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Including blind and visually impaired students in the chemical sciences: establishing good practices

University of Kent
Including blind and visually impaired students in the chemical sciences: establishing good practices
Stefano Biagini, Ben Watson, Nik Duncan
University of Kent

Introduction
This poster outlines some simple measures and adaptations we have made at the University of Kent to make Chemistry laboratory sessions safe and accessible to visually impaired students. Often using existing equipment and approaches we were able to ensure that students engaged meaningfully with all aspects of each session and many of

Laboratory adaptations
Using webcams to enhance visual feedback
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Accessible videos
An example of two versions of a lab walkthrough video. The first is the original video and the second has added Audio Description. The Audio Description helps to convey information to visually impaired learners.
Original version (with no description) 0:00
Version with Audio Description 2:01
0:00 / 0:33
Transcript

Cultural change and building confidence
Future projects: collaborate with us
Crowdsource resources
In our experience the real barrier for blind and visually impaired students is the lack of established best practices and resources in education and training provision with a lack of clarity around the best way to make long standing practices inclusive.

[NARRATION](#) [AUTHOR INFORMATION](#) [ABSTRACT](#) [REFERENCES](#) [CONTACT AUTHOR](#) [GET POSTER](#)

Stefano Biagini, Ben Watson, Nik Duncan

University of Kent

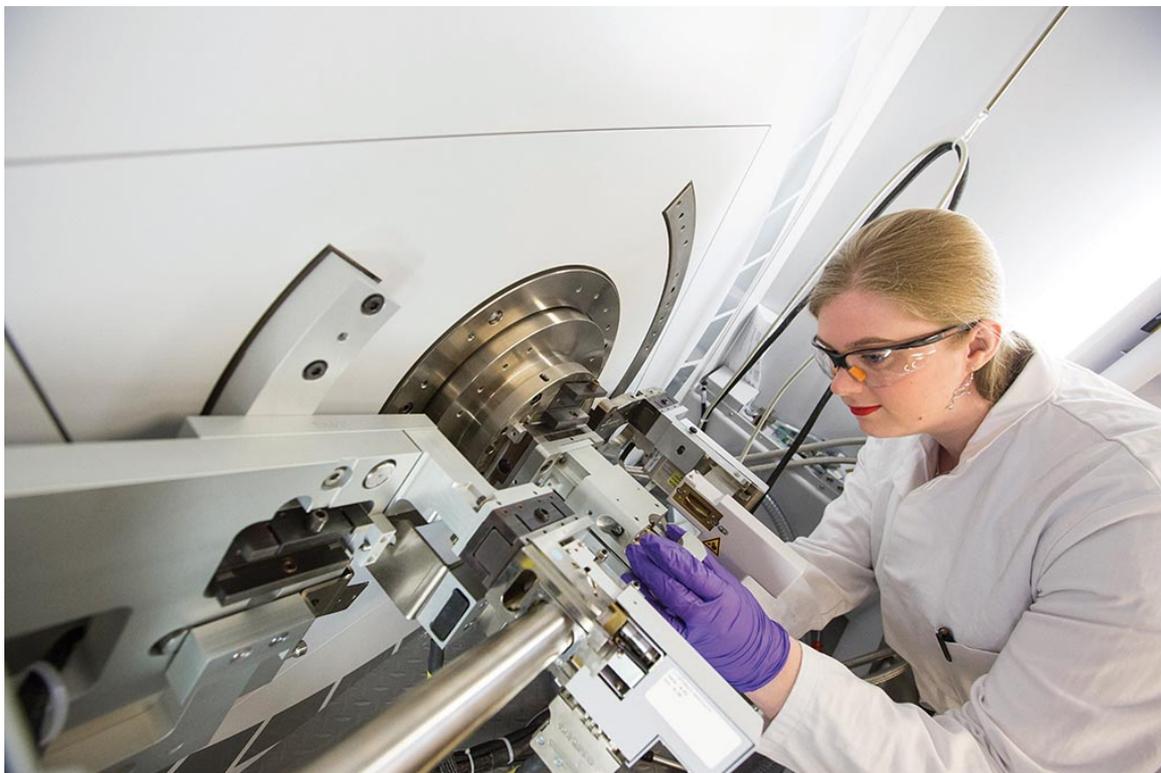


PRESENTED AT:



INTRODUCTION

This poster outlines some simple measures and adaptations we have made at the University of Kent to make Chemistry laboratory sessions safe and accessible to visually impaired students. Often using existing equipment and approaches we were able to ensure that students engaged meaningfully with all aspects of each session and many of the adaptations were so helpful that they have now been adopted as mainstream practices.



Many of the barriers encountered by students in accessing their learning and teaching are caused by oversight in the design of the learning and teaching environment. With a shift toward anticipatory action universities can meet the requirements of their students.

The Public Sector Bodies (Websites and Mobile Applications) Accessibility Regulations (2018) (<https://www.legislation.gov.uk/ukxi/2018/952/introduction/made>) requires the University to make sure digital content is accessible to everyone by September 2020, essentially ensuring that all our digital content is 'perceivable, operable, understandable and robust' in accordance with the WCAG 2.1 AA accessibility standard. (<https://www.gov.uk/service-manual/helping-people-to-use-your-service/understanding-wcag>)

At Kent, the university has sought to embed inclusive approaches to the delivery of information and the use of assistive technologies for all by taking a holistic approach to the mainstreaming of adjustments as an approach to learning, teaching, research and support. The OPERA (Opportunity, Productivity, Engagement, Reducing barriers, Achievement) project (<https://www.kent.ac.uk/student-support/opera>) is aimed at ensuring information services are accessible to all with ultimate aim that information is as accessible as possible in line with the view of this as something inseparable from good design: Accessible design is good design. Everything we build should be as inclusive, legible and readable as possible.

