Improving vision impaired students' access to graphics in higher education: Model principles

Graphical learning material is central to learning and teaching in higher education. Students in higher education with a vision impairment experience significant difficulties in accessing graphical materials, forming a barrier to their full participation in higher education.

Graphical material is that which is not presented as text or audio. In addition to graphs, diagrams and photographs, it can also include videos, group work, mathematics, music and phonetics.

A two year study examined vision impaired students' access to graphic materials at university in Australia (Butler et al., 2016). The need for improvement was revealed in a national survey of 71 vision impaired students in higher education:

- 84% of respondents "skipped over graphical material and potentially missed important information because it was inaccessible" either often (41%) or sometimes (43%).
- 94% of respondents agreed that they could "benefit from improved access to graphics in study materials" often (42%) or sometimes (53%).
- Half of the respondents said that they had definitely (30%) or somewhat (20%) "avoided a potential study area or career due to concerns about access to graphics in that field". This was a greater issue for blind respondents, of whom 44% indicated that they had definitely avoided a study area or career.
- A higher than expected proportion of surveyed vision impaired students were studying in the text-based field of Society and Culture (43% compared with 24%). Conversely, vision impaired students were under-represented in STEM fields (11% compared with 24%).

There are educational, legal and moral obligations to provide vision impaired students with equivalent access to learning materials. Australia's Disability Discrimination Act 1992 (Australian Government, 1992) legally requires educational institutions to ensure students with disabilities are able to access the full curriculum. The Disability Standards for Education 2005 (Australian Government, 2005) provide clarity and a framework to ensure that students with disability are able to access and participate in education on the same basis as others, and more specific guidance is provided in the Guidelines on Information Access for Students with Print Disabilities (Australian Vice-Chancellor's Committee, 2004).

The principles and associated strategies were developed as the result of consultative workshop examining the findings and of a two year project funded by the Australian Government Office for Learning and Teaching. Thanks are extended to the many students, disability advisors, academics, accessible formats producers and others who shared their experiences and ideas throughout the project.

Vision impaired students can gain access to graphics through generalist strategies that can potentially benefit all students, alongside the provision of more specialised support. Multi-stage consultation with key stakeholders resulted in agreement on these four guiding principles:

1. Support for the learning requirements of vision impaired students requires **communication and shared responsibilities** between students, academics, support staff and specialist services.
2. Many of the learning requirements of vision impaired students can be addressed through **inclusive teaching strategies**.
3. Vision impaired students have **specific learning requirements** for which higher education institutions are obligated to provide appropriate services and support.
4. Vision impaired students require further specialised support, including the use of **appropriate strategies for accessible graphics**.

While the main focus of this work is improving vision impaired students' access to graphics, many of the proposed principles and strategies are applicable more generally to vision impaired students' access to text or the inclusion of all students with disabilities in higher education.

Principle 1: Support for the learning requirements of vision impaired students requires **communication and shared responsibilities** between students, academics, support staff and specialist services.

Roles and responsibilities must be understood and agreed to by all stakeholders.

With diverse stakeholders involved in ensuring vision impaired students have access to graphical content in their studies in higher education, it is vital that each person understands their own role and responsibilities and those of others. These stakeholders include students, academics, faculty staff, disability services, accessible format providers, advocacy services and publishers (Appendix 1).

Semi-structured interviews and pilot studies (Butler et al., 2016) revealed a number of areas in which roles and responsibilities were not well-defined, resulting in a range of difficulties:

- academics often do not understand their responsibility for ensuring study materials meet a minimum standard for accessibility
- students often expect disability services staff to act as advocates, however the staff see themselves as facilitators, with student advocacy located as a separate department
- there is a blurred line between expectations for students to be independent and the provision of equitable access to materials

"Academic staff … often see it as not their responsibility to modify their teaching techniques to accommodate students with a disability" - student

Suggested strategies:

- face-to-face meeting at or before start of semester between student, academic(s) and disability support staff
- formal documentation of responsibilities to be signed by relevant parties
- involvement of course director to oversee academic faculty staff

Refer to Appendix 2 for a list of suggested responsibilities.

Foster effective and timely formal (and informal) communication processes between all stakeholders.

