be resisted so it is not enshrined as best practice. Instead it was suggested that perhaps a library of methods should all be documented. This would save institutions time, energy and money and ultimately benefit staff, students and applicants. It was highlighted that to ensure knowledge held by only a few individuals/departments across the country was not lost it must be documented. Finally it was agreed that making LaTeX etc. learning resources available pre-arrival may be a positive step.

# Workshop 1: Exploring barriers by sharing experience

## Aims

- To explore the experiences, knowledge of and expertise in barriers to STEM
- To build on the presentations given at the start of the day
- To prepare the group to work together more formally in the afternoon

## Questions considered

1. What are the main barriers for students with VI studying STEM subjects at university?
2. What specialist skills might a student with VI studying a STEM subject need to acquire; when and how are these best acquired and developed?
3. What information is required and when by a school or college student with VI aspiring to study a STEM subject; what enables them to progress confidently towards that aspiration?
4. What specialist knowledge should staff in schools, colleges, the DSA process and universities have or acquire about approaches for studying STEM for students with VI; are there gaps in the support offered?
5. What are the main barriers for graduating students with VI aspiring to employment in a STEM industry; what is required while at university to enable a student to progress confidently towards that aspiration?

## Group 1

This group was formed of a Physics Graduate with VI, a Mathematics Teacher (VI specialist), a Vision Support Team Leader from a regional Sensory Support Service, a HE Disability Advisor, and a HE Widening Participation Co-ordinator.

### Question 1

- STEM subjects are visual and white/black boards are used
- Health and Safety issues in the lab environment – what is good practice?
- Accessible materials and making notes – complex question

*'Needs to be communication both ways: what student can use and what university can provide'*

*'When I did physics I was making notes in Braille but was using different methods for the workshops as maths is a complex subject, you can use LaTeX [...] but LaTeX and Braille doesn't suit all'*

- For the student - not having the right skills

*'You have to be 'up and running' before the course starts, so some students might need to be at the university in advance but under UCAS you don't know till late what university you will go to'*

- Variable software/tutors/staff understanding
  - Need partnership between DSA and Departments
  - Pre-university – visits by the Department staff

## Question 2

- Self-reliance – not all students come with ability to self-advocate

*'If you have been reliant on support at school, transition to the university might be a challenge'*

*'How do you know at what stage you need certain skills? ...Before university I should know what skills I will need'*

- Computer literate – more computer literate than average students and may require specific skills to be learnt
  - Pre-university – training in summer schools might be helpful

*'Some schools encourage use of different formats (LaTeX), but how one could know what exactly will be useful at university?'*

*'You need to be able to produce documents that tutors will be able to see, it is an advantage to have notes from lecturers in the format you can use'*

## Questions 3 and 4

- UCAS – application response from Department; first-liaison/engagement as soon as possible

*'We discussed subject, library, talked about other students' experiences... Students know very little about the university if there is no effort from the university...'*

*'...Who is responsible for the information flow – university or school? It is responsibility of university but also school... but there is a gap and lack of flexibility when there is a specific focus on VI'*

*'...We are getting in touch with the student very early, in November, by sending an introductory letter'*

*'As soon as we get an application we are getting in touch with the school'*

- Intro to LaTeX at Sixth Form might help to overcome potential problems

*'Introduction to LaTeX at A-Levels might be sufficient for starting undergraduate studies, but this can be achieved in a specialist setting...'*

*'...If these skills are essential, so is it a role for specialist schools in the process of transition? Should we be saying that skills are essential and what needs to be in place?'*

*'MathType system is only one way how to work. Students need to have options and being able to find out what works for them, not someone telling them how it should be done... You need to find out how you can format it'*

*'...Understanding all that, could we say that there is a 'bottom line' when and what student has to know and may be provide some choices?...'*

- Peer sharing information – undergraduate –to-school

*'There needs to be collaboration between schools and universities'*

- Summer schools – ICCPH

*'Many students who are not in a 'specialist setting' might lack aspiration... they might lack positive role models'*

*'Skills can be learned at the summer schools, for example I came across a summer school that had a number of different workshops to help students to learn but are five days of summer school enough?'*

*'...Who is paying for summer schools?'*

- Attitude of schools needs to be positive in STEM for VI

*'I cannot imagine that a teacher would say 'you are blind and can't do maths!' Where is evidence for that? The difficulties of the subject make it difficult for the teacher to prepare the student. You can't expect every school to have expertise in it'*

*'The 'move' has to be central as the cases are sporadic with geographical variations...'*

*'Some counties pulled their services across wide areas together'*

*'We have worked on the 'maths taster event' for year 9 and had to recruit a group from the all SW region to have a reasonable size group'*

## **Question 5**

- Recent economic downturn
- Lack of knowledge from employers – HR and employers still have a narrow view of what is possible for people with VI

*'There are employment opportunities from employers who are dealing with VI as they are knowledgeable of what is possible'*

*'I can imagine employers are concerned with health and safety issues'*

- Career section at university

*'I haven't seen many students applying to STEM. Is there an issue with employers or students are simply not available? There is no evidence...'*

- Work in VI sector
- Having examples of students with VI working in different careers

## Group 2

This group was formed of a Computer Science Graduate and HE Systems and Network Administrator with VI, a Geography and Computer Science Graduate with VI, a Head of a regional Sensory Support Service, a FE Visual Impairment Co-ordinator and a HE Senior Disability Advisor.

### Question 1

- Attitude: influence of schools

*'You have to develop interest in STEM in schools'*

*'Students need to be convinced that STEM is worth investing into as there will be financial implications'*

- Transition: control of funding and budget for student support external of colleges/HEIs, with funding issues the need to 'convince'/good will

*'Any support requires preparation and is therefore associated with cost. If you are the only person in your school it is difficult to make your case and push resources for support'*

*'VI has low incidence and it's all about incidence... the higher incidence- the easier to 'push' more resources into support. So, VI is pretty much about 'good will' of people around you and is about bringing people 'on board''*

- Teaching, accessibility of course materials

*'blackboard issues when lecturers don't have notes and have all information 'in their head''*

*'What do we do in teaching about visual concepts? Course design is a good example – all course materials designed with accessibility issues...'*

- Knowledge 'within' teachers – meeting different needs within a complex area of STEM subjects

*'Knowledge on VI support of individual teachers – can't be covered at teacher training as this area looks like almost a subject on its own right'*

- The format of the basic introductory information, especially at the points of information

*'There are information accessibility issues but banks manage it all?! There is always a statement that you can request information in different formats'*

*'We should be supportive of students' own choice'*

### Question 2

- Timing of skills acquisition
- Appropriate skills – element of student choice

*'It has to be student choice which university to go and how to learn... Some students might not want to learn Braille; I relied on tactile diagrams...'*

### Question 3

- Course description and details of content, including how study takes place, information about assessment, etc.
  - Highlighting areas that present challenges (or may)

*'Students need good descriptions of what a course involves, examples of diagrams, interaction... for everyone, not just disabled....'*

*'A lot these days based on internet support... schools and colleges might teach very little skills'*

- Signposting to support via institution/externally

### Question 4

- Product support

*'Talking text or LaTeX can produce maths. However, there is little work done on how to read chemical equations... There is some work but in a very early stage... So we need to support these new products. It is easy to focus on maths but there are some issues around diagrams...'*

- Transcription skills
- Knowledge of existing support, technology, resources available. Teachers and disability practitioners do not need to be experts in subject areas but need to know about resources and solutions

*'Knowledge needed of what is there. If these developments are subject specific, how can disability specialists access this information?'*

*'Open University has Tutors' Forum about experience and every case should be written up... solutions for disabled students can be used for designing tutorials for all students'*

### Question 5

- Hidden discrimination within employers
- Access to work funding issues/remoteness
- Finding out about jobs – improving with online resources but this depends on how accessible specialist industries post adverts are
- Appropriate professional bodies for advice and guidance
- Skills at the university :
  - independent study principles;
  - awareness of Access to Work while appropriate – knowledge of how to use Access to Work efficiently is a skill

### Group 3

This group was formed of a Mathematics Graduate and PhD student with VI, an RNIB Development Officer, a Vision Support Teacher and a HE Mathematics Teaching Fellow with experience supporting a student with VI.

