Developing an inclusive curriculum for visually disabled students

Geography Discipline Network (GDN)
Higher Education Funding Council for England
Improving Provision for Disabled Students

Inclusive · Curriculum · Project
<www2.glos.ac.uk/gdn/icp/>

The Inclusive Curriculum Project (ICP) aims to develop, disseminate and embed resources for supporting disabled students studying geography, earth and environmental sciences in higher education and to transfer the generic lessons widely to subject-based academics, educational developers, learning support staff and disability advisers. Its primary outputs include:

- the ICP Guide series - Nine complementary guides, aimed primarily at staff in geography, earth and environmental sciences, and one guide aimed at students:

  1. Issues in developing an inclusive curriculum

  2. Developing an inclusive curriculum for students with mobility impairments

  3. Developing an inclusive curriculum for visually disabled students

  4. Developing an inclusive curriculum for students with hearing impairments

  5. Developing an inclusive curriculum for a) students with mental health issues; b) students with Asperger Syndrome

  6. Developing an inclusive curriculum for students with dyslexia and hidden disabilities

  7. Developing an inclusive curriculum: a guide for heads of departments and course leaders

  8. Developing an inclusive curriculum: a guide for lecturers

  9. Developing an inclusive curriculum: a guide for departmental support staff (i.e. administrators and technicians)

  10. To a Degree: a guide for students with specific learning difficulties, long-term medical conditions or impairments

- a student survey report: 'The experience of disabled students in geography, earth and environmental sciences of teaching, learning and assessment in HE';

- a set of case studies on the experience of disabled students of teaching, learning and assessment in HE, and the experience of departments and disability advisory units of supporting the learning of disabled students.

All of these outputs are available via the GDN website at <www2.glos.ac.uk/gdn/icp/>. Both the Guide series and the survey report are also available in hard copy format via the GDN Publications Office. A complete set of the ICP Guides will be distributed in hard copy to all Higher Education institutions in England and Northern Ireland at the end of the project.

Project Team

Lead site

> University of Gloucestershire: Professor Mick Healey; Michele Hills; Dr Jacky Birnie; Anna Donough; Dr Phil Gravestock; Dr Tim Hall; Dr Margaret Harrison; Carolyn Roberts

Consortium

> Lancaster University: Dr Gordon Clark; Terry Wareham; Rosemary Turner
> Liverpool John Moores University: Naseem Anwar; Dr Clare Milsom; Sue Thompson
> Middlesex University: Professor Ifan Shepherd; Sue Bleasdale
> Open University: Dr Jonathan Leach
> Oxford Brookes University: Professor Alan Jenkins
> University of Plymouth: Professor Brian Chalkley; Judith Waterfield

Advisory Panel

> Dr Rita Gardner (Royal Geographical Society (with the Institute of British Geographers))
> Professor Graham Gibbs (University of Oxford)
> Dr Annie Grant (University of East Anglia)
> Judy Hartley (Griffith University, Brisbane, Australia)
> Professor Brenda Smith (Higher Education Academy)

Developing an inclusive curriculum for visually disabled students

Ifan D H Shepherd

Middlesex University

Editors' note

This is a guide with a difference! As author Ifan Shepherd was researching this booklet, he became convinced that he wanted to produce a longer guide than would fit in the series so that he could address a wider range of issues. We were delighted with this suggestion and agreed to publish it as a web document, while also producing this shorter stand-alone version in hard copy.

To allow you to cross-reference between the two guides, we have retained the numbering of the extended web guide in the printed version. Hence there are some sections which do not appear in this guide. To whet your appetite to go and look at the extended version, we have included the headings of the extra sections in italics in the contents page of this guide. The extended version may be read online or as a downloadable document by going to <www2.glos.ac.uk/gdn/icp/>.

We should, however, emphasise that this printed version has an integrity of its own and there is no need to cross-reference to the extended version to understand the issues discussed here.

Michele Hills and Mick Healey

Contents

Note: Headings in italics refer to text in the extended version of the guide only, available on the web via <www2.glos.ac.uk/gdn/icp/>.

About the author

My name is Ifan Shepherd, and in my day job I am Professor of GeoBusiness at the Middlesex University Business School. However, despite my current title, I have spent most of my professional career as a geographer. I have been involved over many years with research and development in the field of educational innovation, key skills and computer-assisted learning, and I have been a visiting consultant on e-learning to several universities in the UK. I am a member of the editorial board, and former joint editor, of the *Journal of Geography in Higher Education*.

My current research interests include: the transfer of knowledge and skills; data visualisation; multi-sensory GIS; e-learning; business applications of geographical information systems and computer mapping; evaluation of information quality on the internet; and the building of a spatial database for late nineteenth-century London. I have undertaken numerous consultancies in the public sector, including several large-scale audits: of poverty in the London borough of Hounslow; of early years provision in the London borough of Hackney; and of NHS Direct in West London.

I have a personal motivation for writing this guide. As a child, I vividly remember a blind neighbour in my home village in Wales who taught basket making in a local evening class. At that time, basket making was one of the few, and certainly the most readily recognised, occupations open to blind people. A measure of the progress made since my childhood in bringing blind people back into the social and economic mainstream is the considerably greater range of occupations now open to them. Nevertheless, unemployment among blind and partially sighted people is still very high, currently running at about 75% (NFB 2000b), and certain job markets, most notably the UK armed forces, are still resistant to disabled entrants. The term 'partial citizenship' used recently to refer to the quality of life still experienced by many disabled people seems to capture the current state of affairs perfectly.

I was also inspired, more recently, by one of my geography students who, despite having only about 10% vision, refused to be anything other than 'normal'. Not only did he master the art (as it then was) of map interpretation, assisted by maps that had their artwork redrawn by our departmental technician with extra-thick lines, but he also joined the student Outdoors Society and spent weekends dragging companions across the Pennines in the north of England. Not unexpectedly, the field courses he attended presented him with few significant challenges.

In the past decade, I have been involved in research into multi-sensory GIS and data visualisation, and this has opened my eyes to the sensory deprivation perpetuated by modern geographical software (and especially GIS, desktop

mapping and remote sensing packages) that caters almost exclusively for the visually adept. Although several sections of this guide reflect a belief that computer and networking technologies can be applied to helping visually impaired students learn more effectively, or to remove barriers to learning that might otherwise exist, I hope that this technological perspective does not overshadow the human approaches that are essential if visually disabled students are to participate in effective learning in GEES.

Acknowledgements

Editors' Preface

This guide is one of a series of ten published by the Geography Discipline Network (GDN) as part of the **GDN Inclusive Curriculum Project** (ICP), a three-year initiative running from January 2003 to December 2005, funded by the Higher Education Funding Council for England's *Improving Provision for Disabled Students* programme.

The ICP Guide series is written primarily for academics, educational developers, learning support staff and disability advisers supporting disabled students studying geography, earth and environmental sciences in higher education. In addition, one guide is aimed at helping disabled students to optimise their experience of higher education. The project builds on the success of an earlier HEFCE-funded GDN disability project, *Providing Learning Support for Disabled Students Undertaking Fieldwork and Related Activities*. This project, unbeknown to us at the time, broke new ground. Adams (2002), the Director of the National Disability Team (NDT), subsequently stated that:

> *'The Geography Discipline Network project was, for a variety of reasons, an extremely important project:*
>
> *a. It was one of the first disability-funded projects that exclusively addressed issues concerned with teaching, learning and assessment.*
>
> *b. It was led by academic staff in partnership with disability practitioners – this kind of partnership has signalled a real shift in thinking regarding disability issues.'*

The project, as is the current one, was undertaken by the Geography Discipline Network, a consortium of old and new universities based at the University of Gloucestershire, whose aim is to research, develop and disseminate good learning and teaching practices in geography and related disciplines.

At the beginning of the Inclusive Curriculum Project, we wanted to capture the student voice. Accordingly, we undertook a survey of disabled students studying geography, earth and environmental sciences in the consortium institutions (Hall & Healey, 2004). The survey was supplemented by case studies of the learning experiences of disabled students and the different ways in which departments and tutors have supported them, which are also available on the GDN website at <www2.glos.ac.uk/gdn/icp/>.

Awareness of the need to develop inclusive practices, which provide equal opportunities for disabled students in various elements of their courses, is spreading throughout Higher Education Institutions (HEIs) in the UK. This has been stimulated by the Quality Assurance Agency (QAA) *Code of Practice - Students with Disabilities*, published in 2000, and the extension of the Disability

Discrimination Act (1995) to education through the Special Needs and Disability Act (2001), later incorporated into Part IV of the DDA and the Disability Discrimination Act (2005).

The ICP project focuses on the fundamental principle of inclusivity, whilst addressing the day-to-day practical realities of supporting students with a wide range of specific physical and mental difficulties. Although the series is written from a disciplinary perspective and some guide titles address particular areas of disability, the project provides guidance which offers transferable lessons for what is good practice throughout teaching and learning in higher education.

Despite using medical categories for describing impairments, we are committed to emphasising a social model to exploring disability, which examines the barriers to disabled students which society creates. The distinction between the medical and social model is important because it shifts the responsibility for improving the provision for disabled students from the individuals themselves to society, and the strategies and policies that higher education institutions and their constituent departments develop and enact. However, we support recent modifications to the social model which emphasise the reality of the lived experience of disabled people, and we are sympathetic to calls to construct a more adequate social theory of disability which recognises that everyone is impaired (Shakespeare & Watson, 2002). The focus of this series of guides is on identifying the barriers that disabled students face to participating fully in the curriculum and the ways in which institutions, departments and tutors can help to reduce or overcome them.

The GDN ICP team comprises a well established group of discipline-based academics, educational developers and disability advisers. Each guide has been written by a specialist author or team of authors, based on outline content and structure discussed by the team as a whole, and has been reviewed in detail by nominated representatives from the team. Each draft was also circulated to the whole team and a panel of external advisers for comment before final editing.

Rather than adopt an imposed standardised format across the series, each authoring team was given freedom to develop their guide in the way they felt most appropriate. This also applied to the much-exercised question of appropriate language. Editing, therefore, has been intentionally a 'light touch' process, so individual guides in the series may vary from time to time in relation to language protocols adopted. In terms of layout and presentation for both printed and web-based versions of the guides, however, the editing team has attempted to follow nationally-established accessibility guidelines as set out, for example, by the National Disability Team <www.natdisteam.ac.uk/Accessible%20printed%20documents.doc> and TechDis <www.techdis.ac.uk/index.php?p=9_4>.

The project was undertaken in consultation with the Higher Education Academy Subject Centre for Geography Earth and Environmental Sciences (GEES). It has the strong support of the main professional associations and representatives of Heads of Department in the geography, earth and environmental sciences sector:

- the Royal Geographical Society with the Institute of British Geographers (RGS-IBG)

- the Geological Society (GeolSoc)

- the Conference of Heads of Department in Geography in Higher Education Institutions (CHDGHE)

- the Committee of Heads of Environmental Sciences (CHES)

- the Institution of Environmental Sciences (IES)

- the Committee of Heads of University Geoscience Departments (CHUGD).

We would like to thank the many individuals who have contributed to the ICP project and to making this series of guides possible. In particular, we recommend to our readers the stalwarts of the Geography Discipline Network project team, many of whom have over many years uncomplainingly devoted more of their time than we could reasonably expect to producing high quality materials and sound advice. We would also like to acknowledge the project Advisory Panel, the National Disability Team and the numerous colleagues who helped to keep the project on track and provided additional resources when necessary.

The net outcome of recent quality assurance and legislative changes is that HEIs need to treat disability issues in a more structured and transparent way. In particular, we may expect to see a relative shift of emphasis from issues of recruitment and physical access to issues of parity of the learning experience that disabled students receive. The implication of this shift is that disability issues 'cannot remain closed within a student services arena but must become part of the mainstream learning and teaching debate' (Adams & Brown, 2000, p.8). But there is an opportunity here as well as a challenge. As we become more sensitive to the diversity of student needs, we can adjust how we teach and facilitate learning in ways which will benefit all our students.

Michele Hills and Mick Healey

University of Gloucestershire
October 2005

References

Adams, M. (2002) Learning, teaching and disability: the need for a new approach, *Planet* Special Edition 3, pp.7-10.

Adams, M. & Brown, P. (2000) *'The times they are a changing': Developing disability provision in UK Higher Education*, paper presented to Pathways 4 Conference, Canberra, Australia, December 6-8.

Hall, T. & Healey M. with other members of the GDN ICP Project Team (2004) *The experience of learning at university by disabled students in geography, earth and environmental sciences and related disciplines: a report on the Geography Discipline Network (GDN) Inclusive Curriculum Project (ICP) Student Survey* (Cheltenham: University of Gloucestershire, Geography Discipline Network).
Available at: <www2.glos.ac.uk/gdn/icp/survey.htm>.

Shakespeare, T. & Watson, N. (2002) The social model of disability: an outdated ideology? *Research in Social Science and Disability*, 2, pp.9-28.

1 Introduction

'As for him being blind, that has never been an issue. He doesn't perceive it to be a disability and neither does anyone who works with him.'