Key strategies are outlined in the Kent Inclusive Practices (KIPS) (<https://www.kent.ac.uk/guides/how-to-create-accessible-content/kips>). This has seen us reconsider approaches to learning and teaching delivery, exploring digital platforms and systems to implement accessibility initiatives and to raise awareness of inclusive design and assistive technologies..

The goal is for all systems and services to be usable: without vision, with limited vision, without perception of colour, without hearing, with limited hearing, with limited dexterity, with limited cognition, without speech.

The basic premise is that an accessible environment works well for everyone regardless of disability.

INCLUSIVE DESIGN FOR EDUCATION



Inclusive Practice

Inclusive practice is an approach to teaching that recognises the diversity of students and enables all students to access and participate in educational activities and to demonstrate their knowledge and strength (Equality Challenge Unit). Whilst there are no practices that work for all students, there are several best-practice examples that have been found to be widely effective at improving accessibility and educational value. In the chemical sciences at higher education level there are pedagogical components that are consistent across organisations. Lecturing and workshops/tutorials which involve Power Point or whiteboard (or similar) presentations; supporting text which includes textbooks, journal articles and handouts; laboratory experiments; and video recorded supporting teaching.

Basic Principles

- Choose digital where possible
 - Accessible e-resources can be navigated by everyone using the technology they are comfortable with.
- How to make documents and presentations (including images and other media) accessible. (<https://www.kent.ac.uk/guides/how-to-create-accessible-content/make-documents-and-presentations-accessible>)
- Make your videos accessible (<https://www.kent.ac.uk/guides/how-to-create-accessible-content/make-videos-accessible>)
- E-resources can quickly and easily be converted into more accessible formats using software such as SensusAccess. (<https://www.kent.ac.uk/guides/access-content-your-way-sensusaccess>)
- Promote productivity tools (assistive technologies) to everyone (<http://www.kent.ac.uk/tools>)

- Key strategies are outlined in the [Kent Inclusive Practices \(KIPS\)](http://www.kent.ac.uk/kips) (<http://www.kent.ac.uk/kips>). This has seen us reconsider approaches to learning and teaching delivery, exploring digital platforms and systems to implement accessibility initiatives and to raise awareness of inclusive design and assistive technologies.

Accessible PowerPoint

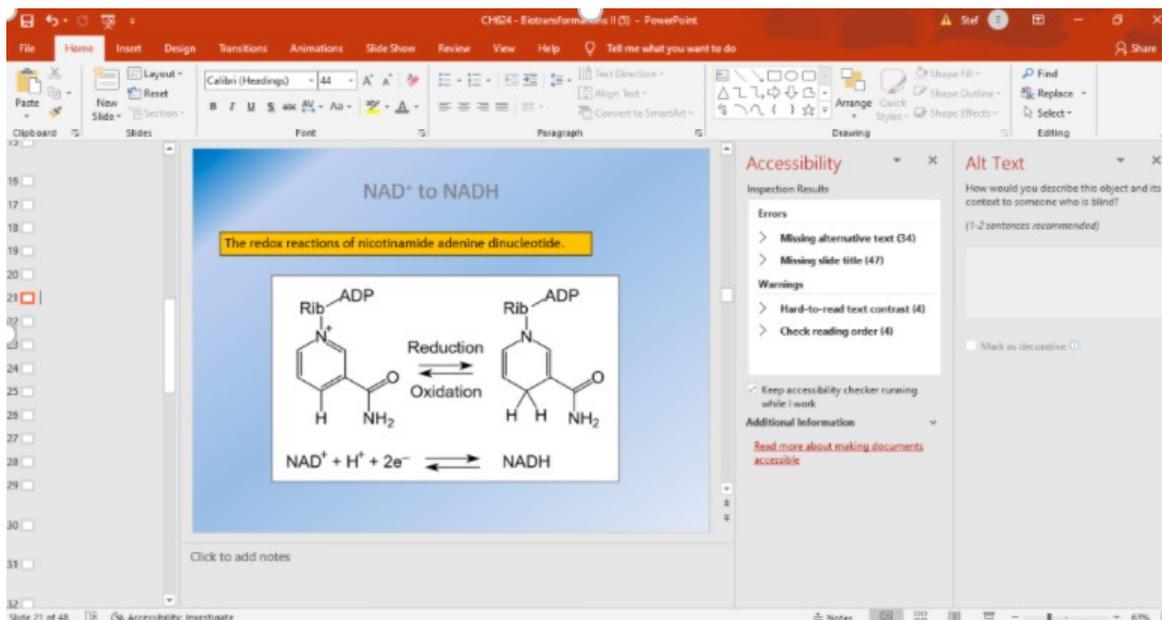


Image shows a screen-print of a Power Point presentation slide which is not inclusive. The slide appears to have a title, but it is a text box and will not help navigation of the presentation – it is also in grey font which has poor contrast with the background. On the left the navigational view shows that the slide does not have a title and therefore it is not possible to quickly find a desired slide. The selected image on the slide is lacking an alternative text description. The Accessibility checker shows that there are 34 images missing alternative text and 41 slides missing a title. The checker also flags several warnings such as poor contrast and reading order. The latter is the order that an individual slide will be navigated by a visually impaired individual who will use a keyboard to tab from one item to the next.