Effective communication processes are essential before and during semester to facilitate a dynamic approach and to capture otherwise isolated pockets of expertise in the subject matter, accessible formats and the student's needs. Stakeholders who should be included in communications are the student, disability support staff, academics (faculty staff, chief examiner, lecturer and tutor), participation assistants, accessible formats producers, publishers and library (Appendix 1). Of these, the student is most central and decisions should not be made without consultation with the student, as required by the Disability Standards for Education 2005: "Before the education provider makes an adjustment for the student, the education provider must consult the student" (Australian Government, 2005).

The majority of problems with accessible materials provision (Butler et al., 2016) can be attributed to communication gaps, for example:

- anxiety experienced by students unsure of whether materials were in production
- delays or failures in provision of materials, leading students to require extensions or to drop or postpone units of study
- provision of materials which were unclear, with a lack of opportunity for students to seek clarification or request changes

"I thought diagrams were being done but they weren't" – student

"It took days to go through the chain of communication ... Working out what the student required was hard. I don't think we've ever had direct contact with an academic."
– accessible formats provider

Suggested strategies:

- upon enrolment in a subject, a written introduction is sent to the lecturer, chief examiner, tutor and faculty chair
- face-to-face meeting at or before beginning of semester with student, disability services and academic staff
- dedicated staff member for managing communication: feedback collection, translation of language between student and academic, sending reminders
- log and track all jobs on a platform open to all stakeholders for transparency and to reduce unnecessary communication. When ready, files may also be downloaded from this platform. Such a production system could perhaps be shared among Universities.
- dedicated collective communication channel for each subject being studied by a student
    - email is popular and effective because it is already being used by all stakeholders
    - facebook group
- production of print-friendly accessible graphics (e.g. tactile graphics with print overlay) to allow sighted staff to check materials have been provided to the student, e.g. tactile graphics with print overlay

Formal mechanisms are required to capture and distribute feedback regarding disability services.

In keeping with standard practices across most other spheres of university, a formal mechanism to capture, share and act upon feedback is required for continual improvement of services. Feedback from students and academics can have value for disability services staff, academics, accessible formats providers and publishers. However, formal feedback mechanisms are currently rare within disability support services (Brandt, 2011; Holloway, 2001). A formal mechanism is also required to ensure that feedback is considered and acted upon within the university.

This principle is supported by the Guidelines on Information Access for Print Disabilities 10.1: "The University has put in place processes to ensure monitoring and review of the implementation of its policies and guidelines." (AVCC, 2004).

Suggested strategies:

- disability services to request feedback from students and academics at set times, for example 4 weeks after the beginning of semester and then again at the end of semester
- encourage engagement by personalising requests (phone calls are ideal) and/or offering inducements

Principle 2: Many of the learning requirements of vision impaired students can be addressed through **inclusive teaching strategies**.

The Guidelines on Information Access for Students with Print Disabilities 6.1 require that "The University has processes in place to ensure that teaching staff, including casual staff, receive training in inclusive teaching methods and course design." (AVCC, 2004).

Improve disability awareness among academics.

There is a low awareness of the Disability Standards for Education among teaching staff and a lack of engagement by academic staff has been observed in higher education (Department of Education and Training, 2015). International studies have likewise highlighted a lack of training, understanding or experience dealing with disabilities as barriers for university students with disabilities (Díez, López, & Molina, 2015; Hadjikakou & Hartas, 2008; Lewin-Jones & Hodgson, 2004; Moswela & Mukhopadhyay, 2011). When asked a general question about the main barriers to access to graphics, 18% of vision impaired students surveyed in Australia highlighted this lack of awareness among academic staff. Likewise, academics requested more information about vision impairment and how to adjust their teaching practices (Butler et al., 2016).

"I needed to know more. I don't know what [the student] can access and how she accessed it." – academic

"A lot of academics ask the DLU for help or education … about how to best teach students with disabilities, but the DLO staff do not have the expertise to assist" – disability services staff member

Suggested strategies:

- training for all academics on the principles of multi-modal learning, reasonable adjustments and disability services. External training is available from Access Audits Australia, the Australian Network on Disability, the Centre for Disability Studies, the VET Development Centre and elsewhere.
- additional, more specific training or information for academics teaching a vision impaired student

Encourage use of teaching strategies that improve accessibility and learning outcomes for *all* students.