### Question 1

- 'Old methods' in delivering lectures, for example boards are still used

*'You need to know what you have to learn from lectures in advance as maths equations are complex to read....'*

- Accessibility of materials and software

*'The main thing is to access the materials, such as books, notes, exam papers...'*

*'STEM subjects are more likely to be delivered in LaTeX. I have never had difficulties with LaTeX but my IT skills are very high.'*

*'Sometimes subjects are combined, for example Maths and Philosophy at [named university], so students don't have to do many modules in maths but need to invest in learning software... Does the student need to invest in learning of a 'language' that he will never use again?'*

- Access to books

*'Sometimes it is difficult to approach publishers; we are trying to create a system where it can be avoided'*



*'Lecturer does recommend books but as a reference, so other books can be used'*

*'To use other books can create issues around quality as at universities we are trying to replicate experience in learning... but it might not be possible in case of student with VI...'*

- Efficiency of support

*'I had excellent support as I was able to e-mail my files and it all will be quickly translated. [My institution] might have special circumstances for support and may be this can be shared?'*

## Question 2

- Reading, writing, diagram and research skills

*'Writing might be easier than reading...if you are familiar with LaTeX you can easily pick up some maths equations. Learning could start at A-Level at school'*

*'I am thinking about different students' experiences as some of them might have excellent specialist support available at school. This might not be the case in the mainstream schools...'*

*'Resources and support should be available to all students at pre-entry stage'*

*'Looking at maths, there are some helpful 'tricks' that could be picked up and learned from the students who've done it. Learning of these 'tricks' could start at GCSE... We could create a list that can be translated in LaTeX and standardised. Standardisation is important as equations look identical visually but very different when translated'*

*'you want students to be able to make own diagrams'*

## Question 3

- Teachers knowledge and experience is needed or students will not aspire

*'Some teachers might have negative experiences with maths and not to inspire students because of their negative experience...'*

*'There are many teachers who are desolate about maths... Aspiration and professional support are very important'*

- Need clarity as to appropriate and viable options for accessing STEM text

*'It has to be about the student and how this student interacts with IT.'*

*'I am on the mailing list for the blind maths students and it has been said that university should provide everything in Braille... but I am not sure that it is fair on universities as no university will be able to translate everything I need in Braille....'*

*'When using Braille, everything is slowed down... but you have to be able to interact simultaneously..., so translating into Braille isn't the best way....'*

#### Question 4

- Access methods for STEM subjects

*'not many people in the country know how to use the systems'*

- DSA Assessors' specialist skills

*'The benefits of earlier learning can be undermined by the DSA process; assessment of needs can't be 'a box tick exercise' that indicates that the student needs a laptop. Current recommendations do not fully reflect student's needs, particularly IT skills'*

*'DSA assessors might be reluctant to learn about VI as it is an additional thing... What is the general background of DSA assessors and Connexions staff in relation with STEM and what is their level of understanding regarding VI and STEM?'*

#### Group 4

This group was formed of a Mathematics Graduate and PhD student with VI, a HE Visual Impairment Advisor with VI, a Vision Support Teacher, a JISC TechDis Senior Advisor and a DSA Needs Assessor.

#### Question 1

- Lack of resources and materials in accessible format for STEM subjects
  - Copyright law; difficulties working with publishers
- Poor level of support in developing computer skills – ability to read and write in the format you feel comfortable with
  - Consistency of provision and accountability

*'School had money... but bought only a laptop'*

*'The level of students' expectations are dependent on whether students are in a specialist or mainstream school, so student may not be aware of what good support is and what questions to ask. At the moment – students and parents don't know!'*

- Aspiration (students and agencies)
- Awareness of what is available and lack of anticipation

*'lack of anticipation is a barrier, you need to prepare in advance'*

- Low self-reliance and self-advocacy

*'In schools decisions are made 'on behalf' of the student... Student needs to develop skills to know by A-levels what they need to know about the subject and what they want... how to build up to the point where a student is not dependent on teachers in making a decision about the subject?'*

## Question 2

- Read, write and study in format you feel comfortable with but also access to other formats
  - Flexibility and ability to experiment with different support systems and software
  - Range of skills – access to information in braille, audio info, use of symbols

*'I have been advising my students on 'being bi-lingual'... How do you get to the point of having flexibility? Students need to be able 'to move out of' their 'comfort zone' and practice for 2-3 months, so one specialist skill would be to encourage skills that would allow student to try different things and 'experiment' with software'*

*'Key skills are reading and writing without going through transcription e.g. LaTeX [...] I have experimented with different things. I had a group of students and we helped each other to try new... it is down to personality and preferences....'*

- Independent study and travel skills

*'Independent travel skills are not specialist skills but you 'can't do' at the university without them...'*

- Self-advocacy
- Ability to identify clear goals and mile stones

*'The question is when and what information is required?'*

## Question 3

- Can you assume access to lecture notes in advance (and in the format required)?

*'Will academic staff be willing to provide lecture materials in advance?'*

- Feedback from and communication with other students should be available

*'Ideally the university should have a track record of the experiences of other students [...] informal student community cross country to talk about experiences'*

*'It will be good to have a list of people who are doing STEM subjects, so you can 'call for help' in short notice'*

#### **Question 4**

- Understanding of importance of Braille skills for STEM subjects

*'Some children don't learn Braille until late [...] if you can use Braille you can read a range of formats'*

- DSA process

*'There is no knowledge about the specific subject support in DSA'*

*'There is a perception that the DSA processes are influenced by marketing rather than by understanding what support is needed, we did work with libraries and its always about 'Read and Write and Inspiration'. What learners need may come in hundreds of different ways... What happens if the needs are different?'*

*'How to supply these different needs through standardised DSA process?'*

*'DSA – need to liaise and negotiate with students to identify and arrange resources...'*

*'Standardisation of DSA process might not be realistic in the case of VI'*

## Workshop 2: Drafting a framework to assist learners and their teachers to plan for higher education

Groups considered the student's journey split into 5 distinct phases:

1. Pre-application
2. Pre-entry
3. Transition to HE study (first year)
4. Later years of study (possibly including placement year)
5. Career planning

In each phase groups considered 4 areas:

1. **Student's actions:** What does the student need to do in this phase and what are their information needs? Who is available to advise?
2. **Skills development:** What are the skills development needs of the student at that stage in order to progress confidently to later stages? What specialist skills may they need to start acquiring or develop further at this stage? Who is available to teach or support this development? Who is available to advise?
3. **Teaching and learning:** What barriers might there be to a student progressing? How can teaching staff work to remove these barriers? What are the development and information needs of the teaching staff? Who is available to advise?
4. **Support:** What specific support and equipment might be required or offered? How can a student be enabled to discover an approach which works for them? How are the resources sourced and staffed? What are the development and information needs of the support staff? Who is available to advise?

Groups drafted the framework as a table with the 5 phases as rows and the 4 areas as columns – an empty table is drafted below for clarity:

	Student's actions	Skills development	Teaching and learning	Support
Pre-application				
Pre-entry				
Transition				
Later years				
Career planning				

The group discussions were also recorded to ensure that we were able to interpret the written output and to expand on it where necessary.

## Method

Each group produced a framework and we have integrated these into one and present this below. In the skills column there was some disagreement between groups as to which skills might be learnt (though agreement on a broad classification of skills) and when they were best learnt (though agreement on a gradual approach and the need for preparation). This has been captured in the integrated framework. Where groups covered similar points these are amalgamated and if a point was made by only one group it was either kept or reported within a broader point should one be present already. This collation of the framework outputs was completed by the authors. Before presenting the framework we first note some further discussion themes via quotes. These are presented as they provide explanatory background for the framework.

## Discussion points

While drafting the frameworks many points noted during the talks and workshop 1 discussion were revisited and expanded upon and some new points were also made or strengthened. We highlight some themes with explanatory quotes from the groups before presenting the integrated framework.

### How early?

It was discussed that at least some input or advice was needed as early as year 9 in the pre-application stage to ensure students are aware STEM subjects are available to them:

*'How far back do we go in starting thinking about pre-application stage? Year 9?'*

*'At GCSE student needs to have broad ideas about carrying STEM subjects forward and focus at A-Levels. General information is needed about the subject area at the earlier stages to enable a student to think 'Yes, I can do this!' But who is needed to advise students?'*

*'Some schools have career advice staff... but they won't have specialist knowledge.... RNIB? Who would know?'*

### Making an application

The graduates present had each spend time contacting universities to gauge their ability to co-operate in providing support, the support already in place and whether the university responded in a positive manner. It was noted that there is a wide range of responses, flexibility and level of support already in place. Applicants are likely to need to start this process early and universities may need to take heed of perceptions applicants form during these early contacts:

*'...One university I e-mailed to responded in quite a negative way by saying how much it would cost me and how difficult it will be for me – reply was long. I felt that there are some problems and didn't apply. I felt some universities didn't want me to apply...'*

*'Lots of times students speak to different universities... Which universities? Do you select from a list? I looked for the best ones, but who is more co-operative in providing support – but also subject knowledge, attitude to disability. It is about people, at [named university], for example the system was already accessible for me while [a different named university] had to put adjustments in place...'*

*'When you started your process of selecting universities, had you been given a 'reduced' list of universities with the support system in place? No, it is not all about 'what universities can offer', it is about people, how much they are prepared to work with me and meeting my needs – how flexible they are. However, you need to be clear what you are looking for before getting in touch with the university.'*

Some applicants may not have a strong enough skill set to be able to ask the 'right' questions to assess whether the support available would be suitable:

*'Not many students are proactive and able to generate in depth questions about support needs in transition from school to university...'*

### **Skills: what and when?**

There was some acknowledgement that the focus of the school is likely to be on attaining the required grades rather than building additional skills which may be *required*, in the main, only in later studies:

*'At school we focus on grades but we don't think at the time how students will cope when 'they get there''*

Although it was underlined that there is no resistance from teachers – that rather, there is a lack of information and subject specialist expertise:

*'What teachers want to do is to ensure that a student is able to 'move forward'. We need to know what needs to be in place, what is needed. Teachers are willing – there is no resistance from teachers'*

*'Skills development aspect has to come from universities... universities need to specify the skills needed by a student as some skills are generic but other skills are subject specific.'*

*'In the special school, you might have sessions of these skills but not if you are in the mainstream school'*

There was broad agreement that certain types of skills were required (including some level of LaTeX either the full system or enough to use, for instance, a specialist editor such as MathType) and may need to be considered *before* arrival.