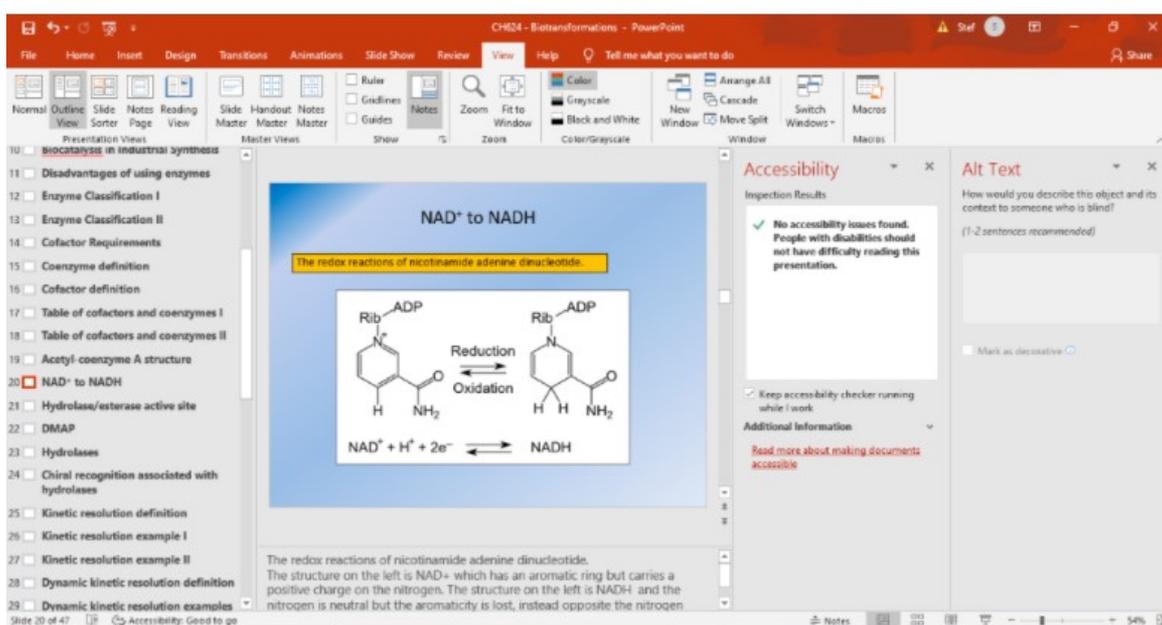
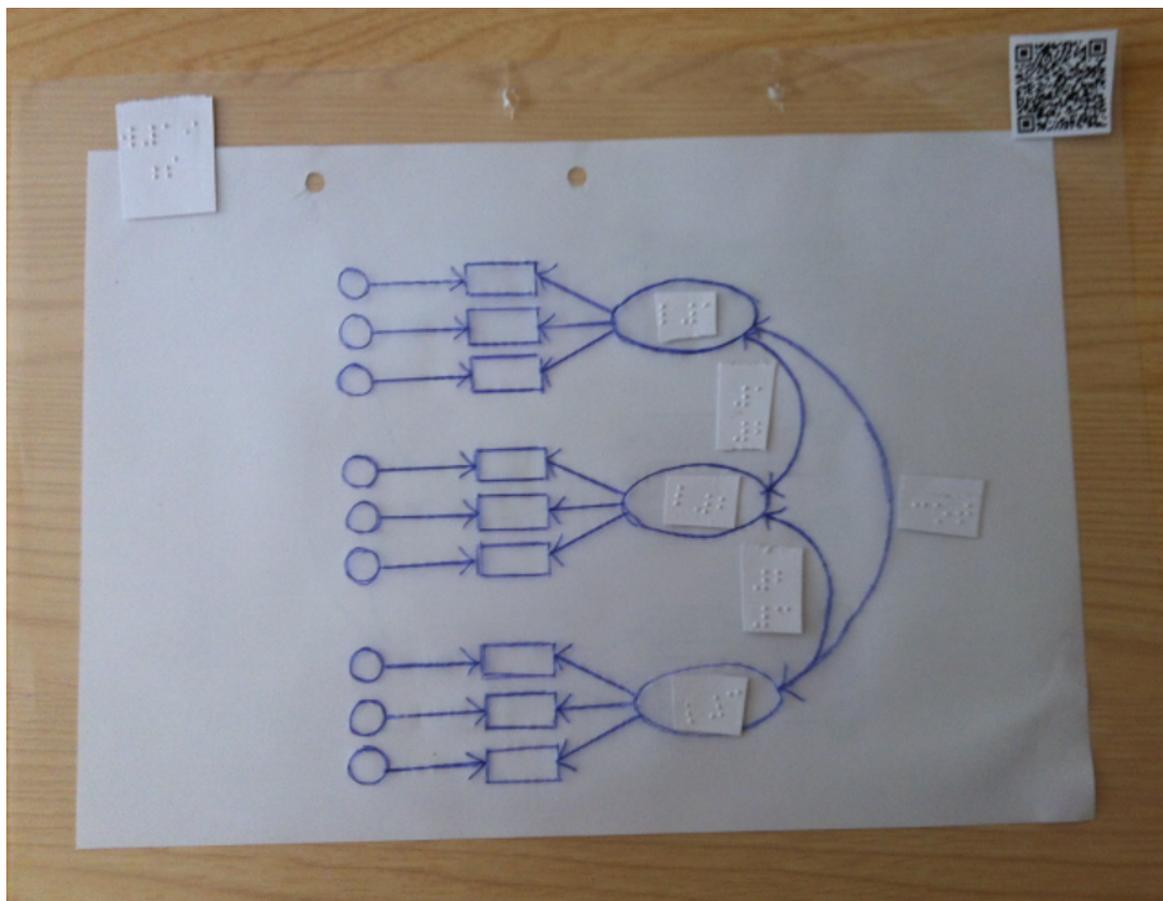