　　　　　　　　　　　　Janet Pickering, PA to David Blunkett

'For me, my disability is a fact and not a problem. I'm not living the life of a disabled person. For sure, I have to handle some things differently from other people. But it's not so different from the life of someone who is not disabled. In any case, who is really not disabled?'

　　　　　　　　　　　　Thomas Quasthoff, opera singer

1.1　Aims of this guide

The purpose of this guide is to help staff identify and remove the barriers that visually disabled students may encounter when studying one of the GEES disciplines - i.e. geography, earth and environmental sciences - and to suggest ways in which students can be helped to enjoy a fulfilling learning experience. Some of the advice and guidance offered will be generic, reflecting the importance of a strategic approach within institutions and departments to the planning and delivery of inclusive curricula. However, much of the advice will apply to specific forms of visual disability, and to the demands made by the study of GEES disciplines. Moreover, because each student is unique, most of what is discussed here will need to be made relevant and personal to individual students. It is a key principle of this guide that a blanket approach to the management of the learning needs of visually disabled students on a GEES programme of study is likely to be ineffective.

1.2　Who this guide is written for

This guide is meant primarily for those involved in teaching a GEES discipline. However, because a number of different people share responsibility for delivering the curriculum, the guide deliberately addresses five kinds of reader, three working in GEES departments, the other two working at the University level.

- **Academic tutors** - this guide provides detailed information about ways in which approaches to teaching, learning and assessment can be devised so as to meet the needs of visually disabled learners. Sections 2 and 4 to 6 are primarily aimed at this reader, but their contents may also be of interest to academics in other disciplines that involve a spatial perspective, including archaeology, anthropology, architecture and ecology.

- **Heads of department** - this guide is meant both to raise awareness and indicate policy directions. Section 3 on Management Issues is of particular relevance, though other parts of the guide also discuss issues that have a policy dimension.

- **Support technicians and administrators** - this guide provides some insights into the kind of technology and procedures that can benefit the visually disabled student. Sections 7 and 9 have been written with these readers in mind, though most of the other sections are relevant to their work.

- **Disability Advisers** and other disability specialists. For these, it is hoped the guide as a whole will provide insights into an area of study (i.e. GEES) that may not be familiar - at least in detail - to those who advise academic staff and students and assess student needs in the broad area of disability. The background briefings in Section 7 and the resources in Section 9 may also be relevant, especially to those who may not have specialist knowledge of the needs of visually disabled students in a GEES environment.

- **Educational developers, learning technologists, librarians** and others who provide institutional and/or departmental support for staff and students. For these, it is anticipated that the guide will provide useful background information that will help them understand some of the particular needs of the GEES disciplines. The contents of Sections 2 and 5, together with the resources described in Section 9, may be particularly relevant.

This guide makes no attempt to be exhaustive, and generally refrains from being too prescriptive. The author does not pretend to know all the answers, or to be able to provide the best advice for each and every situation, or each and every student. However, it is hoped that the issues raised and the advice provided will help you to think through the potential problems that might prevent your visually disabled students from gaining the best study opportunities possible, and achieving the very best that they are capable of.

1.3   How this guide is organised

There are two versions of this guide: the standard shorter version, which is available in printed form, and an extended version, which is available online. The extended version includes the full text of four sections (2, 3, 5 and 7) which were considered to be mainly of interest to specialist readers, and additional discussion in some of the other sections (1.4, 4.2, 6.7.1 and 8.1 to 8.4) included in the printed version. The shorter standard version includes the entire Contents list. It was decided not to delete entire sections in the shorter standard version, partly so as to ensure a single set of compatible cross references within both versions, and also to enable authors referencing material in the guide to be able to direct readers to the same section in either version.

This guide is arranged in nine sections. The first section, of which the current sub-section is a part, is a relatively brief introduction to the principles on which the rest of the guide is based. The second, and more substantial section, provides an overview of some of the key issues affecting visually disabled students who decide to study one of the GEES disciplines, and takes a strategic curricular perspective. This section provides a general discussion of the visual nature of GEES, and its significance for visually impaired students. This is followed by a third section which examines some of the broader management issues surrounding visual disability, including legislation, awareness raising among staff and students, and recruitment. The fourth section considers curriculum design in the context of blind and partially sighted students. This is followed by a fifth section which considers the context within which students experience the curriculum, and outlines five significant environments which pose particular challenges for the visually disabled student. The sixth section provides more detailed guidance on teaching, learning and assessing with visually disabled students, and includes tables and bulleted lists that are meant to guide action at various levels: course, module and individual class. The seventh section provides detailed background briefings on various subjects, including: visual impairment, the kinds of assistive technology available to visually disabled learners, and the design of accessible handouts and web resources. After a brief concluding eighth section, a final section provides a key to available resources and a bibliography.

1.4   The principles that inform this guide

Following the World Health Organisation (WHO) (1999) definitions, the present guide considers the provision of learning support for visually disabled students, whose experience of disability is as a result of the interaction between their impairment and the learning environments in which they operate. In common with other guides in this series, the social model rather than the medical model of disability is considered to be a better approach to empowering the visually

disabled student while studying a GEES discipline (though see 1.5). The overview guide to this series (Healey *et al.*, 2006) discusses various models of disability in more detail, and indicates their relationship to subject-based and educational issues in the context of student disability. The current guide takes as its starting point the views expressed by the Teachability Project (Shaw 2000):

> *'While people have impairments, the environment - attitudinal as well as physical - can be disabling. It is simplistic to attribute problems about disability to individuals who are said to 'have' this or that disability when the reality is that many such problems disappear when environments are accessible. And although there is little that staff in higher education can do to change the facts of students' impairments, there may be scope for altering the environment of higher education, which, like any environment, may be disabling.'*

The writing of this guide has been informed by a number of over-arching principles. The universality principle suggests that all people are disabled in some way, typically by features in their environment that are beyond their control. The multi-causality principle suggests that there is no simple causal relationship between a person's visual impairment and disability. The mutuality principle promotes the idea that the task of ensuring that students enjoy a completely fulfilling education is a joint responsibility. Finally, the individuality principle suggests that every visually disabled student should be treated as an individual, with a unique set of needs and abilities. (These principles are discussed in more detail in the extended version of this guide.)

1.5   A word about terminology

In the current guide, the phrase 'visual impairment' is used in a relatively limited way to refer to a (largely) physical condition that indicates a lower, poorer, or otherwise reduced level of performance of a particular visual capability. 'Visual disability', by contrast, is used to refer to the outcome of a variety of factors that affect how a particular learner is able to negotiate their learning environments using the power of sight. It is a term that is meant to refer to both internal and external factors (what we might loosely refer to as the medical and social dimensions of disability, respectively), and it is also meant to refer to the unique response made to these factors by particular individuals. (There may even be individuals whose visual disability does not derive from any obvious physical impairment to their oracular anatomy or physiology.) Use of the terms 'disability' and 'disabled' recognises that individuals are disabled by a combination of many factors, and that these are not exclusively to do with the presumed 'normality' of their visual apparatus, or of their visual information processing capability. Indeed, a visually impaired student may not necessarily be visually disabled, and a visually disabled student may not necessarily be

visually impaired.

This preference for 'disabled' rather than 'impaired' is not without its problems, however. For example, there are some individuals with a visual impairment who do not consider themselves to be disabled. Moreover, many disability advisers and specialists in the field still tend to refer to individuals as being visually impaired rather than visually disabled, and this is a terminology which extends to most of the other guides in the current series. (In Australia, 'vision impaired' is often preferred to 'visually impaired', in recognition of the fact that many who have a physical problem with their eyesight may have no commensurate reduction in their ability to 'see' or of their powers of visualisation.) On the other hand, 'disabled' appears to be the preferred term when discussing learning disabilities, perhaps because there is no obvious physical 'defect' that lies at the root of this particular disability. 'Disabled' is also the preferred term in the legislation aimed at correcting and guiding social action in the UK, perhaps because it sees society as needing to do something about those aspects of individual disability for which it can reasonably be held responsible.

As suggested above in relation to the phrase 'vision impaired', there is no universally adopted terminology. 'Low vision', for example, while common in North America to describe poor sight even when wearing glasses, is infrequently used in the UK. The phrase 'blind and partially sighted' is perhaps the closest UK equivalent, and seems to be used partly in recognition of the fact that only about 4% of 'blind' people are totally blind, and able to see nothing at all. In the USA, the phrase 'legally blind' is used in relation to the assessment of individuals for financial and other entitlements, while 'registered blind' is a roughly equivalent UK term.

Finally, it is worth noting that while the evolution of the language of impairment and disability is placing greater emphasis on the individual, with a shift taking place from noun phrases (e.g. 'the blind', 'the visually impaired' and 'the visually disabled') to more adjectival forms (e.g. 'blind people', 'visually impaired students' and 'visually disabled users'), many of the support institutions that have evolved over the past century or more have names which resonate with an older tradition of lumping together large numbers of unique individuals with their diverse needs under a single label. (Examples include: the *Royal National Institute of the Blind*, the *Guide Dogs for the Blind Association*, the *American Council for the Blind*, the *National Library for the Blind*, the *National Federation of the Blind*, and the *Royal London Society for the Blind*. One of the few exceptions to this pattern is provided by *Action for Blind People*.)

Although thinking about disablement has moved on from the crude Skinnerian behaviourism that attempts to link stimulus and response in a rather simplistic way, alternative theoretical and political perspectives are still (sometimes hotly) contested. Although most people involved in disability research and practice

have adopted the social model in preference to the medical model, this is not universally the case. Moreover, in a recent paper, Shakespeare and Watson (2000) suggest that even the social model is limiting, and that the impairment/ disablement dichotomy is an inappropriate basis on which to construct a disability philosophy. The approach adopted in this guide embraces this view, and is encapsulated in the four principles discussed earlier.

4 Curriculum design

In this section, we identify some of the major strategic options that are available in designing - and redesigning - learning opportunities that do not disadvantage those for whom visual information and visual approaches to learning may be problematic. Using fieldwork as an example, we outline some of the practical steps that need to be taken when designing learning experiences so that they achieve the goal of providing an inclusive curriculum.

4.1   Strategic options

There are three broad educational strategies that can be taken when considering the participation of visually disabled students in GEES study activities:

- Expect students to *adapt* to an unchanged programme of study.

- *Accommodate* students by making various modifications to the study experience.

- Provide an *alternative* form of study to the experience.

It is no longer acceptable to adopt the first of these strategies on an exclusive basis. Indeed, it runs contrary to the mutual adjustment model proposed elsewhere in this guide. The other two strategies represent ways of meeting the 'reasonable adjustments' principle in the Special Needs and Education Act (SENDA). Elements of all three approaches may be usefully adopted on a pick-and-mix basis as needs dictate. However, in the light of DDA Part 4 (SENDA 2001), an important consideration is whether particular elements of the curriculum are central or core to a course. Where they are not, then reasonable adjustments are probably unavoidable, and any defence of the status quo on the grounds of prejudicing academic standards is unlikely to be accepted.

These broad-brush approaches are best illustrated by considering how they might apply to a particular form of teaching and learning in GEES. For this reason, fieldwork is used as an extended example throughout this section, but they are more broadly applicable to other forms of teaching and learning, as discussed in section 6. The approaches outlined below are not meant to be mutually exclusive, but are provided as suggestions to guide initial planning. It may be useful to adopt more than one approach for individual students.

4.1.1   Waive participation in specific study activities by visually disabled students

This is the 'easy option', and might have been considered an acceptable approach until relatively recently. However, it is no longer either acceptable or necessary. The remaining options described below represent possible alternative approaches, using fieldwork as an example.

4.1.2   Replace fieldwork with non-fieldwork activities

For the visually disabled student, some fieldwork activities may be difficult (e.g. handling field surveying equipment), impossible (e.g. landscape sketching), or dangerous (e.g. wading across a river or taking samples from a cliff face). If the field activity does not need to be undertaken in the field in order to yield the required learning outcomes, then there is no reason why substitute activities might not be adopted. In order to decide on appropriate substitute activities, the learning outcomes will need to be carefully analysed.

Remember, however, that blind people and those with a visual impairment are neither helpless nor incompetent. Indeed, there are many examples of people who have accomplished an enormous amount in the outdoor world, despite lacking the ability to see. A famous example is 'Blind Jack', or John Metcalf, who was born in eighteenth century Knaresborough, in Yorkshire. Despite losing his sight at the age of six through smallpox, he became an accomplished musician, guide and road maker. Starting when he was over fifty, he built hundreds of miles of roads and bridges in the north of England, using special tools such as a specially adapted 'viameter' for measuring distances, which he was able to 'read' by touch <www.knaresborough.co.uk/history/town/parttwo.htm#blind>.

4.1.3   Replace real fieldwork with virtual fieldwork

Some elements of the traditional field course (e.g. the 'look-see' coach trip) can be less than fulfilling for many visually disabled students. In such cases, a great deal more can be obtained from studying the field location using a variety of electronic study aids - 'virtual' fieldwork activities, websites, interactive CAL software, or surfing the web. What each of these activities has in common is that they can often be made accessible to the visually disabled student by adopting the kind of accessibility technologies discussed in section 7 of this guide.