*‘Students need to be computer literate... At which point do students need to have the STEM subject specific computer skills?’*

*‘Is LaTeX a skill? Yes, you need it even before you start’*

*‘Students should be sure that they have the skills to cope with the course, make sure universities know what you use. I was confident as I used LaTeX, so you and the university can work together’*

*‘You need to have in place as much as possible – learn LaTeX and other things – otherwise if you will be worried about moving and settling in – what about all the academic stuff?’*

After the day an attendee noted that while it seemed that learning of new skills *‘should happen’* that the timing of such skill acquisition remained problematic. Acquiring new skills prior to university entrance may distract from the core aim of achieving good A level grades but even in this situation it was not felt to be clear cut:

*‘is it better in the long term even if A-level results are slightly lower than they could be[? It is] a very fine line and difficult to judge, leaving learning the specialist skills to later does make it much harder when starting at university.’*

Experienced universities may be best placed to train specific skills required for a subject if such training is not available in school:

*‘How about learning from people who have experience in supporting students at school and universities by running a pre-entry event?’*

More generally it was felt that engaging with the university pre-arrival is important:

*‘Open Days are good – but they are very busy – and for many students it is too early to know what universities they are going to apply to. Open Day pre-engagement is too early... over summer period is a good time?’*

*‘I had a lot of e-mails exchanged about what I am doing but nothing official such as an event.’*

*‘[Named university] has good practice: visit school and chat to a perspective student to identify what support is needed at the university – to ensure teaching and learning quality. So we recommend to engage with a school or college’*



It was also noted that while it was agreed that certain classes of skills were required being prescriptive about specific methods was not helpful. All groups highlighted that other skills are particularly important for STEM subjects while not specifically being STEM skills, for instance, self-advocacy, communication skills and speed of working:

*‘Students need to be able to identify their needs and be clear about it’*

*‘Social networking is important, getting peer support...’*

*‘In HE [you are] required to produce things quickly’*

Finally, skills which all university students with VI, regardless of subject of study also required were noted e.g.

*‘If you are in a specialist school, you have already lived away from home but your environment was very adapted. This would be different for someone from the main stream schools, so different students will need to learn different skills to become fully independent...’*

*‘It is dependent on [...] how independent students are. Students have to develop independent living skills in advance to be able to succeed in the new environment. Skills for life are important’*

Some skills it seemed would need to be developed further at university during the transition to a new teaching and learning environment:

*‘You need to learn how to get the most from the lecture and to understand what is going on on the board. This can be possible by knowing how much you need to understand from the lecture. It is different to learn with 120 other people and this is a different type of learning... In an ideal world you will go through the lecture notes afterwards to consolidate everything but in reality there are time constraints’*

*‘Everyone does maths very differently – the learning style has to be tailored to the individual... Finding a learning style that is sustainable requires effort and self-discipline’*

This also highlights that students, for instance, require notes beforehand and perhaps other study support to enable building of strategies.

### **Support via DSA: identification, timing and type**

A Disabled Student’s Allowance (DSA) Needs Assessment is a mechanism not only to determine what equipment, non-medical helper support (study support workers) and allowances should be recommended but recommendations can also be made to the institution. It is key that the needs assessor has a clear understanding of how STEM subjects are taught, the specialist skills required for STEM and the constraints under which the student and the department may be working (e.g. a department may

not have staff who are able to create accessible resources which contain equations). However, the needs assessment process was criticised as was the limited flow of information from STEM departments into this process:

*'What is the background of the Needs Assessors? If Needs Assessors don't have a specific background they can't advise properly!'*

*'Universities are software subject specific, so it may be that they need to become more proactive in talking to students about students' needs at the university... but how do we do that?'*

*'The Needs Assessor should know what a course entails, what software is used by the university, what the student currently uses and how this might work with the specialist subject areas and what skills would be required... but at this stage it is very late to learn new skills...'*

*'The Needs Assessor might recommend to use Braille [via transcription]. It is assumed that if in Braille it's accurate but Braille [transcription] isn't very accurate. Although accuracy of the software is improving there are silly things like capital letters in the middle or the end of the sentence...'*

The timing of the A level grades and hence the final decision regarding which university leaves little time for a needs assessment, delivery and training on equipment. An earlier Needs Assessment may not be possible if the strategies a student needs to use are dependent on the department and institution in which they will study:

*'We need to remember that there is not much time available to a student to learn everything which will be required at the university if you don't know earlier on to which university to go. I had to get in touch with the university before my A-Level results, so it is a gamble – if you don't know which university – how can one collaborate with it in advance with 'all on teaching-learning strategies'....It is a gamble...'*

Support via the DSA may include non-medical helpers (study support workers). It was noted above in the skills section that study support to build strategies and specialist training in STEM access technology may be needed – but the focus should not just be on technical and study strategies. Students may feel isolated especially if their methods for interacting with university systems make it difficult to work with other students:

*'I am using my laptop and don't log into the university system....You might feel excluded'*

*'Would academic or social mentors be helpful?'*

## Institution support: what and how?

The need to share good practice between the universities which had successful support mechanisms and those with less experience was noted:

*'It is good to share good practice and for the students to go where they want to go... and be sure that the support mechanism could be developed at [other] universities. Students should be confident that the support mechanism can be put in place.'*

It was also highlighted that universities should learn from current students and clear mechanisms for this to happen were required:

*'Universities have support services... but they should learn from students. I am not sure if this mechanism exists and is complete'*

Support set up does not end with the creation of accessible lecture notes or the DSA recommendations. The university may need to invest in additional equipment and spend time considering how to adjust assessments successfully while maintaining academic quality:

*'At my university we have put a lot of thought in about exams, but at the end the university wasn't happy for me to use my computer for exams, so the university had to get a new computer and install all the software. I then had to test it worked properly for me. After the test the computer had to be re-checked so it was 'all clean' and I hadn't transferred any of my notes on to the computer... it took us months to complete.'*

*'Assessment regime needs to be established earlier: how exams will be delivered, what about supervision, extra-time needed, what are the standards and quality assurance? It is all down to individuals at the moment. [Named university] is very strict with exams, at other universities exams are open-ended.'*

## Student questions

One group noted a set of questions a student might use as a basic guide when they are working with the university and their needs assessor to design an approach:

- Have I got the skills to read and produce materials in an appropriate format?
- What format will I receive the materials in and who will transform it if required?
- Who are my key contacts and who will be responsible for what?
- Have I read the relevant equalities policy and does it have SMART objectives?
- Am I fully aware of my rights and responsibilities?
- Am I able to self-advocate and if not, who could help me?

- Is there a service level agreement in terms of timescale for alternative formats and support?

It is noted that these questions are not exhaustive but should be seen as a starting point on which individual students are encouraged to expand.

### STEM: How to teach, how to support?

Teaching staff are unlikely to have experience teaching a student with VI in either a large lecture group or a small group. They will have valid questions on how to approach this – some of which may be specific to STEM:

*‘How to teach if you might not be able to go through all planned material?’*

For instance – if long mathematical or chemical equations are present it may not be possible or useful to read these aloud in class. Diagrams may be too time consuming to explain and mathematics notation when read aloud can become ambiguous. A change in teaching approach may need to be radical:

*‘Use e-materials, so pupils don’t ‘do learning’ in the classroom, use the classroom for discussions, consolidation and reflection.’*

*‘[Named university] has an advantage in the tutorial system in place for each student, so the tutor can explain what you need and you are on the top of your academic work and have good notes in advance...’*

In parallel with the student questions above, a basic list of questions for staff collaborating to find an approach might be:

### Staff questions

- How will any required additional resources such as software, hardware, e-books etc. be funded, procured and delivered?
- How accessible is course specific software?
- How accessible are course materials and resources e.g. including e-books?
- How do you know a resource is accessible? Has it being tested by a person with VI?
- Is accessibility part of your procurement policy?
- How do I get staff development in STEM accessible teaching?
- Have you rated your reading list for accessibility and publisher responsiveness?
- Are there web resources or forums/lists I can join for professional development?
- Do I know who to ask for help on STEM accessibility?
- How do we quality control our service e.g. in terms of timescales?
- Are my lecture notes accessible and available on the virtual learning environment or web?

It is noted that these questions are not exhaustive but should be seen as a starting point on which individual staff are encouraged to expand.