Image shows a screen-print of a similar Power Point presentation slide as the previous image, but which has been prepared with inclusive best practice. The slide has a title which forms part of the navigation of the presentation. All font sizes are 24 or higher and a sans serif font has been used. On the left the navigational view shows all the slides have titles and these all differ from each other which makes content easier to find. The selected image on the slide has an alternative text description. The notes section also explain the slide content. The Accessibility checker confirms that there are no accessibility issues, and a visually impaired person should not have difficulty reading the presentation. The presentation will also be easier to navigate for non-disabled individuals and the improved content descriptions will hold greater pedagogical value.

Creating tactile images

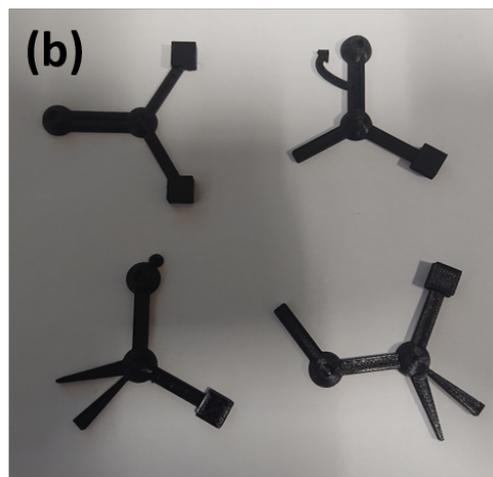
Simple process for creating tactile images quickly and effectively using German film, QR codes and Braille labels.

- Tactile images are drawn onto embossing film using a ball point pen or similar object (to create raised lines that visually impaired students can feel to delineate different graph features). When drawing images it is important to avoid an image that is too 'cluttered' or noisy. Lines that are too close together will be difficult to differentiate between, and it may be necessary to enlarge the image to fill the page to enable a readable image. For example, we found that bar graphs drawn with lines and scale marks along the axes were cluttered and it was better just to use raised marks to distinguish the boundaries. Also, it is sometimes better to use raised marks instead of complete lines to mark the trajectory of lines across the graph in order to avoid confusion.
- QR codes that link to a web page with an alternative text description to accompany the tactile image are produced. The description would effectively convey the meaning and context of the image to someone who cannot see it, explaining the characteristics of each image.
- Braille labels were made for key elements, such as axis, week of lecture, slide number, etc. See image below.



3D-printing

We have been developing tactile learning as a way to engage with concepts in materials and solid state chemistry and to begin to visualise the complex building blocks used to define structure. By 3D printing inorganic kits (shown in Fig. a) below) students are free to truly appreciate the structure, compare different building blocks and to approach the material being taught in class in a new way. Fig. b) shows organic reaction mechanisms.