- **Undertake virtual fieldwork**
  Digital resources of various kinds may be available to provide substitutes for some conventional field activities. (They can also be used to provide briefing for conventional fieldwork.) One of the most recent examples of 'virtual' fieldwork facilities is the JISC-funded

Virtual Field Course Project based jointly at Leicester University and Birkbeck College <www.geog.le.ac.uk/vfc/index.html>. This has produced a range of computer-based facilities, some of them tailorable and extensible by users, which are designed to enhance the field experience. A potential problem with this kind of resource is that it is designed primarily for fully sighted students, so it is difficult to know, for example, how the 360-degree panoramas provided for various locations on Dartmoor can be usefully viewed by some blind or low vision students.

An important requirement of virtual fieldwork is that it should provide the visually disabled student with an opportunity to carry out realistic primary investigation (e.g. undertaking environmental measurements or carrying out social surveys). The Soil Surveyor software <www.clues.abdn.ac.uk:8080/tltp/soilsurv.html> developed by the CLUES project provides students with exercises in geographical sampling involving field locations, where the field activity is replaced by air photographs and Ordnance Survey maps. Another example is the GeographyCAL unit which introduces Social Survey Design <www.geog.le.ac.uk/cti/tltp/t17.htm>, in which various sampling exercises are provided as an adjunct to guidance on the broader process of planning a survey. There is a pressing need for other software of this kind to be developed.

- **Surf the web**
  A great deal can be learned about the geography of a given study area by surfing the web. However, although this might allow the visually disabled student to unearth a considerable volume of factual information, it will have to be carefully planned by tutors to ensure that appropriately challenging learning objectives are set for them. For example, they might be asked to undertake an in-depth evaluation of the effects of regional development policies on the economy of the local area. An additional internet resource is the webcam - small video cameras which send regular images to websites. These have been placed at numerous urban, roadside and tourist locations around the world, and extensive lists of webcams are available at <www.webcamworld.com> and <www.earthcam.com>. However, despite their apparent potential as 'windows on the world', staff should take time out to select those which have clear educational value, and especially those which might be useful for undertaking desktop fieldwork. An example of using a webcam for a practical exercise might be undertaking screen-based traffic counts in a tourist area. Again, some thought will need to be given to ways in which visually impaired students can make effective use of these highly visual information sources.

Another useful resource is the 'web essay' describing the geography of a particular area. Some of these have been created by commercial organisations or tourist boards, but an increasing number of geography departments have built websites around their field courses (examples are provided in Shepherd, 1999). In several cases these grow annually as repeat visits are made to a particular field location, and examples of the results of student practical work are often included. With careful thought, these might be 'raided' and used as a basis for field-related study activities without the need for an actual field visit. Visually impaired students should be able to use screen reader software to access the text in these essays, and should be encouraged to report to academic staff examples of images that have been included without textual descriptions (e.g. through appropriate 'alt' tags), so the web authors can be informed.

4.1.4   Provide field activities at alternative locations

If field activities prove problematic on account of the venue, and if a visually impaired student might be better able to undertake the activities at other locations, then an alternative venue might be substituted for the main field venue. As an example, consider the undertaking of a shopping survey on a village high street. For the visually impaired student, part of the problem in undertaking such a survey would be the unfamiliarity of the village selected for the survey. If the visually impaired student was able to undertake the same survey at a shopping centre well known to them, then they might be better able to carry out the work safely. Against this benefit is the problem that the visually impaired student would miss out on socialising with the other students in their cohort.

An actual example of this kind of adjustment is provided by the case of the first-year physical geography field trip reported in the online case studies that accompany this series of guides. Rather than take all students on a single field course, the course organisers decided to offer two trips that would run in parallel, and students would be free to choose between them. One of the courses involves multiple short stops to look at geology, landforms and Quaternary history (in the Mendips), and is accessible to students with visual and other disabilities. The other, which examines the same topics but in more arduous terrain (the Brecon Beacons), was less well suited to disabled students. The interesting thing about this adaptation is that it preceded any conscious attempt to redesign the curriculum with disability in mind. As the field course tutor put it: '*This is not in response to recent changes, but something we have done for many years that has worked well*'.

4.1.5 Accommodate visually disabled students' needs during regular fieldwork

This approach is consistent with the mutual adjustment model discussed elsewhere (sections 1.4.3 and 4.4), and might include the following actions:

- Change routes and paths taken in the field to make them easier and/or safer for the visually impaired student to follow.

- Modify selected field activities to make them more 'do-able' by the visually impaired student. For example, rather than asking the student to undertake a questionnaire survey by visiting a sample of residential addresses, they might be asked to question people at a fixed location (e.g. in a shopping centre or at a community centre).

- Ensure that any visually impaired student has a buddy to accompany them while in the field, and help them take field notes and record field measurements and observations.

- Provide additional time to get around in the field and undertake required activities. Where group work is involved, careful planning and briefing will be needed to keep the other students onside.

- Enable students to present the results of their field investigations in non-visual, or perhaps multi-modal, formats.

4.1.6 Abandon fieldwork for all students

A radical approach might be to replace fieldwork for **all** students by alternative learning activities, rather than in a discriminatory way for visually impaired students (as in 4.1.1). One way of doing this might be to use virtual fieldwork, as described above. Another might be to undertake the study activities normally undertaken in the field locally (e.g. on campus). At the heart of this suggestion is the idea that the field is a venue for exercising skills, rather than a specific skill *per se*. If this is the case, then the skills exercised in the field may be undertaken equally well on campus. Among the incidental benefits to students are that this might involve less cost and disruption, especially for those who are supporting themselves through college, or for those who have significant family commitments.

4.2 Inclusive curriculum design (case study)

In this section, some of the issues involved in designing new learning experiences for visually disabled students are discussed. In order to make the discussion more concrete, the issues are again framed in the context of the design of a new field course. Most of the principles outlined here can be transferred, with suitable adjustments, to the design of other types of learning

experience, whether it be a laboratory exercise, a small group seminar, or an individual project.

The basis for successful fieldwork by visually disabled students needs to be designed into the curriculum from the outset. Several aspects of this design process are described below. The key principle is to plan well ahead of the new course and to involve visually disabled students in your planning from the outset.

(The remainder of this case study is included in the extended version of this guide.)

4.3   Supporting visually disabled students

An important aspect of the study experience of the visually disabled student is the day-to-day support they can expect while studying GEES. Here, we consider two types of support that can improve this experience; one provided by humans, the other by an animal. In both cases, mutual adjustments may be needed to ensure that the support is used to best effect. (See section 4.4 for a fuller discussion of the mutual adjustment model.)

4.3.1   Staff and student buddies

Although there is a danger in treating the visually disabled student as a 'helpless' individual who needs continual 'watching over', there is an equal danger of leaving such students to fend for themselves during various phases of their study. In the daily environment of the college campus, the visually disabled student will have developed routines for getting around, and will quickly develop a familiarity with the layout and location of the various facilities they need to use. However, on a field course, where there is little time to develop such habitual familiarity, it may be sensible to consider an alternative approach: the buddy.

Benefits of buddies

If the visually disabled student has not encountered the idea before, it would be worthwhile discussing with them the benefits of being assigned a particular member of staff, or one or two students, who can act as continual reference points or assistants during field study. (The institutional Disability Adviser will be able to advise on institutional experience and practice in peer support and the use of personal support workers.) Although buddies can be valuable on campus, they are even more important on field courses where the venue and study locations will probably be unfamiliar. A student companion will not only speed the learning process, but will also reduce the risk of accidents.

Buddies can fulfil several specific roles on field courses:

- take notes (e.g. in lecture classes, at briefing sessions, during fieldwork interviews, in the field);

- accompany the visually disabled student while undertaking interactive activities (e.g. street interviewing);

- accompany the student while undertaking field activities (e.g. landscape observation and recording, environmental data gathering).

Selecting buddies

Buddies should be chosen at an early stage, and preferably well before the field trip itself, so that a relationship based on trust can have time to develop. You should recognise that an on-campus buddy may not be studying the same subject as the visually disabled field student, or may not be in the same student cohort undertaking the fieldwork. If a different buddy needs to be chosen for fieldwork, ensure they are fully trained (e.g. through the university Disability Support Unit). Check with both parties whether they wish to have rooms near each other at the study centre, or share the same room if double-up accommodation is being used. Of course, the buddy who provides sterling support on campus may not be the most appropriate for the field course, which may require someone with reasonable levels of physical fitness and general spatial awareness. Consequently, visually disabled students might need to select someone specifically to provide support during fieldwork.

4.3.2   Guide dogs

For a blind student, the presence of a guide dog may make fieldwork possible, whereas the absence of a dog may make certain activities extremely difficult to undertake. The use of a guide dog raises several questions: How should a student's guide dog be accommodated? How should other students behave with the guide dog around? And what specific implications does a guide dog have for field study? Many general answers are available on the website of the Guide Dogs for the Blind Association <www.guidedogs.org.uk>, or through the links to the many guide dog websites in North America listed on the Ability website <www.abilitynet.org.uk/Guide_Dogs.html>.

In planning course-related activities which include a blind student bringing along their dog, there are a number of issues that need to be considered:

- *Space.* Ensure that suitable space for a guide dog is available, for example in briefing and work sessions, on minibuses during field courses, and during visits to external organisations.

- *Feeding.* The guide dog may need feeding at different times to its student owner, so some flexibility in the daily timetable might be welcome.

- *Weather, etc.* Guide dogs may get very wet if it rains, or very dirty if fieldwork is undertaken on open ground or near rivers. This should be borne in mind when planning sites for outdoor activities, and especially field courses.

Ask the visually disabled student when and where they are likely to need to be accompanied by their guide dog. Where the dog is not needed, consider whether it may need to be quartered. Many blind students will always want to be accompanied by their dog (e.g. in a briefing session at the study venue) even if you feel there may be no 'need' for its presence.

Guide dog etiquette

In most people's experience, a dog is a pet, but in the life of a blind student, a dog performs an essential role. Like guard dogs, tracker dogs and sniffer dogs, they are first and foremost working animals. This means that other students may need to be alerted to the fact that the blind student's guide dog should not be treated as a pet.

Rules of engagement for guide dogs:

DON'T

- pet or stroke the dog;

- feed the dog;

- attempt to distract the dog's attention - this could be extremely dangerous.

DO

- talk to the blind student normally, face to face if possible, in an appropriate manner, rather than to their canine helper;

- remember when helping a user to cross roads or negotiate other obstacles to ask first - the dog may already have been trained for just that eventuality.

4.4   Mutual adjustment

In the introduction to this guide we introduced the mutual adjustment model, and suggested that the interests of visually disabled students would be best served by regular three-way communication, negotiation and compromise between students, academic staff and disability advisory staff. Some of the ways in which adjustments might be made on both sides are discussed here.

One way that communication might begin is through an **information-sharing** exercise. For their part, the student would be asked to declare the nature and severity of their visual disability. (The issue of student disclosure was discussed in section 3.3.4.) This information should be treated as confidential unless the student made it clear that they wished information about their disability to be made known to other staff and/or students. For its part, the department should make available a detailed inventory of all problems and resources known to them in relation to the visual demands of the curriculum.

Another area in which mutual adjustment could be considered is in **time allocation**. From the student's perspective, this might mean that sufficient (maybe additional) time is given to attend classes and briefing sessions, to read prepared materials, and to make their way to and from field course venues and sites. From the staff point of view, additional time may need to be allocated by a Head of Department to redesign courses for inclusiveness, the time allocated to small group study activities may need to be extended, the time needed to drop off and pick up students on field courses may need to be adjusted, and the handing-in deadlines for coursework may possibly need to be adjusted. Decisions should always try and accommodate worst-case scenarios.

Mutual adjustment may also require the design of **alternative study activities**. Where these are introduced, care should be taken to ensure that the visually disabled student experiences an equivalent learning experience - i.e. is not fobbed off with a time-filling but largely meaningless activity (see also section 4.1).

Setting up a mechanism for ensuring a mutual adjustment strategy is something that needs to be factored into the early days of a programme, during the application and induction process. This will help to ensure that all major problems have been foreseen, appropriate plans have been laid and relevant resources identified. Further adjustments may also be necessary throughout the degree programme, because the potential impact of a student's visual impairment may not become obvious until a particular study activity has been encountered, perhaps for the first time. **Regular communication** is therefore an essential component of the mutual adjustment model. Neither party should wait for the other to indicate that things are going wrong. Regular discussion, however brief, will prevent what might be a drama from turning into a crisis. Whether this requires a special tutor to be allocated to visually disabled students - or maybe all students with disabilities - is perhaps for an individual department to decide. This decision might be based on the numbers involved and the nature of the study activities likely to be undertaken by students.

One area where mutual adjustment may be necessary is with those blind students who have a **guide dog**, as discussed in the previous section. It is important that other students recognise that the dog is a working animal rather

than a pet, and staff will need to take into account the space and other needs of the dog when planning demanding kinds of study activity, whether in the laboratory or out in the field. The visually disabled student may also need to accept that their dog may not be admitted into every study environment, and they may also need to exercise some patience over the way in which other students attempt to treat their dog.