### **The need for centralised resources**

Many times throughout the day the need for centralised resources was noted:

*'If a university had a student previously, it could be helpful to share learning from the experience but many universities won't have this experience as there are not many students with VI in the universities...'*

*'Parachuting' staff might not be efficient, so how about creating central resources that include recommendations for studying? Universities and schools can use it as required and on-line training might be available through that?'*

*'So... Resource Centre could help to ensure full engagement in the assessment process, support dialog with support staff at schools and universities, share information. It could include advice from universities on how to apply, by having access to the Central Resource HEIs could run events and look how to integrate.'*

Such a central resource would not just be for staff but for students to share experience:

*'We bring students together to discuss a particular subject and for them to have an opportunity to meet again and have a conversation'*

*'I agree – it is important to be able to share information. I used the math mailing list [probably Blindmath list]... But similar exists for Science in the US...'*

However, it is not apparent how such a central resource would be created, funded and maintained:

*'If money were there then universities might be able to do it, where are the funds?'*

## Integrated framework

This framework and the accompanying recommendations and areas for consideration in the next section integrate the four group frameworks and draw on the discussions of those groups. The framework is presented as a table to highlight the structure of the information; however, we acknowledge that this may be difficult to read due to the length of the cells. The same information is presented, by row (and so phase) in the section Appendix: Integrated framework in linear format by rows at the end of this document.

**Table 1: Integrated framework**

	<b>Student's actions</b>	<b>Skills development</b>	<b>Teaching and learning</b>	<b>Support</b>
<b>Pre-application</b>	<p><b>Do:</b></p> <ul style="list-style-type: none"> <li>▪ Identify interests and plan route through correct choice of subjects at school</li> <li>▪ Gain input from teachers, SENCOs, disability staff and other advisors on route, modes of study, likely required preparation etc.</li> <li>▪ Start pre-application process earlier than UCAS process including approaching universities for access to STEM information.</li> <li>▪ Compile a potential</li> </ul>	<p><b>Skills to develop:</b></p> <p><i>It is noted that specialist and subject skills are best developed gradually, likely starting in a school environment during A-level and continuing through pre-entry and transition.</i></p> <ul style="list-style-type: none"> <li>▪ Subject specific knowledge and specialist skills appropriate to STEM study including IT skills, use of technology and study skills.</li> <li>▪ Specialist skills should include acquisition of an effective reading and writing method for</li> </ul>	<p><b>Barriers to progression and methods of resolution:</b></p> <ul style="list-style-type: none"> <li>▪ Staff and parents may inaccurately discourage interest in STEM due to negative stereotypes or insufficient information.</li> <li>▪ Experience in specialist areas including skills development for STEM study not necessarily available in all schools.</li> <li>▪ Teachers may have limited training in how to meet the diverse needs of students, how to take a flexible approach and to communicate</li> </ul>	<p><b>Identification, access to and resourcing of appropriate support and equipment:</b></p> <ul style="list-style-type: none"> <li>▪ Students may require access to specific technology and training e.g. in use of IT, Braille. Their access to and use of technology and training may need to be reviewed in light of a decision to focus on STEM subjects at A-level.</li> <li>▪ Specialist transcription services may be required for STEM resources.</li> </ul>

	<b>Student's actions</b>	<b>Skills development</b>	<b>Teaching and learning</b>	<b>Support</b>
	<p>short list of universities and open dialogue regarding their approach and support which they could offer.</p> <p><b>Information needs and advisors:</b></p> <ul style="list-style-type: none"> <li>▪ Advice on the appropriate time to start planning for studying a STEM subject.</li> <li>▪ Positive, realistic information and early advice (pre-GCSE and A-level choices) to students, teachers and parents to prevent barriers including assumptions about what can be studied. This should include careers advice.</li> <li>▪ Access to role models including successful students, graduates and employees in STEM subject areas.</li> <li>▪ Evidence that 'someone has done this before' at individual institutions.</li> </ul>	<p>equations whether in Braille, large print or audio. This is likely to include introduction of some quantity of LaTeX and decisions regarding appropriate text editing environments (e.g. MathType and Word, Emacs etc.).</p> <ul style="list-style-type: none"> <li>▪ Specialist skills should include acquisition of an effective method for working with diagrams. This might include use of tactile diagrams.</li> <li>▪ Specialist skills should include acquisition of higher level IT skills; learning to make good use of digital media; research skills for searching, sifting and prioritising and study skills including a self-aware approach to for instance, planning an approach to study, monitoring speed of working etc.</li> </ul>	<p>information in different ways. This may have a disproportionate effect on experience of STEM subjects due to the modes of communication generally used.</p> <ul style="list-style-type: none"> <li>▪ Schools may have limited access to information required by the student to prepare specifically for STEM study and so may find it challenging to provide information in a timely manner.</li> </ul> <p><b>Information needs of and advisors for teaching staff:</b></p> <ul style="list-style-type: none"> <li>▪ Communication between institutions, organisations and agencies involved in transition is required to support staff in information provision and skills development.</li> <li>▪ A collaborative approach between</li> </ul>	<ul style="list-style-type: none"> <li>▪ Students may require support in accessing transition information, making choices and planning.</li> <li>▪ Universities are best placed to communicate how STEM subjects are taught at HE level, the skills required and the approaches which work. Widening participation taster days/courses should be offered early to pupils with VI and summer schools should be offered for both pupils and subject teachers at A level. These events should include a 'taste' of how support would work, what technology might be used and how teaching and learning can be accessed in STEM. Role models or evidence that 'someone has done this before' can also be provided.</li> </ul>

	Student's actions	Skills development	Teaching and learning	Support
	<ul style="list-style-type: none"> <li>▪ Clear course descriptions which specify access approaches and required skills.</li> <li>▪ Access to a central pool of information (currently disparate, individuals hold information in isolation) regarding studying STEM subjects for students with VI. This should include resources, practical information and advice.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Soft skills are particularly important including: being able to self-advocate; being able to identify needs and clearly communicate them; decision making skills; ability to respond flexibly to a range of situations.</li> <li>▪ Students also need to develop independent living skills, mobility and travel skills and knowledge of adjustment at university.</li> </ul> <p><b>Supporting and advising on development:</b></p> <ul style="list-style-type: none"> <li>▪ It is acknowledged that the school's focus may be on students gaining grades to secure a place and that specialist STEM skills may be challenging to deliver. Students and teachers require access to central resources for</li> </ul>	<p>subject and VI specialists is required to ensure that specialist skill development can be delivered.</p> <ul style="list-style-type: none"> <li>▪ Staff may need to engage in further reflection on practice with access to specialist advisors (including those with experience of preparation for HE) to adapt teaching to meet skills need by VI students e.g. learning Braille, typing skills, tactile diagrams, specialist skills for STEM.</li> </ul>	<p><b>Information needs of and advisors for support staff:</b></p> <ul style="list-style-type: none"> <li>▪ A central pool of information, suitable to role and institution level (i.e. School/FE/HE) should be available advising on availability of assistive technology, software, transcription, training etc. specifically for access to STEM subjects.</li> </ul>



	Student's actions	Skills development	Teaching and learning	Support
		<p>specialist skill acquisition and may benefit from partnership with a HEI.</p> <ul style="list-style-type: none"> <li>A student's family is likely to play an important role in development of soft skills and independent living skills.</li> </ul>		
<b>Pre-entry</b>	<p><b>Do:</b></p> <ul style="list-style-type: none"> <li>Use university websites and prospectus as a first line accessibility check. Use open days to check against own skills and requirements.</li> <li>Establish contact with the university department and Disability Services. Organise to visit both and start planning an approach.</li> <li>Establish contact with current students with VI studying a similar STEM subject.</li> <li>Open dialogue with</li> </ul>	<p><b>Skills to develop:</b></p> <p>It is noted that specialist and subject skills are best developed gradually likely starting in a school environment during A-level and continuing through pre-entry and transition.</p> <p>The skills a student might need to develop are highlighted in the above pre-application stage. Additional skills relevant at pre-entry may also be:</p> <ul style="list-style-type: none"> <li>Start to develop skills to manage time effectively and cope with the change from highly supervised learning to</li> </ul>	<p><b>Barriers to progression and methods of resolution:</b></p> <ul style="list-style-type: none"> <li>The main barrier to progression is if any part of the institution is not aware in advance of how to meet a student's needs. This is not limited to the student's department or the disability service but includes IT and e-learning systems, the library (electronic and physical resources) etc. All facets may need to consider not just general good practice</li> </ul>	<p><b>Identification, access to and resourcing of appropriate support and equipment:</b></p> <ul style="list-style-type: none"> <li>DSA Needs Assessment centres should ensure that assessors working with students studying STEM subjects have appropriate training and access to relevant information so effective study strategies and aids are identified.</li> <li>Accessibility of the physical campus, IT and e-learning, the library, student services</li> </ul>