Many of the strategies and practices which would help vision impaired students access graphics are also of potential value to the wider student cohort.

Students with low vision in all stages of our studies reported that they are expected (and want) to directly access the original print materials but they struggle with issues such as colour/contrast, fonts and sizing (Butler et al., 2016). Materials that are clearly formatted and free from distractions are beneficial for all students, not just those with a disability (Dyck and Pemberton 2002).

"I am still struggling to see because they don't always use a good font." – student with low vision

Suggested strategies:

- accessibility checks for essential software such as online materials portal, Turnitin, etc.
- authoring guidelines advocating clear print, designed for academics producing class materials
- best- and worst-practice examples of education materials with annotation for academics producing class materials
- academics to verbalise slide numbers and diagrams being pointed to (useful for students listening to lecture recording)
- use of 3D models (useful for all students present)

Principle 3: Vision impaired students have **specific learning requirements** for which higher education institutions are obligated to provide appropriate services and support.

Students with disabilities require specialised support for transition to higher education.

Difficulties in transition from school to university was highlighted as an issue by students and disability advisors throughout our study (Butler et al., 2016) and similar studies of students with disabilities in higher education (e.g. Kann, 2001). The Education department in each state and territory of Australia has an accessible formats production unit and specialist vision teachers provide support to students and ensure their needs are met. At university, students are expected to advocate on their own behalf and materials or accommodations are provided only on request. Yet, almost half of students who register for disability services are unaware of the accommodations available to them (Kent, 2016). Initial support and information is vital to ensure vision impaired students are able to successfully transition to the university environment where a greater level of independence is expected.

"[The university] provide induction for undergraduates and PhD students. They need to do the same for students with disabilities, explaining the services available and how to go about accessing them."
- student

Suggested strategies:

- linkages between university, secondary school and blindness sectors to share expectations for incoming university students and develop the necessary skills
- disability services presence at University Open Days
- information about disability and advocacy services to be sent to all students who identify as having a disability upon enrolment
- disability services presence as part of orientation activities at the start of each semester
- university orientation programs specifically for students with disabilities
- peer mentoring

Vision impaired students require resources and skills to access materials independently. Universities should assist students in acquiring these.

Use of assistive technology can greatly enhance vision impaired students' access to materials, support their independence and reduce reliance on costly conversion of materials to hard copy accessible formats. The use of adaptive equipment is particularly valuable for research students who need to acquire their own materials, and as preparation for the workforce. However, students must be aware of their options in a rapidly changing technological landscape, have access to expensive specialist equipment and software, and be proficient in its use.

There is often a presumption on behalf of universities that students will come with their own equipment, however the equipment can be prohibitively expensive and funding schemes are based on use: equipment provided at primary and secondary school remains the property of the education department, and the National Disability Insurance Scheme (NDIS) will not support acquisition of equipment for work or education purposes.

This principle is supported by the Guidelines on Information Access for Print Disabilities (AVCC, 2004) clauses 3.3 "The University has a commitment to assist students to develop independent learning skills" and 7.1 "The University provides appropriate adaptive equipment and software for students with print disabilities".

"It is not just access to the teaching materials that it is important,
but also the acquisition of skills necessary to learn,
particularly for students with a disability." – academic

"I lack training [in adaptive technology]. It's really hard to access training." – student

"I don't use any specialist equipment or software.
I don't know what to ask for." - student

Suggested strategies:

- peer mentoring
- sharing information about equipment grants and availability:
    - Vision Australia Further Education Bursary

    - St Vincent de Paul Grant for Students with Disabilities
    - Universities receive 100% reimbursement through the Higher Education Disability Support Programme (DSP) for approved adaptive equipment purchases
- consider the type of materials, technologies and strategies that will be used for assessment purposes and provide exposure and practice in their use throughout the semester

Principle 4: Vision impaired students require further specialised support, including the use of **appropriate strategies for accessible graphics**.

Consideration is given to the multiple roles that graphics play in the overall learning experience.

Diagrams may be used for a variety of reasons:

- to teach about types of diagrams and their use
- as the primary means of conveying a concept
- as an additional means of reinforcing a concept explained in the text
- to summarise a topic
- for enjoyment of the content, e.g. by providing visual interest or sharing a joke
- group work

Due to resource limitations, provision of access for vision impaired students is often limited to only the first two uses of diagrams. Depending on the student's learning style, further diagrams may also be highly valuable.