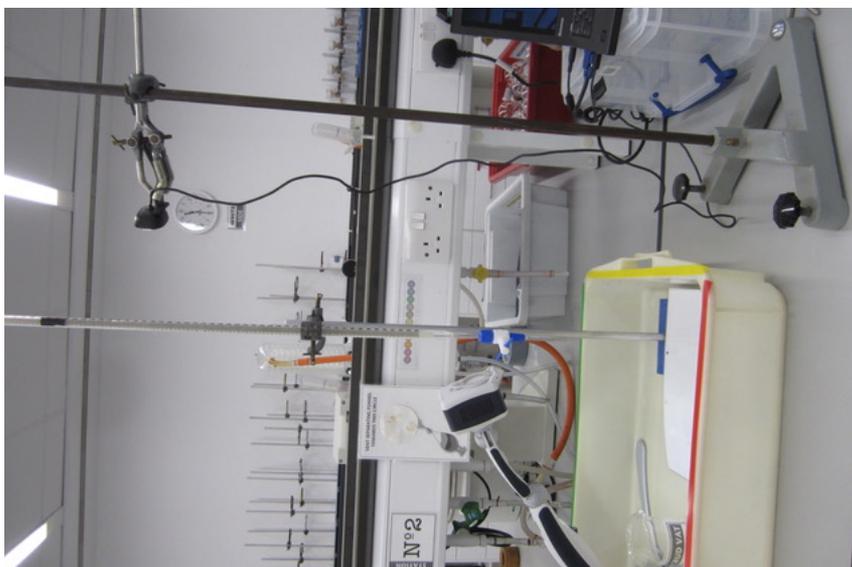
LABORATORY ADAPTATIONS

Using webcams to enhance visual feedback



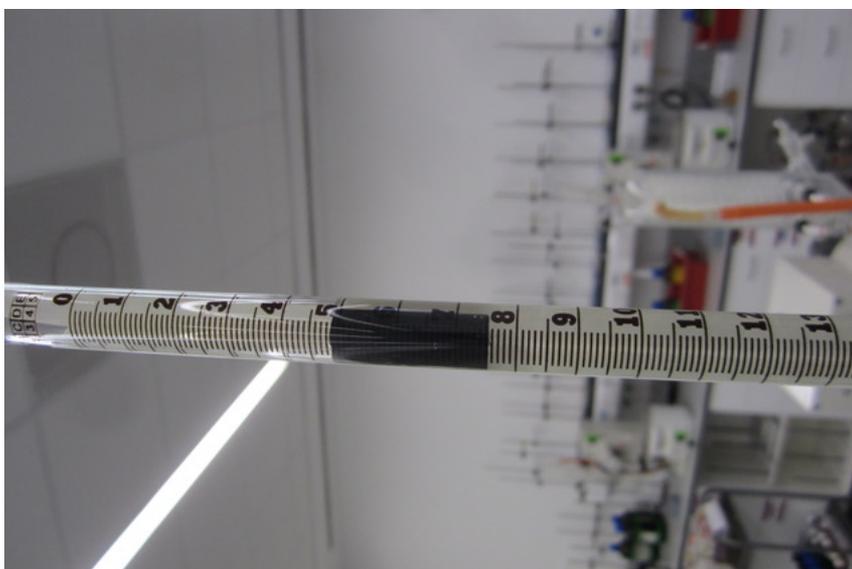
[The text shown for each figure corresponds to the alternative text]

A webcam is clamped on a retort stand such that it can view a burette. The webcam image will be magnified on to a screen (not shown in the image) such that it will allow a student with visual impairment to better see the start and end points of the titration. Also, the burette, which is clamped to a retort stand, is placed inside a large spill tray.



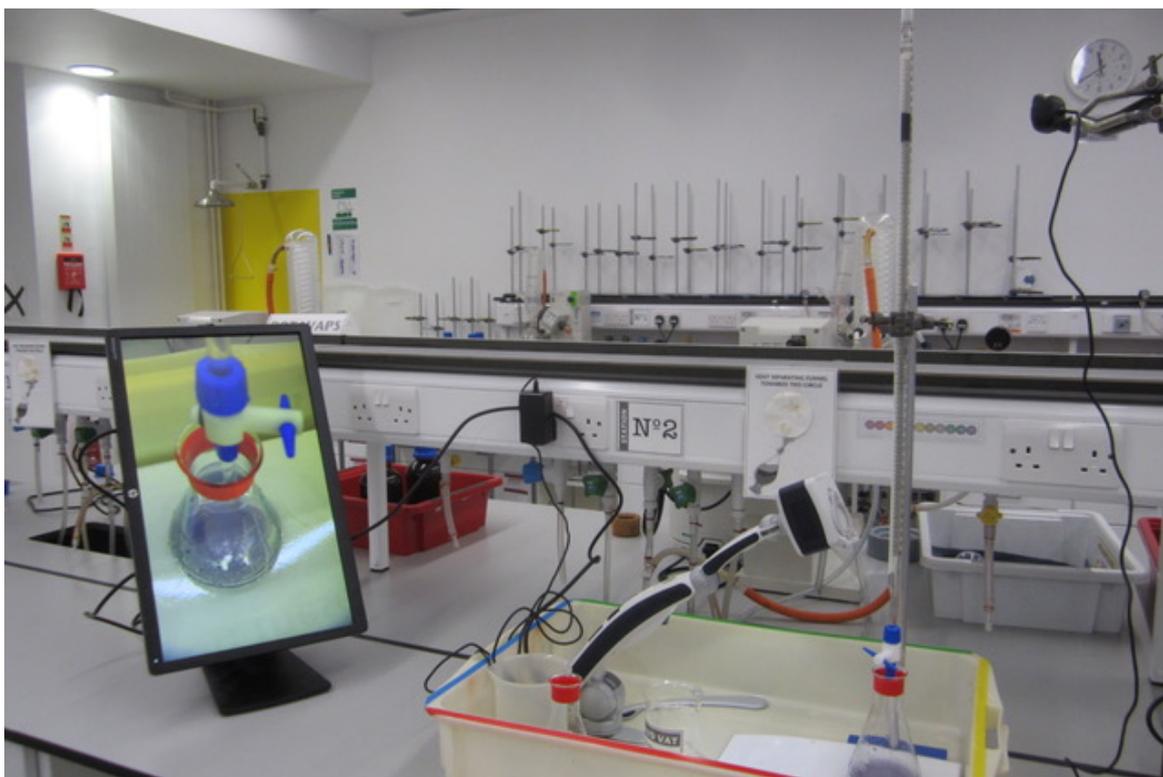
Titration apparatus

A webcam is focused on the burette, set-up inside a splash tray, to visualise the burette reading. A separate webcam is focused on the titre flask to observe the endpoint. To the left of the splash tray is a screen showing the titre flask magnified for better visualisation. This also means that the student does not have to get close to the chemicals in the flask.



Contrast on the burette

The Burette has some black tape applied in the critical area where a reading will occur. This is to allow for better visual contrast between the tape and meniscus of the solution.