Another area where there may need to be give and take is with the visually disabled student who works best by recording or transcribing the spoken word during various study encounters, and may need to use **special equipment** to do this. For example, staff and other students may need to take into account the student who has a hand-held tape recorder, and who needs to be 'close to the action' - whether it is in the front row of the lecture or study room in a field study venue, or close to the person being interviewed in the field. Similarly, where the visually disabled student creates braille during a class, allowance will need to be made for the noise of the typing, and some planning may be needed to ensure the safe stowage of the portable braille reader while on minibuses during fieldwork. (Students are increasingly switching from low-tech machines or a Mountbatten brailer and more are using a laptop, which can be more noisy that the traditional mechanical hardware.) For their part, disabled students will need to acknowledge that their needs may at times inconvenience other students: for example, a blind student may find themselves competing with a partially deaf student for a seat that is closest to a guest speaker.

On the issue of **resources**, it may be necessary to agree on a cost-sharing approach. For its part, the department should consider spending money to buy specific equipment or to use external services (e.g. for the production of raised-line maps). It may be appropriate, for example, when replacing old equipment to define a specification that includes features that assist visually disabled students (e.g. voice readouts from laboratory equipment). For their part, students should take full advantage of the Disabled Students' Allowances (DSA) (discussed in section 3.3.1), and should be encouraged to submit themselves for an official needs assessment to secure the relevant financial support, if they have not already done so. Central institutional funds may also be available, depending on how the additional disability finding from HEFCE is allocated internally. Finally, staff and students might also be able to approach other support agencies jointly to fund the acquisition or loan of special equipment for fieldwork, or the purchase of additional computer hardware or software (e.g. facilities for data sonification).

Finally, a word or two is perhaps needed on **etiquette**. It is sometimes difficult for sighted people, whether staff or other students, to know how to behave when they interact with visually disabled students. The following broad precepts, gleaned from several sources, provide useful guidelines:

- Visually disabled students are rarely deaf, so speak with them in a normal voice.

- Speak directly to visually disabled students rather than through a third party.

- When entering a room or approaching a visually disabled student, introduce yourself by name, and use their name in conversation.

- Ask a visually disabled student before attempting to 'guide' them through a building or across a road.

For an example of how blind people wish to be treated, take a look at 'The Courtesy Rules of Blindness' <www.blind.net/bg000001.htm>. See also the section on guide dogs in section 4.3.2. Above and beyond all these ideas, however, it is important simply to treat visually disabled students as individuals.

A final point concerns the terminology adopted when talking with and about visually disabled students. Although there is a danger in being over politically correct, anxious or coy in our use of language, it is nevertheless useful to know what language is liable to cause offence. A useful discussion of this issue is provided on the Manchester City Council website at <www.manchester.gov.uk/disability/language/index.htm>.

6   Teaching, learning and assessment

In the previous two sections, we examined the strategic options available in designing inclusive curricula and some of the diverse environments within which students are nowadays expected to learn. With this essential background, the current section reconsiders the main approaches to teaching, learning and assessment commonly used in GEES disciplines in the light of the needs of visually disabled students. Most of the issues raised are typically the responsibility of individual academic staff, but most will benefit from collaborative approaches that involve Disability Advisers at institutional level and the disabled students themselves.

6.1   Lectures

Lectures are an essential component of most GEES courses, and are regularly used to orientate, stimulate and inform students. Among the things you can do to make lectures more accessible to visually disabled students are:

- When booking lecture rooms, ensure they have appropriate facilities for visually disabled students and/or their guide dog.

- Ensure that appropriate advance notice is given of the time and place, and check that physical access to the lecture venue is unobstructed.

- Reserve seats near the front of the lecture room for visually (and aurally) disabled students.

- Deliver the lecture from a well-lit position in the room, but not in front of a window or other light source.

- Avoid walking too far away from the student, and using gestures when you are turned away from them.

- Ensure that visual aids used in a lecture or presentation are either directly accessible (e.g. large text format - minimum of 18 point font size) or that some alternative is made available (e.g. in digital format on a floppy disk, or on a website).

- Avoid using handwritten OHP slides. Word processed versions, using standard fonts, are far more legible. (See the section below on handouts.)

- Describe in words the contents of any visual material (e.g. table, graph, map) displayed on screen or board.

- Pace the presentation so that visually disabled students can keep up in terms of (say) braille or PC note-taking. Allow extra time for note-taking, and/or provide suitable summary handouts.

- If a room change is necessary, ensure it has appropriate facilities for visually disabled students and/or their guide dog, and inform them as soon as possible so they have time to learn a possibly new route.

- If handouts are provided, ensure that alternative versions are provided for visually disabled students according to their declared preference and need (see the discussion of handouts below).

Where it is appropriate for them as individuals, visually disabled students should be encouraged to:

- Use a cassette recorder to record the lecture, which they can transcribe at their leisure later. They should ask the lecturer to reserve a front-row seat if they need to do this.

- Use a braille typewriter or laptop computer to take lecture notes.

- Use a peer note-taker - i.e. a student who will share their class notes with them. (The university disability unit may be able to provide free carbon paper to student helpers to provide this service for visually disabled students in their class.)

- Bring their guide dog (if they have one) into lecture rooms. They should ask the lecturer to allocate a suitable seat so that the dog is not in other students' way. (This is especially important in laboratories, where the possibility of accidents may be greater).

Where visually disabled students indicate their intention of using a braille typewriter or laptop during lectures, it might be appropriate for the lecturer to welcome the student during the first class and indicate to the other students the kind of equipment that they are likely to be using, if the student is comfortable with this kind of publicity.

Guest lectures

- Brief any visiting/guest speakers on the need to consider an appropriate speed of delivery to permit the visually disabled student to take notes. This applies equally to lecturers visiting the field study venue or talks being presented at external organisations.

- Ask visiting/guest speakers to provide a synopsis of their talk in written or electronic form before the lecture, so that this can be given to visually disabled students.

- Inform students well in advance of the venue, if this is different from that used for regular lectures.

The intellectual property rights of lecturers (and their employers) are becoming increasingly important in many higher education institutions. In this context, the guidance notes drawn up jointly up by Skill, NATFHE and the DRC on the tape recording of lectures and other learning resources by students <www.natdisteam.ac.uk/natfhe%20reclect.doc> are of considerable significance.

6.2   Reading

Reading is a fundamental part of student learning in higher education. Because of the variety of documents and media that students are required to read (programme and module handbooks, class handouts, textbooks, journal articles, newspaper cuttings, notices on walls and on doors, emails, web materials, etc.), and the variety of circumstances in which they have to read them (e.g. at leisure, under exam pressure, out in the field), this relatively simple act can pose significant problems for visually disabled students.

Visually disabled students can use a variety of reading aids, including:

- magnifying glass;

- on-screen magnifier tool;

- screen-to-speech software (e.g. screen reader);

- audio texts;

- personal helper.

Where students prefer to read on screen, they should be given advice on where they can locate relevant reading material online (e.g. through the Emerald online journals service), and academic staff should provide all programme documentation and class handouts in digital form. However, students should also be advised on the ergonomics of reading from screen, especially if they have to sit much closer to the screen than fully sighted students, and perhaps for considerably longer periods of time.

Reading is often associated with note-taking, which is discussed in the next section.

6.3   Note-taking

Because note-taking is such a fundamental study skill, training sessions should be arranged for blind and partially sighted students on taking concise and accurate notes. These sessions could be arranged jointly between subject

staff and staff in the campus disability support unit. The former would be particularly knowledgeable of the constraints of note-taking in GEES-related study environments, such as laboratories and out in the field, while the latter would be familiar with a range of support technology. These training sessions should also identify differences in note-taking between different core study activities, including lectures, small group learning, in the library, during web research, in laboratories, during fieldwork, etc.

Blind and partially sighted students use a variety of note-taking aids, including:

- braille typewriter or Mountbatten brailler;

- laptop computer or PDA;

- tape recorder;

- microphone input to a PC (software such as Via Voice or Dragon Naturally Speaking permit dictation directly into a word processor);

- personal helper (usually associated with blind students).

Many students will use a combination of these, because their availability and ease of use is likely to vary according to the environment in which the student is working.

6.3.1   Note-taking on campus

All students are expected to undertake a considerable amount of note-taking as part of their GEES-related study, whether in lectures, in the library or in front of a computer screen. It is therefore important at an early stage in their course that visually disabled students not only practise extensive and varied forms of note-taking, but that they also become comfortable with using whatever technology they feel is necessary, and in a variety of study environments. Where students require a helper to read to them, or are used to dictating notes into a speech recorder, some allowance may need to be made by librarians and others where this needs to be done in shared working spaces, and especially in libraries where a rule of silence is often imposed. The Disability Adviser should be able to arrange this early on in the degree programme, and should also be able to arrange access to other facilities needed in note-taking, such as use of a scanner and optical character reader (OCR) software to convert text from the printed page to digital text. Alternatively, and especially if these facilities are heavily used by other students on campus, the disabled student may wish to purchase their own kit through the Disabled Students' Allowances (described in section 3.3.1).

6.3.2   Note-taking in laboratories

Laboratory note-taking differs from other forms of note-taking in that it not only involves writing connected prose, but also usually involves the recording of detailed measurements that are made during experiments and other laboratory procedures. Where standard laboratory notebooks or laboratory sheets are issued to students for this work, tutors should consider drawing up suitable alternatives for visually disabled students, or might even design electronic forms that might benefit all students. Alternatively, they might allow students to tape record their measurements and comments, and enter them into their notebooks (or an electronic version) later. As in lectures, laboratory note-taking is usually under some time pressure, though tutors can perhaps relax this for visually disabled students, allowing them more time to write up their notes. (See the detailed discussion of laboratory work in section 6.9.)

6.3.3   Note-taking in the field

Assistance of various kinds can be provided to help visually disabled students participate in fieldwork, as indicated in section 4:

- Recording device (e.g. tape recorder, Dictaphone, microphone plugged into a PC, or a modern mobile phone). However, use of such equipment may be difficult where there is high ambient noise in the field (e.g. in a busy high street or on a windswept coastal path).

- Buddy or personal helper. This can be helpful in some locations and for some field activities, for example to record notes. Especially when they are recording their own thoughts and ideas, it is perhaps best for the blind or partially sighted student to dictate to a sighted helper. Alternatively, where a more factual record is being created of field features, the sighted helper might describe something they are observing in the field, and then let the visually disabled student record this in their own words, assisted by interrogating the sighted helper.

- Where possible, it might be useful for tutors to arrange prior exposure to some of the environments in which note-taking is to occur, for example in a simulated field environment (e.g. a busy shopping street, a tract of farmland, a stream, or a hill slope). (See also discussion of virtual field courses in section 4.1.3.)

6.4   Tutorials, seminars and small group learning

Group discussions and student presentations pose particular challenges for visually impaired students, particularly when the latter are assessed.

6.4.1   Discussions

Class discussions can be problematic for several reasons:

- Because they are heavily reliant on their hearing, the sound of multiple voices and other extraneous noise can sometimes be disorientating for blind and partially sighted students.

- Because so much conversation is accompanied by body and facial gestures, which are used to signal when someone wants to speak, the visually impaired student can miss out on vital information needed to ensure their effective participation.

Useful tips for staff are:

- Try and book a room that is not likely to be disturbed by regular external noise (e.g. adjacent to a busy corridor) - and ensure there are appropriate facilities for blind or partially sighted students and/or their guide dogs.

- Remind all students of an appropriate discussion etiquette at the start of each session (e.g. only one student to talk at a time).

- Require students to state their names when they are about to speak.

- Invite blind or partially sighted students to make a contribution if it is clear they are feeling left out of the discussion.

- If the discussion is meant to be based on prior reading, make sure that suitable alternative versions of the relevant reading material are made available to blind or partially sighted students (see the discussion of handouts in section 7.3).

Where small group work also involves plenary discussion, the location of group space within a room can be very important. We have already mentioned the importance in lecture rooms of ensuring that visually disabled students have a seat near the lecturer's position. The same consideration should be given to the group in which a visually disabled student is working, especially if the group work consists of some mix of break-out discussions, lecturer comments, observations and guidance, and plenary feedback from the groups.

6.4.2   Making presentations

Standing up and making a presentation, even within a small group, can be a daunting experience for most students. Those who are visually disabled face additional pressures, partly at the preparation stage, and partly during presentation itself. When preparing a presentation, and especially one that is to be supported by visual material (e.g. handouts, OHP slides or a Powerpoint

slideshow), the visually disabled student needs to call on the full range of support technology at their disposal. However, in creating visual contents for OHPs or an electronic presentation, they may need additional support from a sighted helper - preferably a student who is familiar with the subject matter involved. However, the student should discuss with the tutor beforehand how much assistance the helper is permitted to provide, especially if the presentation is being judged partly on the quality of the supporting material. (The issue of equity is discussed in section 1 of this guide.)