> "*I found the descriptions of the cartoons really useful" because they summed up the whole topic and made it more memorable* - student

Suggested strategies:

- begin by providing at least a minimum level of access to all diagrams (e.g. a basic diagram description) then consult with the student to determine what will be of most value.

Application of appropriate technologies and practices to make graphics accessible, as best suited to the individual student, content and context.

A wide range of technologies and solutions are available for access to graphics and the information they convey. Their suitability depends on the student's level of vision, familiarity with formats, access to technology and expertise in its use; the type of graphic and information being conveyed; and its intended use. In general, preference should be given to strategies which enable more timely and independent access to materials.

> *"There is such a broad range of what constitutes a graphic and broad range of subjects that there is no one-size fits all. Students are all different too."* – disability advisor

Our survey of vision impaired students revealed a heavy reliance on less preferred strategies such as descriptions and enlargement. Newer technologies such as sonification, 3D printing and image recognition were desirable to students but very rarely used.

A broad range of methods for presenting graphics accessibly, along with their relative merits, are given in Appendix 3.

Suggested strategies:

- provide students with a range of format options to suit their skills and needs
- minimise the distance between accessible formats production and the student to allow more timely access and easier communication when clarification is required. For example:
- if the importance of diagrams is unknown, a quick lesser-quality solution can be implemented as a starting point to provide students with enough information to request further access to those images they are most interested in. Initial strategies may include captions, verbal descriptions and automated image identification.
- graphics with complex spatial component are best represented in two dimensions, e.g. with a tactile graphic, GraVVITAS or sonification
- graphics conveying 3-dimensional concepts are best represented in 3 dimensions, e.g. models, access to the actual object, or 3D printing
- trial new strategies before full implementation

Use national networks and partnerships to share expertise, best practice and resources and keep up-to-date with changes in technology and the teaching environment.

Disability services staff are unable to maintain expertise in all options for vision impaired students to access graphics and other materials. Vision impaired students represent an increasingly small proportion of the student requiring disability services (Kent, 2016), a wide range of accessible formats and adaptive technologies are needed to suit the individual and context, and accessibility options and the teaching environment are undergoing rapid change. Recent examples include the increased use of blended learning, flipped classrooms, videos and concept mapping and rise of new technologies such as 3D printing and image recognition software. Our survey revealed that most students use strategies they have suggested themselves, however students are also unlikely to be aware of all options, particularly if they have suffered a recent decline in their vision (50% of surveyed students) or if they are international students. Use of networks is therefore vital to share knowledge and expertise.

This recommendation is aligned with one of the four general principles given in the Guidelines for Information Access for Students with Print Disabilities: "Universities are encouraged to pursue cooperative links with other educational institutions in their region and with community service providers in order to enhance access to highly specialised and expensive services." (AVCC, 2004)

Suggested strategies:

- peer mentoring
- creation of a facebook group for vision impaired university students
- use of existing catalogues:
    - CAL Masters Catalogue of materials in alternative formats produced in Australia
    - Bookshare has 200,000 titles available for Australians, many with diagram descriptions
- use of existing networks:

    - ATEND: Australian Tertiary Education Network on Disabilities and its local subgroups such as SHEDN (Southern Higher Education Disability Network)
    - Pathways conference
    - ADCET: Australian Disability Clearinghouse on Education and Training
    - Round Table on Information Access for People with Print Disabilities Inc.
    - ANZAGG: Australia and New Zealand Accessible Graphics Group
    - Australian Braille Authority
    - DIAGRAM Center: research and resources for accessible diagrams (USA)
    - vision service providers such as Vision Australia, VisAbility and the Royal Society for the Blind
- use of existing listservs:
    - AUST-ED: Australian Tertiary Education Network on Disabilities
    - ozbrl: Australian Braille Authority
    - accessible-graphics: (Australia and New Zealand)
    - VIP-L: Vision Impaired People's list (Australia)
    - BlindRUG: Blind R-users Group (International)
    - BlindMath: Blind Mathematicians (International)
    - MenVi: Music Education for Vision Impaired (International)
- creation of a National Disability Advisory Service with specialists in specific disabilities to assist all tertiary institutions

