[O27] Teaching biological science to blind students

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Abstract

A year's experience preparing and delivering teaching materials specially designed for visually impaired – including blind – students has shown that they are capable of achieving many of the learning outcomes expected of sighted students. Advances in information technology enable these students' access to written materials with or without personal helpers. Screen readers and software to present books and documents in auditory format mean that lectures, reading and tutorial work pose only resource problems. The main difficulty for students lacking full vision is participation in practical classes. Whilst many laboratory skills remain beyond the reach of these students, they can be helped to achieve a good level of understanding of many of the exercises presented in a laboratory setting if the learning outcomes are carefully considered, and bespoke learning materials constructed to enable them to be studied using non-visual modalities. For example, in a microscopy class, detailed consideration of what sighted students are expected to learn from the images they will see may allow the construction of substitute tactile diagrams. Bright colours help some students with residual vision, especially if they are made to a suitably large scale. Use of the tactile talking tablet (T3) allows students to study these diagrams with a measure of independence. This technology will be demonstrated, and some of the materials made for our students available for inspection. Three dimensional models made from a range of modelling materials, also brightly coloured, have been made for special purposes, for example to substitute for scanning electron micrographs. The evaluation of one severely and one moderately impaired student of our first year's work will be reported.

Introduction

This paper represents a work in progress: a steep learning curve in the teaching of biological material – specifically neuroscience – to visually impaired (VI) students. At the time of writing this represents barely six months' experience, but by the time the paper is delivered it will be a full academic year and we intend that the work will have been evaluated by the VI students.

Until this year students at Keele with a visual deficit have simply been provided with an amanuensis to help with taking notes, along with specialist computer software such as screen readers. Generally this meant that lecture and tutorial classes could be coped with, but little consideration had been given to laboratory classes and other types of practical work. The SENDA legislation (Special Educational Needs and Disabilities Act 2001) requires that an educational institution takes such reasonable steps as to ensure that disabled students are not at a substantial disadvantage. With two visually impaired students entering year two of a dual honours neuroscience course, we set ourselves the task of making the laboratory classes accessible to these students. At a later date we shall use our experience to convert all of our neuroscience and biology degree courses in the same way.

Our approach has been to consider each type of laboratory class in turn: macroscopic anatomy, microscopy, biochemical techniques, physiological recording, animal behaviour and (in biology) fieldwork. On first consideration it seemed to be impossible for students with severe visual deficits (bordering on complete blindness) to participate in most of these classes. This forced us into a more in depth analysis of the purposes of our lab classes: what was it we hoped that the sighted students would learn? What were the intended learning outcomes, and could they be achieved in other ways? We have had to accept that, for the moment at least, some laboratory skills are still out of the reach of students with limited vision, sometimes on safety grounds. But after the manipulations that VI students cannot perform, results are generated that need to be processed, and there is no reason why VI students should be excluded from this part of the exercise. Practical work in any case is often not concerned with acquiring manipulative skills, but about intellectual processes and illustrating concepts by the use of living or preserved material. It is on producing illustrations and results in a form that is accessible to the VI student that we have concentrated our efforts.

Technological Solutions

The tactile and auditory senses are the main modalities through which VI students can receive information useful in their studies, and these are brought together in a relatively new piece of equipment, the Tactile Talking Tablet (known also as the T3). The T3 is the European version of the Talking Tactile Tablet (TTT) owned by Touch Graphics, New York. It is marketed by the Royal National College for the Blind (RNCB) at Hereford and other companies. When the T3 is purchased from RNCB they provide additional invaluable information and training based on their vast experience of educating visually impaired students, and what follows owes much to them.

The T3 is an inexpensive touch-sensitive device producing immediate auditory information to the user on the object being touched. It consists of a touch-screen computer interface connected to a laptop or PC by means of a simple USB connector. A tactile paper overlay is placed on the touch screen, located precisely and held in place by a hinged metal frame. On touching the overlay at any location the user first hears a set of simple instructions telling him or her to press lightly on raised bumps in two diagonally opposite corners of the screen to ensure that the overlay is properly located. Next s/he runs a finger along horizontal lines at the top of the screen pressing lightly on three more raised bumps on these lines. Each gives a tone indicating successful location: the unique combination of these three bumps identifies the overlay, and the student is now ready to begin. The following words are heard: ‘Feel the shape of the image with your fingers. Press down lightly with one finger to hear the name of the object you are touching. Pressing a second time will give you further information. You can interrupt speech at any time either by moving to a different object or by pressing on the background of the page outside any object.’ The image in one of our neuroscience modules might be, for example a diagram of a motor neurone. In this case the spoken text will identify key structures such as the cell body, dendrites, axon hillock and axon, etc. So the student, having identified the axon hillock by touching it will touch it again, and this time will hear that this is where the nerve impulse is generated. Third and fourth layers of information may be added, going into as much detail as is thought appropriate.

The overlays are produced on special heat-sensitive ‘swell’ paper. A diagram of the learning object is drawn or printed onto the paper, which is compatible with standard ink-jet printers. The print needs to be very dry and the paper is then passed through a heating device that makes the paper swell wherever there is black ink. Thus a tactile diagram is produced. Other coloured inks do not induce swelling, but brightly coloured diagrams are useful for the majority of VI students who may have sufficient residual vision to detect them.