As for the presentation itself, the visually disabled student might need additional familiarisation with the room in which the presentation is to be made, and the equipment that is available. If they need to use specialist equipment (e.g. their own laptop), then the services of a technician might be required in order to swap the standard PC for the student's laptop when it is their turn to present. To avoid knock-on effects, the tutor might rearrange the presentation order so the visually disabled student goes first or last.

6.5   Interpreting maps, images and other graphics

Maps are a standard form of visual communication amongst geographers and earth and environmental scientists. Maps are not only reference sources and navigation tools, but are also a means of presenting numerical and other structured data in graphical form, through thematic mapping and spatial data visualisation. If maps are out of bounds to many visually impaired students, their experience of the subject they are studying may be considerably impoverished.

Maps can be made more accessible to the visually impaired student in two broad ways:

- by creating versions of maps that are readable by students with poor vision;

- by creating map substitutes that are accessed through non-visual sensory pathways.

6.5.1   Redesigning conventional maps

Students with colour deficient vision may experience problems when reading multi-coloured geological or topographic maps. This problem may be largely intractable if commercially printed paper maps are being used. However, if digital maps are being viewed on screen, the problem may be largely solvable because most spatial visualisation software permits the user to change the displayed colour and style of specific features on a map. Copyright clearance should also be sought to scan published paper maps so they can be viewed on screen.

One of the benefits often claimed for digital maps is that they enable the publisher to produce maps with any combination of content and any desired symbolism. Because of the ready availability of desktop mapping and GIS software in most geography departments (e.g. MapInfo, ArcView), it is now easier than ever to convert the symbolism of a standard map into a form that is more legible by partially sighted students. Here are some useful conversions:

- *Reduce information complexity.* This can be done by separating the content of (say) topographic maps into separate layers, and perhaps printing or displaying them individually or in pairs. Although the complex spatial associations between different types of feature may be lost by doing this, the visually impaired student will at least be able to interpret some of the individual patterns, and can always attempt to compare features on a pair-wise basis.

- *Emphasise linework.* This can be done by drawing solid thick lines wherever they do not overlap other significant features, and by adopting larger and simpler point symbols.

- *Choose colours carefully.* Here, the objective is to make colours stand out clearly from the background, and to avoid problems caused by colour blindness. If a single feature is displayed on a map, then colours can be dispensed with entirely, and high-contrast black-and-white used instead.

Some of the simpler maps included on handouts for laboratory or fieldwork can be readily redesigned for visually impaired students, especially using computer-aided design software. Some years ago, the author used this approach with a near-blind student who wanted to be involved in map interpretation exercises, because he had not previously used conventional maps. After discussing various approaches with the student, a technician prepared heavily simplified thick-line versions of the map handouts to be used for map interpretation exercises. Using his residual vision, assisted by strong lighting, he was able to make out the shapes of rivers and contours sufficiently well to enable him to comment on the spatial patterns and what they meant.

6.5.2   Creating non-visual maps

The most common forms of non-visual map are sonic and tactile. Although there were early experiments in producing sonic navigation aids that attempted to provide a high-information representation of the environment, many of the currently available electronic travel aids are restricted to providing the minimal amount of information about the environment that can support the visually disabled person's primary mobility aids. (This is discussed further in section 7 on assistive technology.) Some geographers have also experimented with making 'sonic maps', in which geographical data are converted to sounds so

that they can be heard by visually disabled students (see section 7.2.2). But these are still largely at the experimental stage of development.

Tactile maps have had a longer history, and are currently widely used. (For a general description of tactile graphics, see the complementary discussion in section 7.2.2 on assistive technology. For a general review of their educational use, see Hinton (1994/5).) Tactile maps typically use 'raised-line' technology (i.e. raised lines, shapes, textures and symbols) to enable visually impaired map users to 'read' what a sighted person might see on a conventional printed map. Tactile maps are produced using a number of different technologies. The most common are:

- *Microcapsule paper.* Maps are hand-drawn or printed onto heat-sensitive microcapsule (or 'swell') paper, and when it is heated, the paper covered by black ink raises above the paper surface.

- *Thermoform.* A two-and-a-half dimensional map is produced, to act as a master. A thin plastic sheet is then placed over the master, and vacuum shaped into a tactile map.

- *Embossing*. Maps are created from patterns of raised dots, using a computer-controlled braille printer. This is perhaps the least useful form of tactile map, though it is a cheap method of producing some kinds of tactile diagram.

Recent developments include the harnessing of several sensory modalities, including the tactile. One example is TACIS (Tactile Acoustic Computer Interaction System), funded by the European TIDE Programme (Technology Initiative for Disabled and Elderly people), which uses a combination of tactile, tonescape and speech information to convey spatial information to the user. Air photos can also be converted into tactile versions, as was demonstrated at the recent *Earth From the Air* exhibition at London's Natural History Museum, where tactile versions of 30 aerial photographs taken by Yann Arthus-Bertrand were displayed.

In the UK, tactile maps can be acquired from the National Centre for Tactile Diagrams (NCTD), a non-profit organisation set up by HEFCE at the University of Hertfordshire in 1999. Tactile maps from existing paper sources can be produced very rapidly, and entirely new tactile maps can also be produced, though these usually take longer. The costs are subsidised because of grants received from the various higher education funding councils. As a result of recent Strand Two HEFCE/DELNI funding, the Centre can also provide training (on campus, at the NCTD and at the RNIB) and consultancy services. The Centre has deposited a copy of its Tactile Graphics Handbook Pack with every university Disability Office in England and Northern Ireland.

One of the fundamental issues being discussed in the field of tactile map-making concerns the question of whether tactile maps should attempt to reproduce visual maps in a tactile format, or whether they should seek to represent the environment in ways that are more compatible with the visually impaired user's sense of spatial awareness. (This echoes the contrast between spoken language and the signed language used by deaf people.) There is now considerable research being undertaken into the way in which people with visual impairments build up their awareness of the environment, and how this differs from the process adopted by fully sighted people (Challis & Edwards, 2000; Marek, 2000; Ungar, 2000).

Another issue concerns the standardisation of symbols used in tactile maps. To some extent, this will be informed by research into how best to represent features that accord with users' spatial awareness. One initiative involves building a database of tactile symbols (DOTS) (Tasker, 2000).

6.6   Viewing video and other multimedia

Video has traditionally been used in geographical teaching as a means of introducing students to elements of places and peoples that it might not be feasible to encounter at first hand. Video can be particularly useful because it can be used to introduce students to some of the main characteristics of a field course study area they are about to visit.

On the surface, the viewing and creating of videos would appear to be totally unsuited to blind or partially sighted students. However, this need not necessarily be the case, because many visually disabled people routinely watch TV programmes or visit cinemas. Many of the things that make lectures more accessible can also be applied to the watching of videos. Additional support can be provided in the form of handouts that explain new or unusual terms used, and that describe the content of the key visual scenes on the video.

Helpful advice is provided by the Scottish Sensory Centre (SSC 2000b) on the following issues:

- how to make best use of existing video materials
  - choosing, supplementing, and using them;

- how to extend the use of existing video materials
  - index marks, annotated stills, supplementary audio, text subtitling;

- how to develop new video materials
  - handling colour, contrast, complexity, movement, text and supplementary materials.

Videos can also be used by the students themselves as a study tool (e.g. recording interviews with local informants, or creating a video 'poster' for

assessment purposes).

Many multimedia simulations make extensive use of graphics, whether they are static images, video sequences or animations (e.g. computer-generated animations). Most of these are inherently inaccessible to blind or low-vision students. Rothberg and Wlodkowski (1998) review techniques for enabling graphics within simulation programs to be converted into narrated audio or text-to-speech output.

6.7   Using computer software

Visually impaired students are often expert users of computer software and hardware because an increasing amount of their support environment tends to be digital and electronic. Nevertheless, the needs of such students may need to be reconsidered in relation to the software they are required to use on their GEES course. This may include specialist software which they may not have encountered before, and much of it may demand significant visual capability (e.g. GIS and remote sensing software).

The needs of visually impaired students ought also to be reconsidered if they are required to use software in shared computer laboratories. Some institutions and departments set aside a room with specially adapted PCs for visually disabled students, while others may include adapted PCs in every laboratory. As part of a departmental or institution-wide disability audit, the locations of these facilities should be identified and communicated to visually impaired students. Relevant academic staff might also check whether copies of the relevant software can be made available for loading onto student PCs. (This is certainly the case with some software licensed under CHEST deals.)

6.7.1   Commercial software and visual accessibility

During the course of their studies, students will often be required to use general application software, including word processor, spreadsheet, database, drawing and presentation programs. Because the graphical user interface (GUI) adopted by most PCs is an intensely visual environment, application software is likely to be inherently inaccessible to many visually impaired users. (This issue is discussed in more detail in Section 6.7.1 of the extended version of this guide.)

6.7.2   Improving the experience of using application software

In the rest of this section, some suggestions are provided as to the approaches that visually disabled students might take when using application programs, especially in a GUI environment. Most of the discussion below focuses on the Microsoft Windows environment, which is used on over 90% of desktop PCs, and on its common application programs. It should be noted that

although many of Microsoft's products adopt its Accessibility Guidelines, their effectiveness is varied.

- **Readable text**
  Most application programs allow users to change the font and font size used to display text on screen, including all members of the Microsoft Office suite. Several Windows applications provide a tool to enable quick changes to be made to text size (e.g. increasing the font size in web browsers and increasing the magnification in Word and Excel using the percentage zoom option on the toolbar). (Where websites adopt cascading stylesheet or CSS technology, the blind or partially sighted user may be able to substitute the site's own stylesheet file with their preferred User Stylesheet file, discussed in section 7.4.) Simple fonts are usually more readable than fancy fonts - serif and italics are usually less readable than sans serif fonts and non-italic characters. (All of the text in this guide, for example, is displayed using the Tahoma font, which is particularly clear on screen.)

- **Screen display enhancements**
  Screen enlarger programs allow users to selectively magnify parts of the screen so their contents can be more clearly seen. The effect is similar to holding a magnifying glass in front of a page of text. This kind of utility software is available for most desktop systems, including Windows, Apple, X-Windows and Unix (see Figure 6.1 below). Another tactic for improving screen legibility is to change the standard mouse cursor for a larger and/or coloured one. (Although the size can be changed in Windows itself, the colour change requires a separate item of software.) Another useful tactic is to acquire a large-size screen (e.g. 19-inch) and use a low-resolution display setting.

- **Keyboard navigation**
  The WIMP (Windows-Icons-Mouse-Pointer) environment used on most modern PCs demands excellent vision. For most blind and poorly sighted students, the mouse and cursor combination is difficult to use, especially on portable flat screens where the cursor can be difficult to locate and track visually. Fortunately, almost all mouse actions in the Windows environment have keyboard equivalents, so blind and visually impaired individuals can more or less dispense with the mouse. Alternatively, if the MouseKeys feature is installed (in Windows), the mouse can be moved using the numeric keypad and certain keys can be used instead of the mouse buttons. Inexpensive but effective aids include large print or braille key-top stickers. More expensive solutions include the cursor keys provided on some braille display devices, but these require specially adapted software to work effectively.
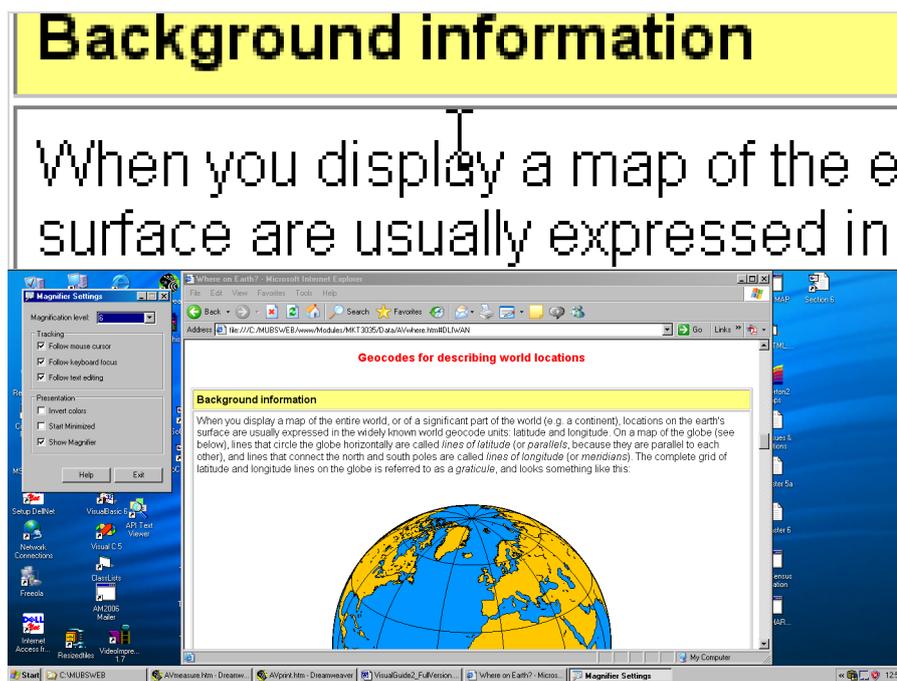
Figure 6.1 Windows screen magnifier showing enlarged version of text
under the user's cursor in a window at the top of the screen.