Utopian view of the future

The principles and strategies suggested above were designed to fit within the current framework. Broader change is needed at the level of funding and institutional structures to achieve an ideal situation in which vision impaired students are able to access to graphical materials without barriers. Ultimately, we must work together at every level towards a situation where:

- At primary and secondary school – children are encouraged and enabled to participate in all aspects of the curriculum, including STEM
- In transition to university – potential issues are identified during transition planning and addressed by building the skills and supports necessary for success
- University learning environments - academics are supported to meet the needs of their students with born-accessible classrooms, activities and learning materials
- University support services – automated, customised and timely rendering of graphical material using state of the art technology
- Transition to employment – students are equipped with the skills, equipment and knowledge required for a positive labour market outcome

We look forward to a time of true inclusivity when vision impaired students enjoy equivalent access to the university experience alongside their sighted peers to reach their full potentials.

References

Australian Government (1992). **Disability Discrimination Act 1992**.

Australian Government (2005). **Disability Standards for Education 2005.**

Australian Vice-Chancellors' Committee. (2004). **Guidelines on Information Access for Students with Print Disabilities.** Canberra.

Butler, M., Holloway, L. M., Marriott, K. & Goncu, C. (2016). Understanding the graphical challenges faced by vision-impaired students in Australian universities, **Higher Education Research & Development**, DOI 10.1080/07294360.2016.1177001.

Brandt, S. (2011). From policy to practice in higher education: The experiences of disabled students in Norway. **International Journal of Disability, Development and Education, 58**(2), 107–120.

Department of Education and Training. (2015). **Department of Education and Training Evaluation of Disability Support Program Final Report**. Retrieved April 19, 2016, from https://docs.education.gov.au/system/files/doc/other/dsp_evaluation_report_final_june_2015.pdf

Díez, A.M., López, R.G., & Molina, V.M. (2015). Students with disabilities in higher education: a biographical-narrative approach to the role of lecturers. **Higher Education Research & Development, 34**(1), 147–159.

Dyck, N. & Pemberton, J. B. (2002). A model for making decisions about text adaptations. **Intervention in School and Clinic 38**(1) pp28-35.

Hadjikakou, K., & Hartas, D. (2008). Higher education provision for students with disabilities in Cyprus. **Higher Education, 55**(1), 103–119.

Holloway, S. (2001). The experience of higher education from the perspective of disabled students. **Disability & Society, 16**(4), 597–615.

Kann, C. H. (2001). Computer needs of students with disabilities. **Planning for Higher Education, 30**(1) pp35-42.

Kent, M. (2016). **Access and Barriers to Online Education for People with Disabilities**. Report submitted to the National Centre for Student Equity in Higher Education (NCSEHE), Curtin University: Perth.