	<b>Student's actions</b>	<b>Skills development</b>	<b>Teaching and learning</b>	<b>Support</b>
	<p>university department to discuss specifics of access approach including to lectures, tutorials, labs, notes and reading list. Check availability of core texts and lecture notes in appropriate digital formats.</p> <ul style="list-style-type: none"> <li>▪ As an outcome of above, identify additional equipment and software that will be needed at university. Ideally do this prior to engaging fully with the assessment of needs process and as early as possible.</li> </ul> <p><b>Information needs and advisors:</b></p> <ul style="list-style-type: none"> <li>▪ Access to a range of local information including local VI services.</li> <li>▪ Clear advice on navigating the DSA process as a STEM student with VI.</li> </ul>	<p>university.</p> <ul style="list-style-type: none"> <li>▪ Skills to manage finances.</li> <li>▪ Staff management skills for working with study support workers.</li> </ul> <p><b>Supporting and advising on development:</b></p> <ul style="list-style-type: none"> <li>▪ In order to continue developing skills noted above during pre-entry students would need access to resources, technology, training and advice during the summer period prior to university. This is necessary to ensure that a basic set of skills are in place to cope with the course pre-entrance. Such pre-entry support requirements would ideally be recommended and funded as an outcome of the needs assessment.</li> <li>▪ The student needs to</li> </ul>	<p>but also good practice in STEM subjects and the specific needs of the individual student.</p> <ul style="list-style-type: none"> <li>▪ Failure to proactively embed inclusive practices for STEM teaching throughout delivery may leave significant barriers which cannot be addressed at short notice.</li> </ul> <p><b>Information needs of and advisors for teaching staff:</b></p> <ul style="list-style-type: none"> <li>▪ Teaching staff need to know what has to be in place for a student in advance to enable the student to achieve. This advice may need to be specifically tailored for STEM subject areas so as to be practical and useful.</li> <li>▪ Schools and colleges could start to integrate in to transition by starting some teaching</li> </ul>	<p>and teaching and learning should be identified via appropriate audits. This should include differentiation between STEM and text based subjects.</p> <ul style="list-style-type: none"> <li>▪ Issues with when DSA funding can be made available may currently preclude students being able to practice/learn skills in advance pre-entry. This would need to be resolved.</li> <li>▪ The university, as well as DSA funding, may need to consider provision of technology, software or equipment. E.g. student may need dedicated terminal in computer lab and exam arrangements may also require procurement of a full mirrored setup.</li> <li>▪ Universities may need to consider what specialist skill training</li> </ul>

	<b>Student's actions</b>	<b>Skills development</b>	<b>Teaching and learning</b>	<b>Support</b>
	<ul style="list-style-type: none"> <li>▪ Technical information on the institutional systems they will need to access and use on arrival – including information about specialist STEM software and equipment.</li> <li>▪ Assistance locating and establishing contact with current students with VI in similar STEM subjects.</li> </ul>	<p>know what support is available on entrance in advance, to enable planning.</p>	<p>earlier, particularly skills, via on-line resources or in partnership with the HEI.</p>	<p>falls within their remit as subject specialists rather than under that of the assistive technology trainer.</p> <ul style="list-style-type: none"> <li>▪ Universities may need to run events and information days to raise awareness of how STEM subjects are taught at university. This awareness is required by the needs assessor, assistive technology trainers and other study support workers in addition to the student.</li> </ul> <p><b>Information needs of and advisors for support staff:</b></p> <ul style="list-style-type: none"> <li>▪ Active dialogue between existing (school) support staff, university support staff, DSA needs assessors and university teaching staff is required for a collaborative approach.</li> <li>▪ Staff in various roles</li> </ul>

	Student's actions	Skills development	Teaching and learning	Support
				require access to resource banks and training resources in methods for accessing and working with STEM content.
<b>Transition</b>	<p><b>Do:</b></p> <ul style="list-style-type: none"> <li>▪ Orient and settle in, navigate living independently and take time to integrate into social network including attending fresher's week!</li> <li>▪ Take responsibility for learning!</li> <li>▪ Work with the Disability Services Team to empower decisions about support.</li> <li>▪ Proactively engage with peers, staff, authors of books you require access to etc. – transition is about networking.</li> <li>▪ Make the most of tutorials – take the opportunity to ask</li> </ul>	<p><b>Skills to develop:</b>  It is noted that specialist and subject skills are best developed gradually likely starting in a school environment during A-level and continuing through pre-entry and transition.</p> <p>If the above has not occurred then a student may commence their course without basic required skills. Their ability to acquire these while studying will depend on the course demands.</p> <p>Additional skills relevant to transition include:</p> <ul style="list-style-type: none"> <li>▪ Explicit learning about the culture of the HEI and department including 'who is who', 'who does what' and</li> </ul>	<p><b>Barriers to progression and methods of resolution:</b></p> <ul style="list-style-type: none"> <li>▪ The most significant barriers to transition are the school not appreciating the requirements of the university course and the university not understanding the requirements of the student or how they previously approached learning at school.</li> <li>▪ Lecturers might not be willing to adjust or able to be flexible in their teaching approach.</li> <li>▪ Lack of alternative formats or staff not having the required skill set to create accessible</li> </ul>	<p><b>Identification, access to and resourcing of appropriate support and equipment:</b></p> <ul style="list-style-type: none"> <li>▪ Feedback mechanisms should be available to all students but explicit invitations to provide regular feedback from students with VI may allow timely identification of need for support or equipment.</li> <li>▪ During transition there may be a need for additional support which might lessen later in degree. Use of mentoring and regular meetings to ensure the student has points of contact. This may need to be identified and</li> </ul>

	<b>Student's actions</b>	<b>Skills development</b>	<b>Teaching and learning</b>	<b>Support</b>
	<p>questions, discuss your learning style, try out methods of interacting with your subject.</p> <p><b>Information needs and advisors:</b></p> <ul style="list-style-type: none"> <li>▪ General and also STEM specific advice and guidance regarding the skills needed to access their course and how to approach their studies throughout transition.</li> </ul>	<p>'who is in my network'.</p> <ul style="list-style-type: none"> <li>▪ Develop self-discipline, motivation and skills to manage time effectively and cope with the change from highly supervised learning to university.</li> <li>▪ Learn to develop own learning methods e.g. how to use and take STEM lecture notes during class etc.</li> <li>▪ Become an independent learner in terms of assistive technology etc. and develop confidence to communicate their use of technology/strategies when meeting with study support workers, teaching staff and, in future, employers.</li> <li>▪ Develop interpersonal and networking skills which enable access to informal peer support.</li> </ul> <p><b>Supporting and advising on development:</b></p>	<p>formats for STEM study – including equations and diagrams.</p> <ul style="list-style-type: none"> <li>▪ Lecture notes not available prior to class.</li> <li>▪ Inaccessible IT and laboratory resources.</li> <li>▪ Inaccessible assessments.</li> </ul> <p><b>Information needs of and advisors for teaching staff:</b></p> <ul style="list-style-type: none"> <li>▪ Staff may need to adapt their teaching style in a manner appropriate to their subject – external training and support may be required and may need to be provided centrally via e.g. HEA and JISC TechDis.</li> <li>▪ Training in both the use of simple accessibility techniques but also in the creation of accessible electronic formats.</li> <li>▪ Discussion and agreement as to the</li> </ul>	<p>funded via DSA.</p> <ul style="list-style-type: none"> <li>▪ External support mechanisms such as the BlindMath mailing list and similar which can provide support to both the student and department staff should be identified.</li> <li>▪ IT, e-learning and library support may be required by both student and staff. Staff responsible for these systems may need to identify and resource changes to increase accessibility – both general and STEM specific e.g. for equations in electronic resources.</li> </ul> <p><b>Information needs of and advisors for support staff:</b></p> <ul style="list-style-type: none"> <li>▪ Support assistants, mentors, notetakers and alternative formats creation with STEM expertise may be</li> </ul>

	Student's actions	Skills development	Teaching and learning	Support
		<ul style="list-style-type: none"> <li>▪ The development of study skills specific to an individual may require input from a study skills specialist with an understanding of STEM subjects or possibly in collaboration with other study support such as readers, note-takers etc.</li> <li>▪ A key question regarding the continued development of STEM specific specialist skills is: where does this learning take place? The STEM department holds the STEM expertise so a collaborative approach between the student, the department and support professionals may be required.</li> </ul>	<p>examination process involving both specialists and university staff may be required. Technology might need to be purchased by university as students may not be allowed to use their own laptop with access technology.</p>	<p>required. This may require recruitment and training on which advice from external bodies may be needed. Ideally a national bank of such specialist services is required to ensure timely access to the right support.</p>
Later years	<p><b>Do:</b></p> <ul style="list-style-type: none"> <li>▪ Focus on academic studies as access issues should have</li> </ul>	<p><b>Skills to develop:</b>  <b>Students should by now have acquired a rich STEM and specialist skill set.</b></p>	<p><b>Barriers to progression and methods of resolution:</b></p> <ul style="list-style-type: none"> <li>▪ Attitudes and</li> </ul>	<p><b>Identification, access to and resourcing of appropriate support and equipment:</b></p>