- **Desktop appearance**
  Visually impaired students can modify several elements of the GUI
  environment to improve the visibility of the desktop:

  - switch to a lower screen resolution - but this may adversely
    affect carefully formatted documents (e.g. webpages);

  - switch on a High Contrast screen display mode (in Windows);

  - use larger text fonts;

  - use the large-sized version of icons (these are enlarged versions
    of the originals);

  - use customised icons for maximum visual discrimination of
    available tools;

  - use their own user style sheet (see section 7.4) to view
    webpages.

- **Sound**
  Sound can be used to augment actions or events:

  - arrange for actions and events to be signalled by distinctive
    sounds;

  - assign audible sounds for keystrokes.

(For Microsoft Windows users, these facilities are available by clicking on the My Computer icon on the desktop, then clicking on the Control Panel icon, then clicking on the Accessibility Options icon. Each of the tabs leads to a set of related options. Similar facilities are available on other desktop computer systems, including the Apple Mac.)

- **Audio input/output**
  Most applications software is able to output textual information in spoken form, either through standard PC speakers or through a sound card. There are some utility programs that can direct text output from application programs to a speech synthesiser. AbilityNet provides a factsheet describing how voice recognition and speech synthesis can be used in tandem, available via <www.abilitynet.org.uk/content/factsheets/Factsheets-list.htm>.

  With the recent advent of effective dictation software for PCs, the promise of audio input is beginning to be realised. Command-driven software (e.g. CAD programs such as AutoCAD) often have add-on software to enable users to speak command keywords, keeping their hands free for other actions. A useful review of voice-recognition systems is available from AbilityNet <www.abilitynet.org.uk/content/factsheets/Factsheets-list.htm>.

For a more detailed discussion of how to design web documents accessible to visually disabled students, see section 7.4 on accessible web design. The use of visual disability features in Adobe Acrobat (PDF) files is discussed further in section 7.3.

6.8 Using web resources

Students studying a GEES discipline are increasingly using web resources, both to complement learning activities undertaken in class, and also as a resource when preparing assessed coursework. Reading from screen can be visually uncomfortable or stressful for many people, and not just for those with a recognised visual impairment. A variety of approaches can be taken to improve the surfing experience.

6.8.1 General surfing rules

Here are some general usage rules to help students minimise eye discomfort (Williams 1998):

- ensure the height of the computer screen is below normal eye level - this is particularly important for users of bifocal glasses;

- sit further away from the screen, because eye strain increases as tasks are closer;

- reduce the brightness level of the screen;

- reduce reflective glare from the screen by using a (polarised) filter;

- balance the illumination on documents used at the computer to that of the screen;

- place documents at the same distance away from the eyes as the screen;

- take regular breaks.

6.8.2   Adjusting font size and colour

Students with poor visual acuity (e.g. low vision or partial blindness) may benefit from other aids when surfing the web. Most browsers, for example, permit the user to increase the size of the text, or to change text and background colours to improve colour contrast and hence readability. Even if web designers do not provide flexible viewing options, and surprisingly few do, students can readily change the default font size on their browsers to improve the readability of the documents they are reading.   In each case, the new setting overrides that embedded in the document and stays in force until it is changed again.

As this guide is being written, the Opera browser has by far the greatest number of aids to help visually disabled student surfers, including the ability to recognise certain mouse commands.

Students who have a greater technical competence may wish to specify their own reading preferences when visiting websites. This can be done by creating a 'User Style Sheet' (see section 7.4 for further details) and requesting the browser to use this when displaying the pages on a particular website. The definitions made in a User Style Sheet can be made to override any settings stored in the website's own style sheet, so that the font size and colour, as well as many other aspects of the appearance of a website, can be brought under their personal control.

6.8.3   Look, no mouse!

Many visually impaired students find it difficult to position the mouse cursor precisely on the screen, and prefer to use the keyboard rather than a mouse when using a browser. The main desktop operating systems (Windows and Mac) provide a standard set of keyboard shortcuts for undertaking common screen-based tasks. When surfing the web, an important facility is the availability to use the TAB key to move from one link to another on a web

page. If 'accesskey' statements have been included within a web document, it is also possible for the reader to move rapidly from one section of a page to another using simple key combinations. Unfortunately, few web designers completely support keyboard navigation for webpages. Because the ability of visually impaired students to access web materials depends to a large extent on how designers created the webpages in the first place, we return to this issue in section 7.4, where we indicate some of the web design principles and techniques that should be adopted for the benefit of visually impaired student surfers.

6.8.4   Listening to the web

For students with a severe visual impairment, reading may have to be supplemented - or even replaced - by listening to the text on screen being spoken by software known as 'screen readers'. (More detailed information is provided in section 7.) This software extracts text from the screen and passes it to a speech synthesiser device. Staff who provide information in the form of webpages (e.g. on an intranet website, or via a virtual learning environment such as WebCT or Blackboard) should ensure that all graphical images are described textually in the web document using 'alt' tags. Some of the other document formats commonly downloaded from the web, notably PDF files, will usually require specialist software to speak their content (e.g. PDFAloud for listening to PDF files). Graphics output on screen (e.g. Flash animations) have proved problematic in the past, but there are now software aids that provide access to textual descriptions of such material.

6.9   Laboratory work

Some form of visual ability is essential in the specialist GEES laboratory. Many of the learning activities associated with a 'hard science' environment involve instrument reading, measurement and recording, and these activities usually require reasonable visual acuity. There are also significant health and safety implications of being able to operate safely among equipment, materials and substances that may be hazardous, and acting safely usually makes visual demands on students. In this section, some of the typical activities involved in GEES laboratory work are discussed, the visual demands made on students are identified, and some indication is given on how to solve some of the problems that may arise.

While most of the discussion is framed in terms of specialist scientific laboratories, much of the discussion will also apply to computer and other laboratories. Similarly, the general discussion of note-taking in section 6.3 can also be applied to laboratory work (e.g. in the compilation of laboratory notebooks).

Several general adaptations and variations might be made to laboratory work for the benefit of visually disabled students:

- providing additional supervised access;

- encouraging students to work with a buddy or helper during experiments;

- designing variations on certain experiments which are less demanding visually;

- demonstrating selected procedures rather than require them to be undertaken personally.

The remainder of this section discusses some of the more specific challenges faced by visually disabled students in the laboratory.

6.9.1 Examining specimens

The typical geology laboratory contains a large number of rock and other specimens. Although students learn to recognise various types of rock, plants and other environmental items from visual inspection, in many cases - and especially so with rock samples - they also learn through touch. Lecturers and technicians can help visually impaired students acquire well-developed identification skills by:

- emphasising the importance of tactile identification techniques;

- providing hand-held magnifiers for close-up viewing of specimens;

- using colour recognition instruments (e.g. the Cobalt Speechmaster described under assistive technology in section 7).

Some laboratory specimens, as in museum exhibits, are kept in display cases, in special drawers or behind plastic shielding to protect them from the wear and tear of repeated handling by students. This is likely to prove a source of difficulty for visually impaired students. In some cases, such students might, because of their small numbers, be given special dispensation (under appropriate supervision) to handle some of the more fragile specimens. Alternatively, reproductions might be available for them to handle. In some cases, highly authentic reproductions of environmental samples can be bought from specialist suppliers. (It is not so long ago, after all, that the real skeleton owned by every medical student ceased to be the real thing.)

These forms of adjustment and training can provide ideal preparation for field courses where visual identification is a regular component of the student's learning.

6.9.2   Using microscopes

Microscopes, both monocular and binocular, are widely used in physical geography, ecology, geology and environmental science courses. Typical applications include: identification and analysis of grain sizes and shapes, pollen grain analysis, identification of micro-organisms (especially micro-invertebrates) and micro-fossils (especially foraminifera), interpretation of thin sections, and the classification of plant and animal specimens.

Some of the common visual problems experienced when using a microscope include:

- Failure to adjust the eyepiece so that it is focused correctly for each individual student. Laboratory instructors need to emphasise that the equipment needs to be reset for each new student, and each time a different student uses the kit. This is an extremely important lesson in classes where equipment is scarce and items have to be shared between several students. What might appear at first sight to be a visual impairment problem may well turn out to be the result of an equipment setup failure.

- Failure to keep the head steady and the eyes a consistent distance from the eyepiece when a clear image has been obtained. This can be particularly taxing if students are required to sketch what they see in the image, and are continually shifting their visual attention and focus from the eyepiece to a sheet of paper. Seating position can also be an important factor in maintaining a clear view, when (for example) two adjacent students share a microscope and attempt to view an object while sitting at an angle to the microscope's eyepiece(s).

- Failure to re-adjust the eyepiece to re-focus on the specimen following a change of objective (i.e. changing to a lens with a different magnification).

- Inability to distinguish effectively between colours that occur when objects (e.g. rock thin sections) are viewed with a crossed polarising filter. Because specific colours are indicative of the presence of specific minerals, it may be difficult for those with defective colour vision to perceive these effectively. (A similar problem may occur when interpreting dyed animal or human tissue under the microscope, or when reading multi-coloured geological maps).

- Placing a slide upside down on the stage.

- Failure to position a slide flat on the stage. For example, students with low vision might mistakenly rest one end of the slide on the mounts or the x,y adjusters, with the result that they will never be able to bring the specimen on the slide into focus.

On binocular microscopes, additional problems include:

- Failure to set up the eyepieces to suit the individual student's eye spacing and possible differences between the focusing capability of each eye.

- Positioning the eyes too far away or too close to the eyepieces.

- Inability to keep the eye-line horizontal, with the result that black 'fringes' appear in the view, obscuring the object of study.

Some of the difficult tasks that confront visually impaired students are:

- Inability to focus eyes on objects in an image.

- Inability to discriminate subtle outlines or boundaries (e.g. through texture or colour changes) within an image.

- Problems with Becke line discrimination when discriminating between two or more minerals. (This task, which depends on variations in the refractive index of minerals, can be taxing even for fully sighted individuals.)

In general, effective training can alleviate many of the visual problems that students face when using laboratory microscopes. In particular, time should be found to indicate to students the often large number of features on modern equipment that are available specifically to ensure that an optimal image may be acquired, even in difficult viewing conditions, or for those with low vision. These include:

- Multiple objectives (i.e. lenses with different magnification levels) - these can considerably enhance the effectiveness of discrimination and counting tasks, even by students with specific visual impairment. (For example, a high objective should be used when counting the hairs on micro-organism legs.)

- Fine focus - enables changes to the focal plane of the lens which enable the viewer to interpret some of the three dimensional structure of (say) a pollen grain.

- Diaphragm - reduces glare and helps the student focus on smaller objects on a slide.

- Light dimmer switch - also helps to reduce glare.

- Oil immersion - sometimes used with high magnification objectives to prevent light scattering.

One of the general problems with the use of microscopes by GEES students is that the ratio of learning time to usage time is frequently very high. Staff

are often forced by the limited time at their disposal to perform a 'rushed job' during training. Many are often unable to devote a complete timetabled session to microscope set up and use when the equipment may only be used once or twice during an entire semester. Students may also pay insufficient attention to the learning phase in their enthusiasm to see very small things. A potential result of these problems is that a considerable number of students - including fully sighted students - may suffer from sub-optimal vision while using a microscope. This problem probably requires a broader-based solution, perhaps at a course or departmental level.

For students who are visually impaired, the problems of using a microscope may be more severe. However, relatively simple adjustments may make even microscope viewing accessible to all but a very few students. For example, a small video camera can usually be fitted to a polarised light microscope, and the images displayed on a TV screen or fed in digital form to the student's PC. Some geology lecturers use this approach routinely for the benefit of all students during their classes.

6.9.3   Undertaking measurement and analysis

Visual acuity is frequently called upon when operating laboratory measuring equipment. For example, Vernier scales are found on several kinds of device, from the x,y adjusters on a microscope to a mechanical staff. (Similar demands are also met in the field, where Abney levels and clinometers use Vernier-like scales.) It can sometimes be difficult for older teaching staff to demonstrate the adjustments often needed with such scales, especially if the scale is marked with extremely fine graduations.

The simplest visual tasks in the laboratory involve reading textual labels on cupboards, drawers, trays, or individual items of equipment. Other important reading tasks involve hazard and warning notices. Laboratory staff should adopt the standard advice available from the Royal National Institute of the Blind (RNIB) and the Health and Safety Executive (HSE) to ensure that the size, fonts and colours adopted for such labelling are readable by students with low vision and the commoner forms of visual impairment. Sometimes it is not feasible to make labels readable except by people with good eyesight. (Labels printed onto specimen slides prepared for microscopy are a case in point.) However, an alternative would be to write or print a code number on the slide in large letters, which refers to a clearly printed description on a separate list or handout.

The interpretation of readouts from analytical instrumentation can sometimes be visually taxing. Simpler tasks involve:

- reading numbers (etc.) from LCD displays;

- reading a level from the position of a needle on a dial or scale on an analogue measuring device;

- identifying the level of a liquid in measuring/volumetric glassware and plasticware.