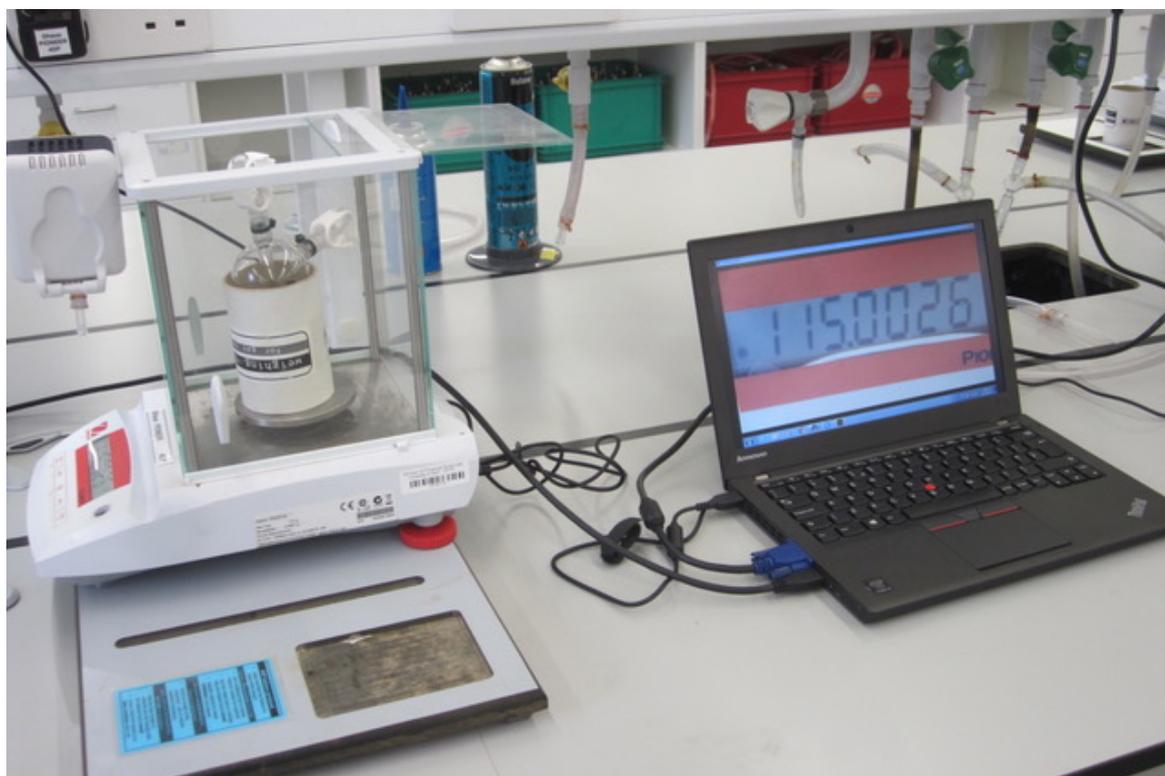
End-point visualisation

A webcam is focused on the burette, set-up inside a splash tray, to visualise the burette reading. A separate webcam is focused on the titre flask to observe the endpoint. To the left of the splash tray is a screen showing the titre flask magnified for better visualisation. This also means that the student does not have to get close to the chemicals in the flask.



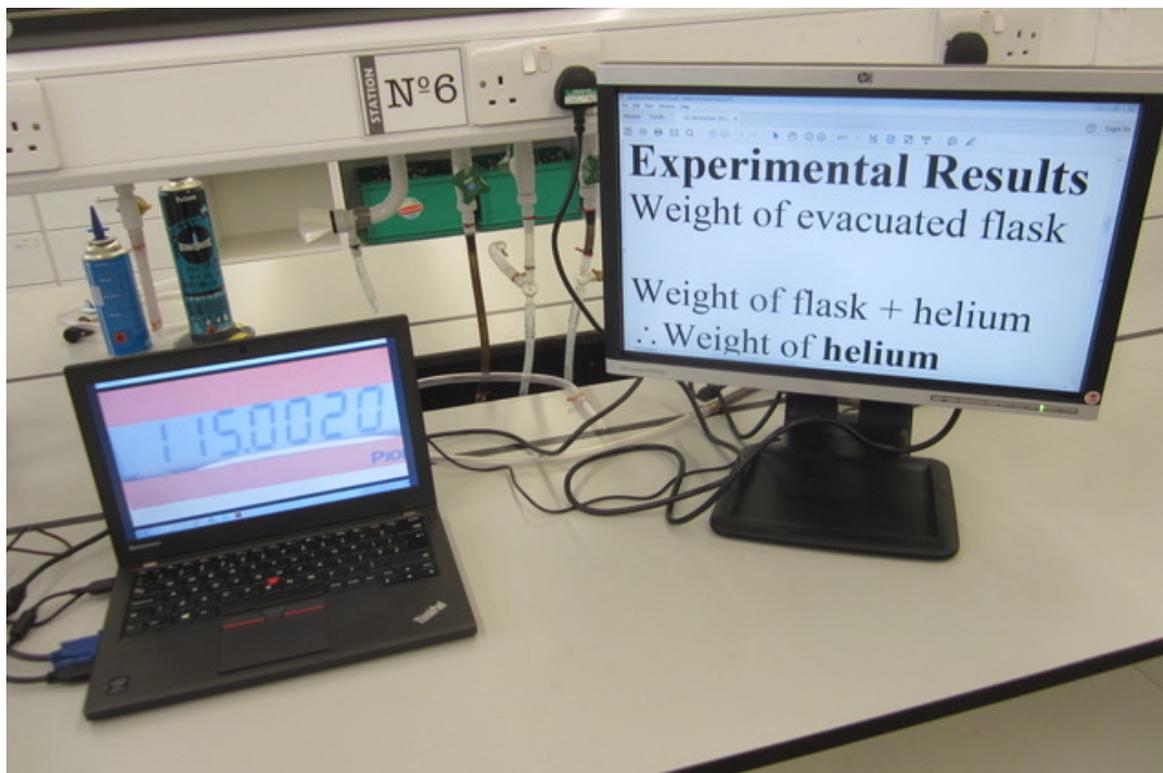
Webcam display

Image of the titre flask captured by a webcam and displayed on a screen allowing the student to observe the endpoint of the reaction without needing to get close to the flask and chemicals.