	<b>Student's actions</b>	<b>Skills development</b>	<b>Teaching and learning</b>	<b>Support</b>
	<p>been lessened by now. However, continue to review, reflect and act to make necessary changes including reflection on approaches to learning.</p> <ul style="list-style-type: none"> <li>▪ Consider a placement if offered. This will require proactive organisation.</li> <li>▪ Research placement, company and role; organise an initial visit to the placement venue, and consider organising a phased first week.</li> <li>▪ Ensure that placement is reflected upon and evaluated both for academic and personal specialist skill development.</li> </ul> <p><b>Information needs and advisors:</b></p> <ul style="list-style-type: none"> <li>▪ To plan for placement with a collaborative team including the Department Placement Team and the Disability Service.</li> </ul>	<p>Additional skills relevant to later years may include:</p> <ul style="list-style-type: none"> <li>▪ Use of a complex set of communication, technical, subject and soft skills to determine, with others, how to access placement systems and software.</li> <li>▪ Developing mobility, orientation and travel skills in employment venues if on placement.</li> <li>▪ Development of research skills in preparation for dissertation writing.</li> </ul> <p><b>Supporting and advising on development:</b></p> <ul style="list-style-type: none"> <li>▪ Students may require specific advice or support in adapting to work ethos for placement year.</li> <li>▪ Development of research skills may require further training or support.</li> </ul>	<p>apprehension regarding placement may result in a student not taking up this opportunity or staff advising against it.</p> <ul style="list-style-type: none"> <li>▪ There may be a need for a suitable work environment for a student with VI to be identified by the university and for the employer to be aware of the student's individual needs. This process requires proactive organisation and a collaborative approach.</li> <li>▪ Lack of advance notice on reading lists may impact on access to resources and timely transcription or creation of alternative formats.</li> </ul> <p><b>Information needs of and advisors for teaching staff:</b></p> <p>By this stage, department staff should be aware how to work to ensure access but new lecturers and</p>	<ul style="list-style-type: none"> <li>▪ The student continues to need to be organised and proactive in arranging and communicating regarding their needs for access. This includes with respect to a placement. The student may require suitable staff support in this. This may need to be foreseen and funded via the DSA.</li> <li>▪ It is important that students on placement have a point of contact at the university and are visited at their placement. They may require additional or earlier visits.</li> </ul> <p><b>Information needs of and advisors for support staff:</b></p> <ul style="list-style-type: none"> <li>▪ STEM placements potentially pose additional issues for students with VI. The situation needs</li> </ul>

	<b>Student's actions</b>	<b>Skills development</b>	<b>Teaching and learning</b>	<b>Support</b>
	<ul style="list-style-type: none"> <li>Assistance from staff in identifying suitable placement venues.</li> </ul>		<p>tutors may be involved at any stage. The department needs to ensure that approaches are agreed and disseminated.</p> <ul style="list-style-type: none"> <li>The university including the department should review and evaluate regularly and identify any required changes to approach. Should the modules or degree change consideration of the impact of this may be required.</li> </ul>	<p>clarification, documenting and disseminating on a national basis.</p> <ul style="list-style-type: none"> <li>Staff will require information regarding Access to Work if it applies for the placement in order to support the student.</li> </ul>
<b>Career planning</b>	<p><b>Do:</b></p> <ul style="list-style-type: none"> <li>Explicitly reflect on placement or work experience learning if applicable. Consider what skills or experience may need to be developed.</li> <li>Explore available jobs, and requirements to organise relocation.</li> <li>Consider whether post graduate study is appropriate.</li> </ul>	<p><b>Skills to develop:</b>  Students should by now have acquired a rich STEM and specialist skill set.  Additional skills relevant to careers may include:</p> <ul style="list-style-type: none"> <li>CV/Application and interviewing skills.</li> <li>Ability to build and communicate a portfolio of strategies around support so as to be empowered but also to take on some level of</li> </ul>	<p><b>Barriers to progression and methods of resolution:</b></p> <ul style="list-style-type: none"> <li>Employers not being familiar with VI or how to meet access needs.</li> <li>Job information may not be clear or available in alternative/accessible formats.</li> <li>Careers resources may not be accessible or may not be specific</li> </ul>	<p><b>Identification, access to and resourcing of appropriate support and equipment:</b></p> <ul style="list-style-type: none"> <li>STEM specific advice on navigating Access to Work funding is needed to ensure that graduates are able to assist in assessing STEM specific needs and to communicate these to people without a STEM background.</li> </ul>



	<b>Student's actions</b>	<b>Skills development</b>	<b>Teaching and learning</b>	<b>Support</b>
	<ul style="list-style-type: none"> <li>▪ Evaluate interview experience and gain feedback to improve skills.</li> </ul> <p><b>Information needs and advisors:</b></p> <ul style="list-style-type: none"> <li>▪ Access to role models of graduates with VI working in STEM based industries.</li> <li>▪ Access to work experience, internships.</li> <li>▪ Advice on Access to Work, rights, welfare and benefits should be given in a timely manner and while still at university.</li> <li>▪ Access to specialist VI careers advice and STEM specific advice including in exploring options, locating and applying and interviewing for opportunities.</li> </ul>	<p>responsibility for access needs in order to educate/reassure potential employers.</p> <ul style="list-style-type: none"> <li>▪ Skills to explore open source software or variant/new software including ability to self-teach and to use technology flexibly.</li> <li>▪ Negotiating skills e.g. to ensure that recognition of experience in accessibility is seen as a selling point.</li> </ul> <p><b>Supporting and advising on development:</b></p> <ul style="list-style-type: none"> <li>▪ Access or advice on diversification of skills or continuing professional development may be required.</li> <li>▪ Students should know their rights under Equality Legislation and this information should be clearly signposted.</li> <li>▪ Staff may need awareness of how to</li> </ul>	<p>enough to meet the information needs of a student/graduate with VI.</p> <ul style="list-style-type: none"> <li>▪ Access to suitable role models during the final year may be difficult to arrange.</li> </ul> <p><b>Information needs of and advisors for teaching staff:</b></p> <ul style="list-style-type: none"> <li>▪ A central bank of accessible resources is required to assist students with VI to plan their career progression after university. Such resources would also assist advisors within institutions.</li> <li>▪ Staff need to be aware that students with VI may require specialist careers advice and access to role models.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Students should be directed to regional services – especially if relocating.</li> </ul> <p><b>Information needs of and advisors for support staff:</b></p> <ul style="list-style-type: none"> <li>▪ Specialist advice should be offered to students with VI regarding career planning in general and STEM careers specifically. This advice may not be available locally so may need to be 'bought in' or communicated via a central resource.</li> </ul>

	<b>Student's actions</b>	<b>Skills development</b>	<b>Teaching and learning</b>	<b>Support</b>
		assist a student with VI to prepare for interviews and psychometric tests and alternatives to these. Students with VI may benefit from specialist advice and practice in these skills.		

## Key recommendations and areas for further work

We summarise below the key recommendations and areas in which we consider further work is required. These draw on the talks, panel question and answer session and workshop discussions.

1. **The various methods of accessing STEM content, of producing accessible STEM content and of locating expertise in this area should be documented. Staff in various roles should be able to access information and STEM specific Continuing Professional Development.**

Due to low incidence of VI this would need to occur at a national level and to be facilitated by a central organisation.

This might include documentation of the skills involved and consideration as to when/if it might be appropriate to learn the skill. This documentation should not enforce any particular approach.

This information will inform staff but also facilitate students in communicating how they access materials in new contexts. Academic departments, including individual **teaching staff** at all levels, **disability services, DSA needs assessors, careers advisors, librarians, e-learning professionals** etc. require access to a central resource bank of specialist information regarding VI and STEM subjects. **This information should be appropriate to role and level and associated training resources may be required.** This is a practical requirement but it is also noted that positive attitudes within schools, FE and HE institutions will rely on the ability to access information and expertise.

2. Access to **role models** including graduates and students with VI currently studying is important for aspiration but also for the exchange of practical information. Due to low incidence this would need to occur at a national level and hence to be facilitated by a central organisation.
3. **Braille skills** were considered to be of particular importance in STEM subjects where it is difficult to rely on audio alone. It was advocated that all learners for whom it is appropriate continue to have access to the opportunity to learn Braille and the Braille mathematics code up to GCSE level.
4. **Self-advocacy, self-determination and communication skills and the skills required to locate and use information to make choices** are particularly important to a student who intends to study a STEM based subject at university. These need to be actively promoted during earlier experiences of STEM study.
5. It is recommended that students are provided with information on and learn to take **multiple approaches** when working in STEM subjects, starting during

sixth form. This will encourage **flexibility**, enable students to exercise choice, reduce reliance on staff and promote self-advocacy, the setting of goals and milestones.

6. Institutions should be encouraged to **audit STEM courses** to quantify the skills and technologies which are required at each level and hence to produce detailed course descriptions including study methods involved etc. This will permit students and applicants to plan ahead rather than learning new skills as they are required. **This information is also required by needs assessors to enable a sound DSA assessment process.** Such an audit would ideally include acknowledgement of remaining access challenges and the proactive resolution of these.
7. Academic departments are encouraged to contact applicants as early as possible in the application process and to form a **pre-entry working partnership** with the applicant and school/college.