Sometimes these tasks may be problematic for visually impaired students. For example, filling a volumetric flask or a pipette to a precisely calibrated volume line can be difficult, even for perfectly sighted individuals, because of the precision with which letters and lines are inscribed on the glassware, or because the size and colour of the lettering, or the size, colour and thickness of the line, may be difficult to read. In such situations, laboratory staff should be able to provide vessels with alternatively coloured lettering, though the choice may be complicated by the colour of the liquids being measured. In addition, some students may have difficulty assessing precisely the level at which the lower level of the meniscus of the liquid reaches the calibrated line, especially where both the glass and the liquid are clear. In these circumstances, it may be possible to add a neutral colouring agent to the liquid, unless a colour change is being analysed.

The interpretation of visual information is also involved in the reading of points plotted on calibration curves, as in the case of flame photometry.

Some types of measuring equipment provide graphical summaries in the form of continuous line traces, which display measurements which vary through time. A classic example is the seismograph, but in the laboratory, students may be required more frequently to use devices that measure changes in chemical concentrations over time. Another example is the bar graph display provided by the GCMS (Gas Column Mass Spectrophotometer) to indicate the chemical breakdown profile of an unknown compound.

Quantitative graphical displays provide two significant challenges. The first is the visual challenge of being able to see - i.e. 'read' - the display. Here, it is important that the graphical elements of the display are configurable by the user (e.g. thicker lines, wider spacing between columns, alternative colours, larger text labels). However, being able to see or read is itself not always sufficient; students also have to have a basic understanding of what they are reading. For example, the student's understanding of units of measurement is crucial in making sense of values that are read from various forms of laboratory equipment. There is little point in a student being able to read 10 cm^3 or 10mg/l^{-1}, however small the lettering, if they have no understanding what the stated unit of measurement means.

The second challenge is the interpretation of the meaning of the graphical display. This is a challenge that confronts all students, though it may be made more difficult for students with imperfect vision because of the problem of

extracting meaning from imperfect (visual) information. (Synthesised speech readouts of the data might be helpful here.) It is beyond the scope of this guide to provide a review of visual data interpretation, though the work of Tufte (1990, 1997, 2001) might prove useful guidelines for staff who design graphical summaries of data required for laboratory interpretation.

Colour defective vision can also be problematic in those situations where specific colours are significant indicators of a measurement value or threshold. Several examples occur in laboratories used by GEES students.

- *Acidity/alkali testing.* The traditional litmus test involves the use of a small tab of absorbent paper that is dipped into the relevant liquid. The acidity or alkali level of the liquid (its pH value) is then indicated by the colour of the paper, which tends towards the blue end of the scale for high pH values (i.e. alkaline), and towards the red end of the scale for low pH values (i.e. acid). If students have problems distinguishing between red and blue, this may prove to be problematic. A more modern alternative form of the kit consists of 'indicator strips' that have four small squares that can change colour. The user dips the strip into the solution as before, but then matches the four colour squares against a rectangular matrix of colours to determine the correct pH value. If this approach is still problematic for students with colour defective vision, then the visually more helpful digital pH device can be used, albeit at greater cost.

- *Interpreting dye colours.* Dyes are frequently applied to animal or human tissue or plant sections in the preparation of specimens for microscope analysis. Here, the colours under the microscope, which are typically shades of red and blue, differentiate the various structures of the tissues based on the colour uptake determined by the variation of the pH of the structures. The student is often asked to compare these colours with those printed in 'atlases' in order to confirm their interpretation. Because specific colours are indicative of the presence of specific tissue types, it may be difficult for those with defective colour vision to discriminate these effectively. (This is similar to the alkali testing problem described above, and also to the polarising light filter problem discussed earlier.)

- *Titration.* This involves dropping small quantities of one liquid into another, typically from a burette, until a diagnostic change of colour occurs - the 'n' point. Where the change is dramatic - either a colourless liquid suddenly changes to a strong hue, or a strongly coloured liquid suddenly becomes clear - most students will have little difficulty.

6.9.4   Some broader issues

The following additional issues relating to laboratory work and visual ability are worthy of mention:

1. **Age.** Visual impairment is likely to affect an increasing number of students and a growing proportion of staff, as mature-aged learners enter higher education and the age profile of lecturing staff moves further up the scale.

2. **Multiple impairment.** Visual impairment is frequently linked to other forms of impairment. For example, manual dexterity is a significant complementary ability to vision in the laboratory, because good hand-eye coordination is required for a number of laboratory tasks. Examples include:

   • adjusting the fine focus on a microscope;

   • adjusting the position of a slide on a microscope stage (e.g. using x,y vernier scales);

   • using tweezers to take apart specimens (plant or tissue), or to position them (as in flame tests);

   • adjusting the position of knobs, dials, taps, etc.;

   • pouring chemicals into vessels, rather than onto work surfaces or colleagues;

   • fixing items of equipment with clamps to a retort stand - here, good hand-eye coordination is necessary to achieve correctly aligned equipment and also to avoid hazardous operation;

   • weighing precise amounts of dry chemicals with an analytical balance;

   • using a dropper to fill a glass vessel up to a calibrated volume line, operating a bulb type pipette filler to draw up liquid into a pipette. In the latter case, students experiencing difficulties should be offered the use of an automated, hand-held pipette filler which can be preset to specific volumes.

3. **Age of equipment.** Older (and cheaper) equipment can pose more visual problems than newer (or more expensive) equipment, for two reasons. First, older equipment may have become considerably worn so that it does not perform as well as new equipment. An example is provided by the laboratory microscope which has been continually moved about rather than tethered to a fixed position, and consequently suffers from slipping adjustment wheels or damaged vernier scales, problems in eyepiece focusing and adjustment, or damage to slide mounting clips.

These all make it more challenging to acquire a perfect image through the eyepiece, even for students with no discernible visual impairment.

A second reason is that newer equipment is generally (though not universally) less taxing on the visual capability of the student. For example, an increasing proportion of laboratory instruments is digital rather than analogue, providing clear numerical readouts in the form of LCDs. In addition, many larger instruments have digital output ports that enable them to be connected to PCs so that the readings provided can potentially be 'spoken' by speech synthesis software. Finally, it should be noted that many modern instruments require less setup work by students, and thus fewer visually taxing actions, before they can be used, because many are pre-calibrated.

It should be noted, however, that this generalisation is not universally true. Some modern equipment is difficult to read because it is equipped, as are so many hi-fi decks designed for the home, with complex and relatively small readouts and labelling. In addition, complex, multi-functional equipment is often equipped with modal switches, whose operations can confuse the fully sighted as well as those with defective vision.

Particularly welcome is the growing range of 'speak your weight' type equipment now available. At the general end of the market are the widely useful talking clocks and watches, body and room thermometers, and talking tape measures (e.g. ProTape), all of which have fairly obvious GEES course applications. At the specialist end of the market are devices that speak the colour of an object at which they are pointed (e.g. the Cobalt Speechmaster), which might be useful in some specialist GEES laboratory activities.

4. **Ergonomics** can also play a part in determining laboratory capability, and can lead to instances where viewing difficulties are induced by factors other than a student's visual impairment. Of particular importance is the seating available to students, especially when using fixed instruments such as microscopes. Taller and shorter people can frequently experience discomfort and achieve less than perfect vision if they have to stoop or stand to look through the eyepiece(s). Another situation, mentioned earlier, is where students share microscopes and often resort to looking at an angle through the eyepiece(s).

5. **Guide dogs.** Traditionally, live animals are excluded from scientific laboratories (unless they themselves are the experimental subjects), because of the potential dangers of spilling hazardous substances or the possibility of expensive accidents through knocking over equipment. Blind students who routinely use a guide dog are at an immediate disadvantage

if this policy is strictly adhered to. One adjustment that might be deemed 'reasonable' is to locate all spillable or breakable items behind a retaining barrier fixed to the edge of laboratory benches (similar to those found in the dining rooms of cross-Channel ferries), or else to locate these items at a higher level than would be occupied by a blind student's dog while walking around or sitting in the laboratory.

6.10   Fieldwork

Field study takes a variety of forms on GEES courses, including:

- local project work - often an adjunct to class or laboratory work, usually involving individuals and small groups. Typical activities include: undertaking questionnaire surveys, learning surveying skills, etc.;

- day trip - some combination of 'look-see' and pre-arranged visits to a selection of locations within a study area, usually with a relatively small group of students from an option module;

- field week - an extensive mix of study activities involving a medium-to-large group of students;

- dissertation or project work - usually involves an individual student, typically without accompanying staff.

The mix of study activities can vary considerably between these formats, and this can pose potential problems to visually disabled students. A useful way of looking at field experiences in order to identify potential problem areas is to identify variations within a number of dimensions, including:

The educational context	Some are compulsory while some are optional.
Subject mix	Some are human, some are physical and some are a mixture of the two.
Physical skill demands	Some require students to walk across difficult terrain, others require them to stand in a street interviewing shoppers.
Nature of learning style	Some involve largely passive observation, others involve active exploration.
Supervision	Some involve close staff supervision, others encourage independent learning.
Expected learning outcomes	Some focus on learning subject content, others focus on skills development.

Curricular links	Some link the field experience to broader learning objectives built into the entire curriculum, others keep the field activity as a standalone experience.

The field environment provides unique opportunities for what might be called 'social learning'. Given that many disabled students report feeling lonely and isolated, it is doubly important that those with a visual disability partake fully in the various forms of social learning during fieldwork, and are not singled out for apparently 'special treatment', or treated with kid gloves. If fieldwork is scheduled for early in a degree programme, it can help to integrate visually disabled students into their cohort, and help to establish collaborative approaches to study that can continue through the rest of the programme.

The design of new field courses was discussed from a strategic viewpoint in section 4. Here, the discussion focuses on the study activities engaged in during fieldwork and identifying potential problems that may be encountered by visually disabled students. Potential solutions are suggested, but tutors leading students in field study should be ready to adapt these to their own circumstances, and also be prepared to act quickly and flexibly should unforeseen problems arise in the field. It should be recognised that not all aspects of fieldwork are equally challenging, and that a considerable amount of the work on residential field courses may be undertaken indoors at the field study centre. For visually disabled students, some of the more challenging or especially hazardous fieldwork activities may be substituted by relevant work at the centre.

Of the issues that need to be considered when preparing fieldwork study to be undertaken by visually disabled students, the following are perhaps the most important:

- *Information dissemination (by staff)*
  Have all staff involved in the field course disseminated relevant information to visually disabled students (e.g. at lectures and seminars, through handouts, on an intranet website)?

- *Information gathering (by students) - maps, articles, guides, internet*
  Have visually disabled students been properly briefed on the preparatory activities they need to undertake for their field course? Do they require any special resources in order to undertake these activities? For example, if the entire student group is to analyse geographical information available in a virtual field course system, how will the visually disabled students do this?

- *Financial support*
  Have visually disabled students been made aware of sources of funding available to them for acquiring special equipment or other resources needed for their fieldwork?

- *Form filling*
  Do your visually disabled students require any assistance in filling in forms related to the field course?

- *Risk assessments*
  Have you undertaken a risk assessment of the entire sequence of activities involved in the field course? This should include the preparatory work in and around campus right through to the follow-up and assessment work after the fieldwork is over.

- *Developing student-led support mechanisms*
  One of the more effective forms of support for visually disabled students will come from their peers. Have you encouraged students to develop strong mutual support networks? It is best to do this right at the start of the degree programme rather than leaving it to the eve of the fieldwork, as this is the best way to ensure that such support will be fully bedded in by the time the fieldwork gets under way.

- *Travel issues*
  Some elements of field course planning are normally left to the students themselves (e.g. travel to and from the field centre). However, for visually disabled students, some form of planning and staff intervention may be necessary. Have you decided which aspects you need to include in your fieldwork planning?

Although this list might appear burdensome, the Disability Adviser will probably be able to help with some or all of these issues, and the visually impaired student can also be an additional source of advice. It is also worth noting that the more inclusively designed the curriculum is (see section 4), the less work will remain for individual fieldwork planners.

6.10.1 Field investigation

Some of the generic issues relating to basic field-related skills are covered elsewhere in this guide (e.g. note-taking using a braille embosser, laptop or Dictaphone). Some of the more specific problems associated with field study are described below, and some indication is given of the kind of accommodation that might be made for visually disabled students. However, as has been stated in other parts of this guide, each student will need to be treated on an individual basis because different forms of visual impairment will impact differently on the ability to participate in field-related activities. It should also

be noted that most problems can be minimised or eliminated by effective preparation, student briefing and training on campus before the field course begins.

- **Observing and measuring the environment**

  One of the most common activities for students in the field is simple observation and identification. From a visual perspective, these activities sometimes involve near vision, as when asking students to identify small fossils in situ; at other times they may involve far vision, as when asking students to describe and interpret a particular landscape. These tasks will impact differentially on visually disabled students, depending on the nature of their visual impairment and the seeing aids they have with them. Care needs to be taken not to demoralise those who, unlike their companions, are unable to find a specimen even in a fossil-rich bed. A useful adjustment might be for the tutor to steer the student towards the general area where a fossil is located, then help them develop a more tactile approach to finding it. Suitable training on campus before the field course should be provided.