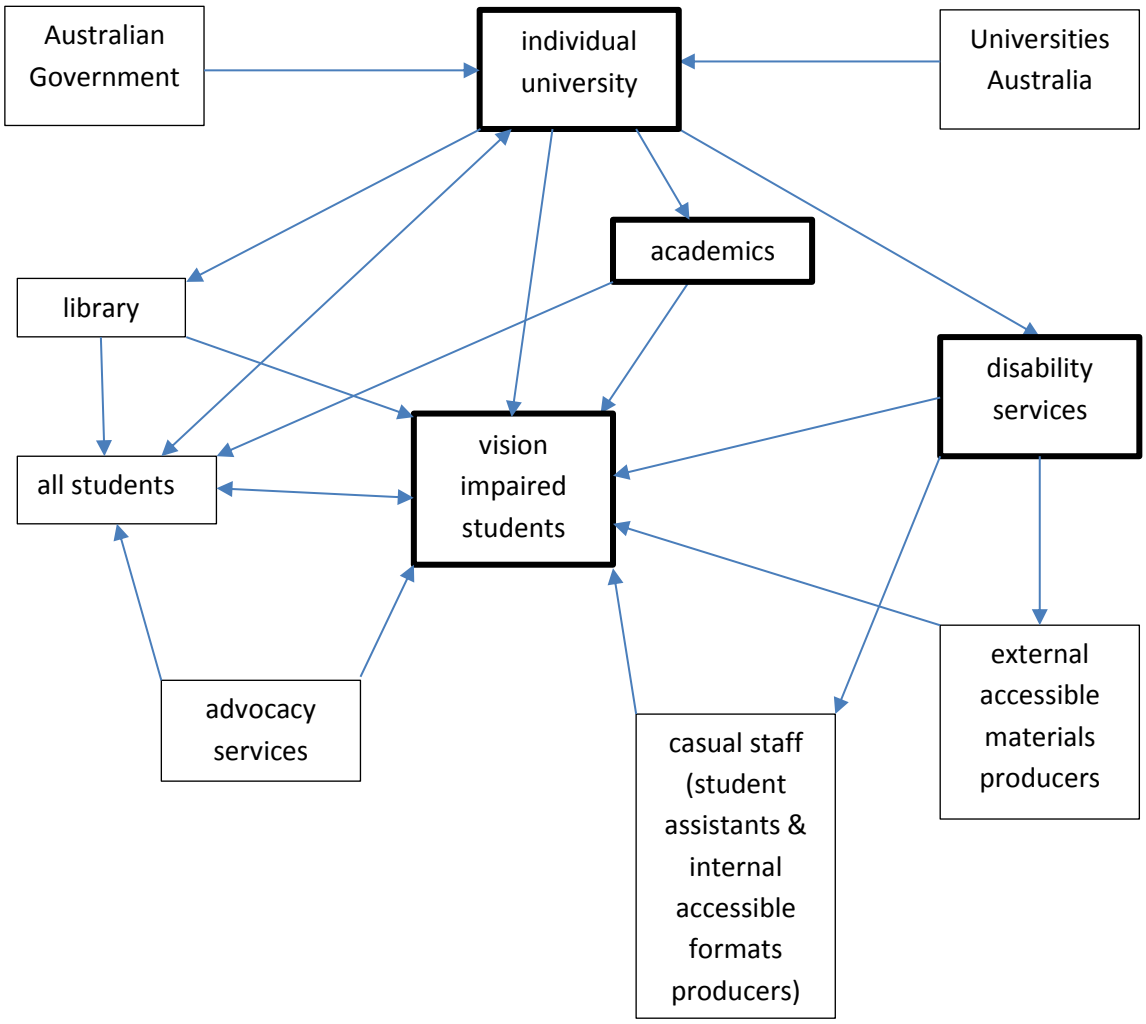
Kilpatrick, S., Johns, S., Barnes, R., McLennan, D., Fischer, S. & Magnussen, K. (2016). **Exploring the Retention and Success of Students with Disability.** Report submitted to the National Centre for Student Equity in Higher Education (NCSEHE), Curtin University: Perth. https://www.ncsehe.edu.au/wp-content/uploads/2016/05/Exploring-the-Retention-and-Success-of-Students-with-Disability.pdf accessed July 2016

Lewin-Jones, J., & Hodgson, J. (2004). Differentiation strategies relating to the inclusion of a student with a severe visual impairment in higher education (modern foreign languages). **British Journal of Visual Impairment, 22**(1), 32–36.

Moswela, E., & Mukhopadhyay, S. (2011). Asking for too much? The voices of students with disabilities in Botswana. **Disability & Society, 26**(3), 307–319.

Appendix 1: Stakeholders involved in provision of access to graphics for vision impaired university students.

Choice and implementation of best practices must consider the requirements and capacity of all stakeholders:



Appendix 2: Suggested responsibilities of stakeholders

Students:

- register with disability services and give notification of requirements as early as possible
- develop skills for using adaptive technology
- examine available learning materials prior to start of semester to investigate accessibility issues
- timely and open communication with all stakeholders, including provision of feedback

Disability support staff:

- facilitation, ensuring open communication and access to information for all stakeholders:
    - responsibilities and timelines
    - accommodations and services available to students
    - information for students about adaptive technology options and training
    - suggested strategies and best practice for academics
- coordinate conversion of materials to accessible format

Course director:

- proactively work with student and disability services to plan upcoming units
- pass on successful strategies from one academic to the next
- ensure faculty staff are aware of their responsibilities

Academics:

- working with the vision impaired student and disability support services:
    - identify essential learning materials, with recognition that most student will not and do not need to access all learning resources
    - identify the most important diagrams
    - provide original source files created prior to conversion to PDF or PowerPoint
    - provide templates or examples for description of specialist diagrams
    - timely and open communication with all stakeholders
- in lectures and tutorials:
    - clearly identify slide numbers and diagrams when speaking about them for the benefit of vision impaired students, students listening to lecture recordings, and students with auditory learning styles
- preparing learning materials for all students:
    - use of clear print guidelines, e.g. adequate sizing and clear contrast
    - provide a caption for all images
    - provision of learning materials with adequate time for access prior to their use in class. Materials from the previous year with annotation may be helpful as a back-up if materials are finalised just-in-time.