Magnifying readings

Image shows how the digital readout of a weighing scale can be captured by a webcam and displayed on a laptop with the image magnified to improve its readability. It also allows a student to get close to the screen without impediment, to better read the digits.



Laboratory manual

The image shows two screens. One screen is a digital readout from a weighing scale that has been captured by a webcam and magnified. The other screen shows an excerpt from the lab manual that the student is following. The text has been magnified and the student has chosen the desired contrast.



Notebook input

The image shows a laptop connected to a larger display screen. This makes it easier for the student to input data.



Standard Practice

A research project student examining a bullet fragment under a microscope with the enlarged image displayed on a screen.

ACCESSIBLE VIDEOS

[VIDEO] <https://www.youtube.com/embed/QftEQi35tBE?rel=0&fs=1&modestbranding=1&rel=0&showinfo=0>

An example of two versions of a lab walkthrough video. The first is the original video and the second has added Audio Description. The Audio Description helps to convey information to visually impaired learners.

Original version (with no description) 0:00

Version with Audio Description 2:01

Transcript

Experimenter

So in this third video we're going to look at stopping the reaction and precipitating our polystyrene. So we've got the reaction here just approaching 45 minutes. And there we go, as it gets to 45 minutes, we are going to stop the stopwatch, get that out of the way, and we're going to remove each of the reactions as quickly as possible and give them a little bit of a wipe to get the oil bath oil off, going to remove all of them at pretty much the same time and put them in our rack to cool down.

Experimenter

We should be able to see here that the viscosity of the liquid in the tube has increased quite significantly. And that's because there's a high proportion of polystyrene in the tube now, whereas before it was just dissolved Benzoyl Peroxide and Styrene. Because the viscosity

is increased, what we need to do is we need to add some solvent, which in this case is Tetrahydrofuran to dilute our reaction mixtures down, this is going to help us arrive at a much nicer final product when we get to the precipitation stage. So I'm going to remove the lids, the little cork lids of each of the vials, and I'm going to use a glass pipette to do this transfer. I'm going to place a few drops of tetrahydrofuran into each of the tubes, I'm going to make sure that I don't put the pipette into the polymer because I do want to avoid cross contamination.

Experimenter

So I'm adding about 20 drops of THF to each of the tubes at this stage. And I'm trying to keep it consistent across all 3.

Experimenter

So once I've finished with the THF I'm going to get rid of that pipette and put it in the sharps bin in the fume cupboard and I'm going to add the lids, the little cork lids, back to all of the 3 vials. We need to agitate these solutions at this point to get it to mix well with the THF. THF is a good solvent for polystyrene that dissolves it quite readily. We just need to make sure that it's homogenous before we move on to the next step.

Audio Description

Stopping the reaction and precipitation of the polystyrene. The setup is a magnetic stirrer hot plate with a thermocouple set to 90 degrees Celsius and containing 3 reaction tubes securely placed within an oil bath. Each of the reaction tubes has a cork sealing the opening of the tube and a sticker with a number.

Experimenter

So we've got the reaction here just approaching 45 minutes. And there we go, as it gets to 45 minutes, we are going to stop the stopwatch, get that out of the way and we're going to remove each of the reactions as quickly as possible and give it a little bit of a wipe to get the oil bath oil off.

Audio Description

The experimentalist removes each tube, one by one, and wipes the excess oil from the bottom with a cloth.

Experimenter

Going to remove all of them at pretty much the same time and put them in our rack to cool down.

Audio Description

Each of the 3 tubes is placed in the corresponding numbered slot on the tube stand. The experimentalist picks up a tube and tilts it sideways, left and right to see the liquid moving inside.

Experimenter

We should be able to see here that the viscosity of the liquid in the tube has increased quite significantly. And that's because there's a high proportion of polystyrene in the tube now, whereas before it was just dissolved Benzoyl Peroxide and styrene. Because the viscosity is increased, what we need to do is we need to add some solvent, which in this case is Tetrahydrofuran to dilute our reaction mixtures down.

Audio Description

The experimentalist picks up a large bottle labeled Tetrahydrofuran: flammable, hazardous, systemic.

Experimenter

This is going to help us arrive at a much nicer final product when we get to the precipitation stage. So I'm going to remove the lids, the little cork lids, of each of the vials. And I'm going to use a glass pipette to do this transfer. I'm going to place a few drops of Tetrahydrofuran into each of the tubes. I'm going to make sure that I don't put the pipette into the polymer because I do want to avoid cross contamination.

Audio Description

The experimentalist drips 20 drops, 1 drop at a time, into each of the reaction tubes.

Experimenter

So I'm adding about 20 drops of THF to each of the tubes at this stage. And I'm trying to keep it consistent across all 3.