Students should be 'up and running' before they reach university in their chosen methods of working with STEM content. This may include raising a student's computer literacy levels in addition to learning specific skills. Partnerships between institutions and schools starting as early as possible pre-entry or summer schools may facilitate this. **Needs assessors should be involved in this partnership to ensure a sound DSA assessment process.**

8. Institutions should be encouraged to ensure that they **proactively hold all lecture notes in STEM subjects in formats which can be used to create suitable alternative formats.** This is likely to include LaTeX and Word using MathType.
9. A **national database of mathematically fluent support staff** able, for instance, to advise on the production of LaTeX resources should be compiled. It is not necessary for all institutions to hold such expertise but it should be evident how to locate it if required.
10. There is an on-going necessity for **improvements to technology** whether that be through research, open source initiatives or commercial products in order to close known technology gaps. However, due to the low incidence of people with VI working or studying STEM subjects and limited pressure from the STEM community on software publishers, movement in commercial products continues to be low. **The STEM community should communicate clearly the need for such tools.** Should clearly defined research or development avenues become available **direct investment from the public sector may be required.**

11. Publishers and providers of STEM materials (e.g. books and journals) should **store the source format** and make this available on request. They should be aware that provision of an accessible format of STEM materials currently requires access to the LaTeX source or similar for screenreader users.

Institutions should consider how the education sector may **put pressure on publishers** to provide STEM content in accessible formats.

12. **Positive information** is required to prevent student and teacher imposed barriers. HE professionals should be aware of issues around progression and transition to higher education for students with VI. Universities, colleges, schools and Sensory Support Services should work collaboratively on developing and delivering aspiration raising activities, workshops and summer schools for students with VI, their parents and teachers. Universities and schools should be proactive in their communication with each other to enable successful transition.

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## Appendix: Integrated framework in linear format by rows

### Pre-application

#### Student's actions

##### Do:

- Identify interests and plan route through correct choice of subjects at school
- Gain input from teachers, SENCOs, disability staff and other advisors on route, modes of study, likely required preparation etc.
- Start pre-application process earlier than UCAS process including approaching universities for access to STEM information.
- Compile a potential short list of universities and open dialogue regarding their approach and support which they could offer.

##### Information needs and advisors:

- Advice on the appropriate time to start planning for studying a STEM subject.
- Positive, realistic information and early advice (pre-GCSE and A-level choices) to students, teachers and parents to prevent barriers including assumptions about what can be studied. This should include careers advice.
- Access to role models including successful students, graduates and employees in STEM subject areas.
- Evidence that 'someone has done this before' at individual institutions.
- Clear course descriptions which specify access approaches and required skills.
- Access to a central pool of information (currently disparate, individuals hold information in isolation) regarding studying STEM subjects for students with VI. This should include resources, practical information and advice.

#### Skills development

##### Skills to develop:

It is noted that specialist and subject skills are best developed gradually likely starting in a school environment during A-level and continuing through pre-entry and transition.

- Subject specific knowledge and specialist skills appropriate to STEM study including IT skills, use of technology and study skills.
- Specialist skills should include acquisition of an effective reading and writing method for equations whether in Braille, large print or audio. This is likely to include introduction of some quantity of LaTeX and decisions regarding appropriate text editing environments (e.g. MathType and Word, Emacs etc.).
- Specialist skills should include acquisition of an effective method for working with diagrams. This might include use of tactile diagrams.
- Specialist skills should include acquisition of higher level IT skills; learning to make good use of digital media; research skills for searching, sifting and prioritising and study skills including a self-aware approach to for instance, planning an approach to study, monitoring speed of working etc.
- Soft skills are particularly important including: being able to self-advocate; being able to identify needs and clearly communicate them; decision making skills; ability to respond flexibly to a range of situations.
- Students also need to develop independent living skills, mobility and travel skills and knowledge of adjustment at university.

##### Supporting and advising on development:

- It is acknowledged that the school's focus may be on students gaining grades to secure a place and that specialist STEM skills may be challenging to deliver. Students and teachers require access to central resources for specialist skill acquisition and may benefit from partnership with a HEI.
- A student's family is likely to play an important role in development of soft skills and independent living skills.

## Teaching and learning

### **Barriers to progression and methods of resolution:**

- Staff and parents may inaccurately discourage interest in STEM due to negative stereotypes or insufficient information.
- Experience in specialist areas including skills development for STEM study not necessarily available in all schools.
- Teachers may have limited training in how to meet the diverse needs of students, how to take a flexible approach and to communicate information in different ways. This may have a disproportionate effect on experience of STEM subjects due to the modes of communication generally used.
- Schools may have limited access to information required by the student to prepare specifically for STEM study and so may find it challenging to provide information in a timely manner.

### **Information needs of and advisors for teaching staff:**

- Communication between institutions, organisations and agencies involved in transition is required to support staff in information provision and skills development.
- A collaborative approach between subject and VI specialists is required to ensure that specialist skill development can be delivered.
- Staff may need to engage in further reflection on practice with access to specialist advisors (including those with experience of preparation for HE) to adapt teaching to meet skills need by VI students e.g. learning Braille, typing skills, tactile diagrams, specialist skills for STEM.

## Support

### **Identification, access to and resourcing of appropriate support and equipment:**

- Students may require access to specific technology and training e.g. in use of IT, Braille. Their access to and use of technology and training may need to be reviewed in light of a decision to focus on STEM subjects at A-level.
- Specialist transcription services may be required for STEM resources.
- Students may require support in accessing transition information, making choices and planning.
- Universities are best placed to communicate how STEM subjects are taught at HE level, the skills required and the approaches which work. Widening participation taster days/courses should be offered early to pupils with VI and summer schools should be offered for both pupils and subject teachers at A level. These events should include a 'taste' of how support would work, what technology might be used and how teaching and learning can be accessed in STEM. Role models or evidence that 'someone has done this before' can also be provided.

### **Information needs of and advisors for support staff:**

- A central pool of information, suitable to role and institution level (i.e. School/FE/HE) should be available advising on availability of assistive



technology, software, transcription, training etc. specifically for access to STEM subjects.

## Pre-entry

### Student's actions

#### Do:

- Use university websites and prospectus as a first line accessibility check. Use open days to check against own skills and requirements.
- Establish contact with the university department and Disability Services. Organise to visit both and start planning an approach.
- Establish contact with current students with VI studying a similar STEM subject.
- Open dialogue with university department to discuss specifics of access approach including to lectures, tutorials, labs, notes and reading list. Check availability of core texts and lecture notes in appropriate digital formats.
- As an outcome of above, identify additional equipment and software that will be needed at university. Ideally do this prior to engaging fully with the assessment of needs process and as early as possible.

#### Information needs and advisors:

- Access to a range of local information including local VI services.
- Clear advice on navigating the DSA process as a STEM student with VI.
- Technical information on the institutional systems they will need to access and use on arrival – including information about specialist STEM software and equipment.
- Assistance locating and establishing contact with current students with VI in similar STEM subjects.

### Skills development

#### Skills to develop:

It is noted that specialist and subject skills are best developed gradually likely starting in a school environment during A-level and continuing through pre-entry and transition.

The skills a student might need to develop are highlighted in the above pre-application stage. Additional skills relevant at pre-entry may also be:

- Start to develop skills to manage time effectively and cope with the change from highly supervised learning to university.
- Skills to manage finances.
- Staff management skills for working with study support workers.

#### Supporting and advising on development:

- In order to continue developing skills noted above during pre-entry students would need access to resources, technology, training and advice during the summer period prior to university. This is necessary to ensure that a basic set of skills are in place to cope with the course pre-entrance. Such pre-entry support requirements would ideally be recommended and funded as an outcome of the needs assessment.
- The student needs to know what support is available on entrance in advance, to enable planning.

### Teaching and learning

#### Barriers to progression and methods of resolution:

- The main barrier to progression is if any part of the institution is not aware in advance of how to meet a student's needs. This is not limited to the student's department or the disability service but includes IT and e-learning systems, the library (electronic and physical resources) etc. All facets may need to consider not just general good practice but also good practice in STEM subjects and the specific needs of the individual student.
- Failure to proactively embed inclusive practices for STEM teaching throughout delivery may leave significant barriers which cannot be addressed at short notice.

**Information needs of and advisors for teaching staff:**

- Teaching staff need to know what has to be in place for a student in advance to enable the student to achieve. This advice may need to be specifically tailored for STEM subject areas so as to be practical and useful.
- Schools and colleges could start to integrate in to transition by starting some teaching earlier, particularly skills, via on-line resources or in partnership with the HEI.

## Support

**Identification, access to and resourcing of appropriate support and equipment:**

- DSA Needs Assessment centres should ensure that assessors working with students studying STEM subjects have appropriate training and access to relevant information so effective study strategies and aids are identified.
- Accessibility of the physical campus, IT and e-learning, the library, student services and teaching and learning should be identified via appropriate audits. This should include differentiation between STEM and text based subjects.
- Issues with when DSA funding can be made available may currently preclude students being able to practice/learn skills in advance pre-entry. This would need to be resolved.
- The university, as well as DSA funding, may need to consider provision of technology, software or equipment. E.g. student may need dedicated terminal in computer lab and exam arrangements may also require procurement of a full mirrored setup.
- Universities may need to consider what specialist skill training falls within their remit as subject specialists rather than under that of the assistive technology trainer.
- Universities may need to run events and information days to raise awareness of how STEM subjects are taught at university. This awareness is required by the needs assessor, assistive technology trainers and other study support workers in addition to the student.