Accessible format providers:

- timely and open communication with all stakeholders:
    - provide clear timelines for production of materials
    - request further information when content knowledge is required to simplify or translate graphic material

Publishers:

- provision of source files
- labelling and describing diagrams
- following accessibility guidelines, as described in DIAGRAM Center's "born accessible" project.

Appendix 3: Methods for accessible graphics

method	suitability	example diagrams	advantages	disadvantages	resources
enlargement	Students with sufficient usable vision. Original image must be high quality with good contrast.		• can use original graphic without modification • can be used independently	• can cause headaches or fatigue • can be difficult to gain an overview and navigate	• software • large screen
verbal description	Information graphics where spatial layout is unimportant.	• single-path flow charts • infographics • concept maps • cartoons • illustrations	• can be provided on the spot (without preparation) • student has opportunity to seek clarification • can also be useful for other students	• student cannot access the information independently • not suitable for conveying spatial information • often requires subject-matter expertise	
written description	Information graphics where spatial layout is unimportant.	• single-path flow charts • infographics • concept maps • cartoons • illustrations	• quick to produce • can be reviewed by the student at any time • can also be useful for other students (if given as alt text in original course materials)	• needs to be prepared ahead of time • not suitable for conveying spatial information • often requires subject-matter expertise	• staff time for accessible format production

image recognition apps or software	Blind research students needing to determine which images to request in accessible format.		• quick • portable • can be used independently	• does not give access to the information in the graphic (only an indicator of whether it is important)	• software or app, e.g. TapTapSee
GraVVITAS	Simple diagrams with important spatial information.	• multiple-path flow charts • simple maps • tables • Gantt charts • graphs (line, bar, pie or scatter)	• cheap • portable • able to convey spatial information • easy to produce • graphs can be produced independently by the student	• cannot convey fine detail	• Author tool (free online) • Reader app (free) • iPad • staff time for accessible format production
sonification software	Line graphs.	• line graphs	• provides quick, independent access from an equation or data		• software, e.g. MathTrax
pre-prepared tactile graphics	Any diagram with important spatial information.	• maps • graphs	• able to convey spatial information • can be combined with print for low vision students • high quality	• expensive • time-consuming • expertise required for production • student must have sufficient tactile reading skills[1] • bulky	• graphics software, e.g. CorelDraw, Illustrator, Inkscape, Word, PictureBraille • specialist equipment (e.g. braille embosser, Tiger Embosser, PIAF) • specialist supplies, e.g. braille or PIAF paper

[1] Many students are not familiar or confident using tactile graphics, however it is important that Universities do not contribute to this problem by failing to provide exposure to them.

					• staff time for accessible format production
ad-hoc tactile graphics	Diagrams with spatial component, required at the last minute without a high level of accuracy.		• cheap • quick • able to convey spatial information	• not durable • limited labelling • student must have sufficient tactile reading skills	• equipment and supplies, e.g. tactile drawing board, thick paper, tracing wheel, string with glue, sticky dots, etc. • staff time for accessible format production
3D-printed models	Only worthwhile when 3-dimensionality is important.	• anatomy • 3D graphs • maps • artworks • historic artefacts • any other objects too small, large, dangerous, delicate or rare to touch	• easier to understand than tactile graphics • can be produced on-site • cheap • can also be useful for other students	• long print time • time and expertise required to create new models • bulky • needs to be supplemented with a description	• 3D printer and materials • 3D design software • staff time for accessible format production
pre-existing 3D models	3D model is readily available or 3-dimensionality is important.	• anatomy or chemistry models • equipment	• may be readily available • can also be useful for other students	• bulky • needs to be supplemented with a description	• may be expensive or time-consuming to obtain