The next stage is to add the auditory information. The T3 comes with the necessary software for this. It is important to have text well planned, as when it is heard by the student it needs to be clear, with no hesitation or unwanted words or sounds. It is good practice to type out the text that is to be used so there can be no mistake. Speaking spontaneous sentences is likely to give a poor result. A reader with a clear, pleasing voice is an advantage, as the student is going to hear this a lot, and idiosyncrasies may become quite irritating.

Diagrams need to be relatively simple: it is important to realise that some of the detail that can be clearly seen in textbook diagrams may be too fine or detailed to be resolved by a fingertip on a tactile diagram. Use of artificial texture (cross-hatching or stippling) may be useful to distinguish structures, but the same considerations apply about fine grain shading and the differences that can be resolved by touch.

A very limited range of overlays is already available to purchase, but as yet few are available for HE level in any subject, and we have found that for specific classes we need to custom design our overlays. For example in a class in which the sighted students were learning about the ultrastructure of brain tissue and interpretation of transmission electron micrographs, it was possible to make T3 overlays to correspond with the illustrations being used by the rest of the class. However, transmission electron micrographs of brain tissue are very complex indeed, and difficult enough for sighted students to interpret, and a great deal of simplification was needed in the tactile diagrams. All but a few components that were the main study objects for the class – nerve terminals with synaptic structures - were removed. One of the tasks of the sighted students was to measure the diameter of a random selection of synaptic vesicles in two terminals and to do a statistical comparison of the vesicle populations to determine whether there was a difference between them. We tried hard to find a way for the VI students to make these measurements, even going to the lengths of constructing a 'clickable ruler' with 1 mm divisions. Such devices are available for purchase from the USA, but prohibitively expensive for a single exercise. In the event this task proved beyond our students at least with the equipment we were able to produce. So in this instance we settled for giving them the measurements and allowing them to do the statistics.

Other technologies

The T3 is a great advance in technology to support VI students, but it is not a universal panacea. RNCB provide a useful decision tree, originally attributed to the American Foundation for the Blind that gives guidance as to the appropriate conditions for its use. These include when the object in question is unavailable, too small, too large or to dangerous to examine by touch, and when the student needs the information to participate in classroom discussions or to answer questions. Even when these conditions are met other learning aids may be more useful. For example, when studying scanning electron micrographs in which the subjects were intact and damaged inner ear hair cells, it was judged that even a tactile diagram would be too flat to give a true impression of the structure. Three dimensional scale models were made from salt-dough, brightly painted and varnished and these proved useful for both our students.

Models of animals, plants and human organs are of course commercially available, but rather expensive, and often not quite appropriate for our specific lab classes. Ability to make good models is therefore a valuable skill: a wide variety of modelling clays and other materials is readily available. Wherever possible, however we are allowing our VI students to feel the real objects being studied. In an animal behaviour class being used, the students were able to handle live laboratory mice and, prior to a frog dissection, they handled the freshly killed animal. We have plans to prepare dried specimens of hard-bodied invertebrates such as large crustaceans, and to use living gastropod and bivalve molluscs. In this way, on our marine field course future VI students will at least be able to experience some of the range of organisms found on the shore.

For our student with some vision we have found the best approach is to use magnification and bold colours. The use of a visualiser (a video camera designed to project documents and other objects onto a screen) has been invaluable. To our surprise and delight a student who attempts to read normal text with his nose literally on the paper was able, using the visualiser, to dissect the sciatic nerve from a frog well enough for it to be used in physiological experiments. The nerve impulses subsequently recorded from this preparation and displayed on a computer screen were then printed out, transferred to swell paper and made into a tactile diagram.

In a developmental neuroscience class both our students were able to make a good attempt at removing a two – three day chick embryo from an egg. Tactile diagrams have been prepared to help them understand its anatomy.

Visually impaired students are not all alike

Accustomed to thinking of our sighted students as diverse in their needs and learning styles, we originally made the elementary mistake of assuming that visually impaired students would have so much in common that they could be treated as a homogeneous group. A short contact with our two students and some instruction from the professionals in helping sensory impaired students (Staffordshire ASSIST) soon disabused us of this fallacy. They are at least as varied in learning style as the rest of their class, and a one-size-fits-all approach is quite inappropriate. They vary from almost blind to possessing a useable amount of residual vision, and from the quiet, thoughtful and studious to the extrovert, outspoken and determined.

Another feature of VI students that has become apparent to us is the effort of concentration they need to make to follow a class of any kind. They need to work much harder than sighted students to achieve the same ends. Tiredness noticeably affects what they can do: even our most impaired student can see something on a computer screen when he is fresh, but this ability leaves him as fatigue sets in.

Examinations and other assessment

Naturally VI students require special examination arrangements, and for conventional exams the use of an amanuensis in a separate room is all that is required. However, some forms of in course assessment, particularly involving practical work need different tests. Although the learning outcomes (LOs) are kept as close as possible to those of sighted students, some changes are inevitable. It is necessary to remember that learning outcomes are what is assessed, so modified LOs require adjustments to the assessment. So far we have only provided help from an amanuensis when a test has involved graphics, but in principle there is no reason why the T3 should not be used to test as well as to teach.

Future plans

The first efforts described above have not been perfect, and we have asked our VI students to comment as they have done each exercise. Their different abilities and disabilities mean that their responses differ, and we have not felt able to impose on their time, as yet, to formalise their evaluations. We hope to be able to do this when their end of year examinations are over, and also to involve them in the design and evaluation of materials for modules they will not study. In this way we hope to be better prepared for future VI students, as Keele begins its Foundation Year for Visually Impaired students, and as they progress onto our principal degree courses.

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