Experimenter

So once I've finished with the THF I'm going to get rid of that pipette and put it in the sharps bin in the fume cupboard. And I'm going to add the lids, the little cork lids, back to all of the 3 vials. We need to agitate these solutions at this point to get it to mix well with the THF. THF is a good solvent for polystyrene it dissolves it quite readily.

Audio Description

The experimentalist lifts each tube individually and rocks the tube back and forth and then shakes them up and down before returning them to the rack.

Experimenter

We just need to make sure that it's homogenous before we move on to the next step.

CULTURAL CHANGE AND BUILDING CONFIDENCE



Disability awareness training

All staff should undergo Equality Diversity and Inclusivity training.

Staff who directly work with students with visual impairments may need bespoke training. Every learner's background is different and there should be a process of mutually agreed understanding between a student and a staff member prior to any teaching. Staff who assist either in the laboratory or as scribes should have the appropriate science background.

Having a baseline knowledge of supporting students with disabilities means that anticipatory approaches can be implemented.

This removes a number of the barriers at the outset and allows staff to focus on more unique adjustments as directed by the student's requirements.

User experience feedback

We feel that the best way to test the accessibility of our resources is to seek feedback from all our users to ensure we constantly improve. The following quote (from one of our students) reinforces the value of this approach:

“I am always telling non-disabled people that the best way to approach a disabled person is with the question ‘How can I help?’

Because from that I know that you want to help, you don't know how to help, you trust me that I can explain and you don't have any preconceptions which can destroy the helping process.”

Another student commented on the key measures that are required for successful

accessibility:

“ Innovative students and staff who are all prepared to go the extra 100 miles to study and to help. When this is in place all other things will take care of themselves.”

Embedding technology for all

Inclusive design principles means that all students can benefit.

At Kent the first broadcast of a lecture was to support a visually impaired student. Feedback from the student is below:

"For the first time, I can actually read the screen during a lecture!!!"

A few years later, the broadcast process that we trialled, informed our transition to online teaching to all students during the COVID-19 pandemic.

FUTURE PROJECTS: COLLABORATE WITH US

Crowdsource resources

In our experience the real barrier for blind and visually impaired students is the lack of established best practices and resources in education and training provision with a lack of clarity around the best way to make long standing practices inclusive.

We would like to establish a guide to best practice for including visually impaired students in the chemical sciences. This will be done by collating examples of good practice in the existing literature and from our experience of working with visually impaired students. We will also use our expertise in inclusivity and accessibility and assistive technology to showcase how we can remove barriers in chemistry resources and highlight opportunities for the community to work together to crowdsource solutions and create a central resource bank of case studies to help overcome barriers.

The long-term aim is that our approach will be adopted by the Royal Society of Chemistry (RSC) leading to the beginnings of global acceptance of minimum standards for inclusive standards for chemical science education.

Going further we would like to share these ready-made resources in a wiki for accessible Science, Technology, Engineering, Mathematics and Medicine (STEMM) resources and that can act as a lookup list and guide for future practitioners and students.

This could include (but is not limited to):

- Project files for printing 3D models
- Video recordings of lab sessions with audio descriptions and captions added
- Sharing tagged documents with alternative text descriptions of diagrams
- LaTeX and MathML conversions of equations
- Examples of ways you have committed to best practices by making own content accessible, both teaching materials and wider research projects
- Requests for publishers to improve accessibility of their materials (and include supplementary materials as standard)

Please email us with your ideas and any collaborative opportunities:
opera@kent.ac.uk

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Maria Alfredsson, Donna Arnold, Aaron Berko, George Dobre, Clair Gould, Spartaco Landi, Phil Marsh, Helena Mee and Alex Wright all contributed to the inclusivity best practices shown in this presentation.

ABSTRACT

Adopting basic principles of inclusive design for education will address many of the challenges faced by disabled students, including visually impaired individuals. We discuss Power Point use and show one method of making graphs and other visuals accessible to visually impaired students. Teaching laboratories remain a distinguishing feature in the study of the chemical sciences. In this presentation we show just one approach that can be easily adapted for many experiments to assist visually impaired individuals. We call on the community to create a toolbox of resources, adjustments and initiatives that can be readily shared globally to promote inclusive teaching of the chemical sciences.

REFERENCES

The OPERA (Opportunity, Productivity, Engagement, Reducing barriers, Achievement) project (<http://www.kent.ac.uk/student-support/opera>)

Kent Inclusive Practices (<http://www.kent.ac.uk/guides/how-to-create-accessible-content/kips>)

Creating-an-Accessible-Science-Laboratory-Environment, Mahadeo A Sukhai, Chelsea E Mohler, Tina Doyle, Erica Carson, Christine Nieder, Daniella Levy-Pinto, Emily Duffett, Frank Smith (<https://accessiblecampus.ca/wp-content/uploads/2017/01/Creating-an-Accessible-Science-Laboratory-Environment.pdf>)

The value of safety and practicality: Recommendations for training disabled students in the sciences with a focus on blind and visually impaired students in chemistry laboratories, Gabriella M. Nepomuceno, Debbie M. Decker, Julian D. Shaw, Lee, Boyes, Dean J. Tantillo, and Henry B. Wedler (<http://dx.doi.org/10.1016/j.jchas.2015.02.003>)

My Experiences as a blind chemistry student. Cary Supalo (<https://www.nfb.org/images/nfb/publications/bm/bm12/bm1207/bm120703.htm>)

RSC Chemistry World June 2019. Access all areas. Nina Notman (<https://www.chemistryworld.com/features/accessible-science-education/3010431.article>)