**Information needs of and advisors for support staff:**

- Active dialogue between existing (school) support staff, university support staff, DSA needs assessors and university teaching staff is required for a collaborative approach.
- Staff in various roles require access to resource banks and training resources in methods for accessing and working with STEM content.

## Transition

### Student's actions

**Do:**

- Orient and settle in, navigate living independently and take time to integrate into social network including attending fresher's week!
- Take responsibility for learning!
- Work with the Disability Services Team to empower decisions about support.
- Proactively engage with peers, staff, authors of books you require access to etc. – transition is about networking.
- Make the most of tutorials – take the opportunity to ask questions, discuss your learning style, try out methods of interacting with your subject.

#### **Information needs and advisors:**

- General and also STEM specific advice and guidance regarding the skills needed to access their course and how to approach their studies throughout transition.

### **Skills development**

#### **Skills to develop:**

It is noted that specialist and subject skills are best developed gradually likely starting in a school environment during A-level and continuing through pre-entry and transition.

If the above has not occurred then a student may commence their course without basic required skills. Their ability to acquire these while studying will depend on the course demands. Additional skills relevant to transition include:

- Explicit learning about the culture of the HEI and department including 'who is who', 'who does what' and 'who is in my network'.
- Develop self-discipline, motivation and skills to manage time effectively and cope with the change from highly supervised learning to university.
- Learn to develop own learning methods e.g. how to use and take STEM lecture notes during class etc.
- Become an independent learner in terms of assistive technology etc. and develop confidence to communicate their use of technology/strategies when meeting with study support workers, teaching staff and, in future, employers.
- Develop interpersonal and networking skills which enable access to informal peer support.

#### **Supporting and advising on development:**

- The development of study skills specific to an individual may require input from a study skills specialist with an understanding of STEM subjects or possibly in collaboration with other study support such as readers, note-takers etc.
- A key question regarding the continued development of STEM specific specialist skills is: where does this learning take place? The STEM department holds the STEM expertise so a collaborative approach between the student, the department and support professionals may be required.

### **Teaching and learning**

#### **Barriers to progression and methods of resolution:**

- The most significant barriers to transition are the school not appreciating the requirements of the university course and the university not understanding the requirements of the student or how they previously approached learning at school.
- Lecturers might not be willing to adjust or able to be flexible in their teaching approach.
- Lack of alternative formats or staff not having the required skill set to create accessible formats for STEM study – including equations and diagrams.

- Lecture notes not available prior to class.
- Inaccessible IT and laboratory resources.
- Inaccessible assessments.

#### **Information needs of and advisors for teaching staff:**

- Staff may need to adapt their teaching style in a manner appropriate to their subject – external training and support may be required and may need to be provided centrally via e.g. HEA and JISC TechDis.
- Training in both the use of simple accessibility techniques but also in the creation of accessible electronic formats.
- Discussion and agreement as to the examination process involving both specialists and university staff may be required. Technology might need to be purchased by university as students may not be allowed to use their own laptop with access technology.

### **Support**

#### **Identification, access to and resourcing of appropriate support and equipment:**

- Feedback mechanisms should be available to all students but explicit invitations to provide regular feedback from students with VI may allow timely identification of need for support or equipment.
- During transition there may be a need for additional support which might lessen later in degree. Use of mentoring and regular meetings to ensure the student has points of contact. This may need to be identified and funded via DSA.
- External support mechanisms such as the BlindMath mailing list and similar which can provide support to both the student and department staff should be identified.
- IT, e-learning and library support may be required by both student and staff. Staff responsible for these systems may need to identify and resource changes to increase accessibility – both general and STEM specific e.g. for equations in electronic resources.

#### **Information needs of and advisors for support staff:**

- Support assistants, mentors, notetakers and alternative formats creation with STEM expertise may be required. This may require recruitment and training on which advice from external bodies may be needed. Ideally a national bank of such specialist services is required to ensure timely access to the right support.

### **Later years**

#### **Student's actions**

##### **Do:**

- Focus on academic studies as access issues should have been lessened by now. However, continue to review, reflect and act to make necessary changes including reflection on approaches to learning.
- Consider a placement if offered. This will require proactive organisation.
- Research placement, company and role; organise an initial visit to the placement venue, and consider organising a phased first week.
- Ensure that placement is reflected upon and evaluated both for academic and personal specialist skill development.

#### **Information needs and advisors:**

- To plan for placement with a collaborative team including the Department Placement Team and the Disability Service.

- Assistance from staff in identifying suitable placement venues.

## Skills development

### Skills to develop:

Students should by now have acquired a rich STEM and specialist skill set.

Additional skills relevant to later years may include:

- Use of a complex set of communication, technical, subject and soft skills to determine, with others, how to access placement systems and software.
- Developing mobility, orientation and travel skills in employment venues if on placement.
- Development of research skills in preparation for dissertation writing.

### Supporting and advising on development:

- Students may require specific advice or support in adapting to work ethos for placement year.
- Development of research skills may require further training or support.

## Teaching and learning

### Barriers to progression and methods of resolution:

- Attitudes and apprehension regarding placement may result in a student not taking up this opportunity or staff advising against it.
- There may be a need for a suitable work environment for a student with VI to be identified by the university and for the employer to be aware of the student's individual needs. This process requires proactive organisation and a collaborative approach.
- Lack of advance notice on reading lists may impact on access to resources and timely transcription or creation of alternative formats.

### Information needs of and advisors for teaching staff:

By this stage, department staff should be aware how to work to ensure access but new lecturers and tutors may be involved at any stage. The department needs to ensure that approaches are agreed and disseminated.

- The university including the department should review and evaluate regularly and identify any required changes to approach. Should the modules or degree change consideration of the impact of this may be required.

## Support

### Identification, access to and resourcing of appropriate support and equipment:

- The student continues to need to be organised and proactive in arranging and communicating regarding their needs for access. This includes with respect to a placement. The student may require suitable staff support in this. This may need to be foreseen and funded via the DSA.
- It is important that students on placement have a point of contact at the university and are visited at their placement. They may require additional or earlier visits.

### Information needs of and advisors for support staff:

- STEM placements potentially pose additional issues for students with VI. The situation needs clarification, documenting and disseminating on a national basis.
- Staff will require information regarding Access to Work if it applies for the placement in order to support the student.

## Career planning

### Student's actions

#### Do:

- Explicitly reflect on placement or work experience learning if applicable. Consider what skills or experience may need to be developed.
- Explore available jobs, and requirements to organise relocation.
- Consider whether post graduate study is appropriate.
- Evaluate interview experience and gain feedback to improve skills.

#### Information needs and advisors:

- Access to role models of graduates with VI working in STEM based industries.
- Access to work experience, internships.
- Advice on Access to Work, rights, welfare and benefits should be given in a timely manner and while still at university.
- Access to specialist VI careers advice and STEM specific advice including in exploring options, locating and applying and interviewing for opportunities.

### Skills development

#### Skills to develop:

Students should by now have acquired a rich STEM and specialist skill set.

Additional skills relevant to careers may include:

- CV/Application and interviewing skills.
- Ability to build and communicate a portfolio of strategies around support so as to be empowered but also to take on some level of responsibility for access needs in order to educate/reassure potential employers.
- Skills to explore open source software or variant/new software including ability to self-teach and to use technology flexibly.
- Negotiating skills e.g. to ensure that recognition of experience in accessibility is seen as a selling point.

#### Supporting and advising on development:

- Access or advice on diversification of skills or continuing professional development may be required.
- Students should know their rights under Equality Legislation and this information should be clearly signposted.
- Staff may need awareness of how to assist a student with VI to prepare for interviews and psychometric tests and alternatives to these. Students with VI may benefit from specialist advice and practice in these skills.

### Teaching and learning

#### Barriers to progression and methods of resolution:

- Employers not being familiar with VI or how to meet access needs.
- Job information may not be clear or available in alternative/accessible formats.
- Careers resources may not be accessible or may not be specific enough to meet the information needs of a student/graduate with VI.
- Access to suitable role models during the final year may be difficult to arrange.

#### Information needs of and advisors for teaching staff:

- A central bank of accessible resources is required to assist students with VI to plan their career progression after university. Such resources would also assist advisors within institutions.

- Staff need to be aware that students with VI may require specialist careers advice and access to role models.

## Support

### **Identification, access to and resourcing of appropriate support and equipment:**

- STEM specific advice on navigating Access to Work funding is needed to ensure that graduates are able to assist in assessing STEM specific needs and to communicate these to people without a STEM background.
- Students should be directed to regional services – especially if relocating.

### **Information needs of and advisors for support staff:**

- Specialist advice should be offered to students with VI regarding career planning in general and STEM careers specifically. This advice may not be available locally so may need to be 'bought in' or communicated via a central resource.