  Another common field activity involves the gathering of qualitative and quantitative data through more systematic observation surveys. These can include: land use mapping, field sketching, event recording (e.g. traffic), perception-based studies, townscape or landscape evaluation studies, etc. Recording sheets or pre-printed forms can help in capturing the data, thereby reducing the need for writing text. Some activities involving sight (e.g. traffic counting, landscape sketching) are always going to be difficult for the visually disabled student. But careful use of student helpers (e.g. the sighted student doing the looking) or appropriate technology (e.g. a camera or video recorder doing the recording) can often be used as enabling devices. Where more systematic and instrumental data gathering and mapping activities are involved, the blind or partially sighted student may not be so disadvantaged. Examples of instrumented recording include: data logging (e.g. water, biogeography, weather); physical sampling (e.g. augering, soils, peat cores, flora/fauna); measuring (e.g. slope profiles, bedform). In these cases, the use of computer-based technology such as a portable PC or computerised data logging kit may make it possible for the visually disabled student to carry out the recording largely unaided. If Portable Digital Assistants (PDAs) with speech output and PCs with voice entry are available, this makes the task even more accessible.

- **Geological sections and soil horizons**

  Earth science students frequently examine geological sections in quarries, roadside cuttings or cliffs during field courses. This activity can pose

significant visual challenges, even for fully sighted students. The clarity with which sections may be distinguished is affected by several factors, some under the control of the field tutor, others outside their control. These include:

- the freshness of the section;

- the amount of ambient light;

- the presence/absence of shadows;

- the amount of colour and texture variations across the exposure.

Similar problems are found when digging soil pits for detailed horizon analysis, although these are not so frequently used on earth and environmental science field courses as they might once have been.

- **Use of surveying equipment**

The following can pose a number of reading problems:

- measuring tape marks;

- reading slopes angles from a clinometer;

- reading scales (graticules) in an eyepiece.

Some of these problems can be partly overcome by suitable training on campus before the field course (the section on laboratory work provides some practical suggestions), or by using buddies to read out the measurements.

- **Interacting with people**

Most field courses involve students carrying out interviews in the field to gather qualitative and/or quantitative data. These may be with experts, local 'voices' or members of the general public, and may take place out in the street, in homes or in offices. A number of steps can be taken to ensure that blind or partially sighted students can participate fully in interview activities:

- *Reading questions on questionnaires.* Use a device (e.g. text-to-voice software on a portable PC) which speaks the contents of the form or questionnaire. (It might be advisable for the student to listen through a earpiece so as not to interfere with interaction with the respondent.)

- *Filling in forms (paper or electronic).* Wherever possible, use recording sheets or forms that reduce the need for entering text by hand. Encourage the use of handheld devices that allow completion of forms by selecting clearly defined options.   A non-technological solution is

for students to work in pairs for interviews, with each student taking turns to ask questions or record answers.

- **Studying documentary evidence**

  Where fieldwork involves access to written records, whether contemporary or historical, the visually disabled student moves into fairly familiar territory. As long as the 'guardians' of the relevant materials (e.g. a museum curator, company archivist or environmental agency librarian) are brought on board, a certain amount of textual analysis may be possible and fulfilling. Again, the pairing of visually disabled students with sighted students is a useful strategy to adopt.

6.10.2 Follow-up work

Working in groups and teams may present barriers to visually impaired students. During the fieldwork period, problems may be minimised because of the close proximity of group and team members. However, problems can multiply as soon as the field course ends. Group-gathered data are often brought back to campus for sharing and subsequent joint analysis. Back on campus, it becomes more difficult for the visually disabled team member to maintain contact with other team members, especially when they have to travel to other team members' accommodation. One way of reducing the problems of arranging meetings is for staff to arrange for all raw data to be collated and shared during the field course (e.g. during evening work sessions).

Back on campus, the following approaches might prove more accessible for the visually disabled members of particular work groups:

- groups should be encouraged to meet at times and places convenient to the visually disabled student;

- data might be posted to a website, thus avoiding the need for arranging meetings. It is not difficult for a technician to develop a web server script to accept, store and make available the submitted information;

- a tutor could act as a data intermediary - individual students deposit the required data with a member of staff by an agreed date, then this is distributed to all members of the group, including the visually disabled student.

Much of the mapping, data visualisation and statistical analysis undertaken after a field course should be organised using the same general strategies in place for this kind of work in the degree programme at large. If the visually disabled student does not have access to suitable facilities (e.g. software adaptations for data visualisation and mapping), several alternative strategies might be considered:

- provide additional time;

- use a student buddy;

- work in groups, so that the visually disabled student undertakes the work that plays to their particular strengths;

- undertake alternative forms of analysis.

6.11   Independent study and reflective learning

Independent study is a regular expectation made of students in higher education, and gradually increases during most undergraduate programmes. It is of greater importance in taught postgraduate programmes, and comes into its own during a research degree. Independent study includes a wide range of activities including textbook reading, essay writing, library research, computer-based and web-based study, and dissertation preparation. These and other forms of independent study are also required during work-based learning, where students are increasingly expected to show initiative on the job.

Another form of independent study is found in the reflection in and on learning that is being recommended to students on an increasing number of courses in higher education. Indeed, the Personal Development Planning (PDP) process established by the QAA (no date) requires all students to maintain a Progress File throughout their period of study in higher education from September 2005.

Paradoxically, perhaps, blind or partially sighted students may exhibit greater independence as learners than fully sighted students, because of the greater practice they have had at coping with adverse learning environments. They may also have developed some of the mental attitudes required for independent learning, including curiosity, motivation and commitment.

6.11.1 Preparing essays, reports and dissertations

This involves note-taking (e.g. from textbooks, journals, the web) as well as note making (e.g. recording specific thoughts and ideas, or observations in the field), and may also involve the completion of field data sheets or questionnaires, all of which may pose additional problems to blind or partially sighted students. (Solutions are discussed elsewhere in this guide.)

The **writing tasks** associated with independent study (e.g. writing an essay, compiling a project report or writing a dissertation) should pose relatively few problems as far as the mechanics are concerned, because most blind or partially sighted students will have developed well-established procedures before entering higher education. Some students may dictate their work into a recording device (this can be done directly into a word processor with software such as Via Voice or Dragon Naturally Speaking), but the accuracy of

this approach may depend on the absence of ambient sounds in the student's work environment. Where the visually disabled student lives in shared accommodation, some consideration might need to be given to this if less than perfect text is presented for assessment. Some thought ought also to be given to providing additional time to prepare selected items of assessed coursework, especially if the student has to employ a sighted proofreader to check their written work.

Considerable thought may be needed if helpers and proofreaders are used in the preparation of work to be submitted for assessment. Because of the widespread abuse of these kinds of assistant, some of whom openly advertise services that go way beyond mere transcription, copy typing and proof checking, discussion and monitoring may need to be undertaken of their use by visually disabled students to ensure equitable treatment among all students. Where, as in the case of the author's own institution, the Students Union has taken a stand against the use of these service providers on account of increased abuse, some dispensation might be necessary in order for carefully screened providers to be used by visually disabled students.

One further accommodation to the needs of visually disabled students might be in the choice of topic on which they are writing. If a standard essay or project topic is highly visual (e.g. landscape interpretation, interpretation of remotely sensed images), it might be appropriate for some students to find an alternative topic which presents them with a lower visual challenge.

Finally, it is worth noting that **research students** may face particular issues and problems, which may be addressed by:

- negotiation between student and department (and possibly a Disability Adviser) over the management of a team of assistant researchers to undertake basic research tasks (e.g. literature searches, data analysis);

- establishing ways of ensuring the research is the student's own and that they are in charge of directing the work of any sighted helpers;

- establishing the extent and limits of the supervisor's role.

Although these issues may also affect undergraduate students (e.g. in relation to a dissertation or individual project), they are of far greater overall significance to postgraduate students undertaking research as their primary activity.

6.11.2 Maintaining a Progress File

The keeping of journals as a log of one's learning progress has been advocated for some time in higher education. With the advent of the Progress File, students are provided with an ideal opportunity to reflect on their experience

of studying GEES at university, and to make proposals for improving provision. This may pose few additional problems for visually disabled students over and above the normal challenge of writing during their periods of study. However, such students should also be encouraged to reflect on the inclusiveness of their learning environments, and these thoughts might be fed back to academic staff in the department with a view to making relevant improvements. As with the issue of disclosing their disability, it is up to the visually disabled student to decide whether to share their thoughts and ideas with academic staff. Some may prefer to communicate with a student buddy or the Disability Adviser.

Personal Development Planning (PDP) is meant to provide an opportunity for students to become more effective learners while at the same time taking a future-oriented look at their learning progress and needs. To this extent, the PDP process is meant to kick-start a student's thinking about a future career from the moment they begin their period of study. (This point is developed further in section 3.5 where we discuss career opportunities.) Reflecting on the skills they have acquired or developed in higher education in relation to their impairment (e.g. managing helpers, organisational skills) may be of benefit when considering which career to follow after graduation.

6.12   Assessment

The assessment strategy should always be an integral part of the teaching and learning strategy. This is especially important for visually disabled students who may already feel disadvantaged by some of the learning activities they have undertaken. If the assessment instruments are biased towards activities that favour sighted students, they may feel doubly disadvantaged. This can easily occur if assessment makes considerable use of graphics, and this is frequently the case in the assessment of fieldwork, which commonly involves posters, field sketches, mapping, and photography. The assessment of GEES subject matter can - and perhaps should - be used as an opportunity to recognise possible strengths of visually disabled students in other areas, including verbal presentation.

Special attention should therefore be given to those forms of assessment that enable blind or partially sighted students to reveal the full range of learning that they have achieved. For example, where visual learning has been involved (e.g. observation and recording on field courses, specimen identification in the laboratory, or image interpretation on a PC), the assessment will inevitably involve an assessment of the visual ability of the student during the learning activities. If some form of accommodation has already been made during these learning activities, it may also be necessary to vary the assessment in order to match the variations in their learning activities.

The Accessible Assessments website at Sheffield Hallam University <www.shu.ac.uk/services/lti/accessibleassessments/> provides useful advice on the design of various forms of assessment for disabled students.

6.12.1 Objective tests

Objective tests are being increasingly used to assess basic learning in year one, but they can also be used effectively at later stages for more complex learning. The main consideration here is the usability of the assessment document. Where a form is printed that can be read by an Optical Character Reader (OCR), visually impaired students may have difficulty reading these forms and making a pencil mark in the (usually small) area allocated on the form. It is therefore usually preferable to provide objective tests online, and several products are available on the market (e.g. Questionmark) which permit the rapid design and uploading of tests onto websites.

6.12.2 Essays, reports and dissertations

Standard essays or reports are likely to be the least problematic for blind or partially sighted students to produce, as these will probably have been used in several previous assessments. If a standard report is required, some consideration ought perhaps to be given to the medium in which the visually impaired student is permitted to present it. In addition to the standard word processed document, tutors should be prepared to accept spoken reports (e.g. on cassette) and entirely digital submissions.

Most of the issues relating to the production of these types of written work have been discussed in a previous section of this guide. As for assessment issues, two are particularly relevant.

- **Due date extensions** to compensate for the additional time that may be required by visually disabled students. Extensions should be discussed well in advance, either with the relevant course tutor, or with the university Disability Adviser who might act as a go-between with the tutor. This can sometimes be a thorny issue because of equity concerns. (How much extra time, if any, should the visually disabled student be given to prepare their assessed work?) This issue is unlikely to be specific to visually disabled students, so there may already be general institutional or departmental guidelines in place. However, there may be special requirements (such as follow-up work in a physical geography laboratory after a field course) that suggests the need for an extra time allowance for visually disabled students. This allowance need not necessarily be the same as that granted to students with other forms of disability, because the follow-up work may not impact equally on all disabled students. Again, a balance

needs to be struck between the equity principle and meeting individual needs. Another problem that can arise is that a visually impaired student who acquires several extensions might find themselves under considerable pressure towards the end of the semester. This problem needs to be foreseen and perhaps managed with the assistance of the relevant tutor(s).

- **The visual content of assessed work.** In some cases, visual information processing will be a central component of coursework (e.g. involving the display, analysis and interpretation of digital spatial data using a GIS, desktop mapping program or image processing software). In other cases, the work being assessed may have involved the visual extraction and interpretation of graphical information (e.g. through the analysis of thin sections in the geology laboratory), and some form of graphic ability might also need to be demonstrated in the assessment. In such cases, where the visually disabled student might legitimately feel at some disadvantage to sighted students, they should discuss their concerns with the course tutor who might be able to adjust the assessment requirements in some way. Where visual interpretation and analysis is a fundamental part of the skills element of the course and needs to be included in the assessment, this requirement should perhaps be discussed in depth with the student when they first apply for a place on the programme or module.

6.12.3 Examinations

Formal examinations typically involve all students taking a particular module sitting together in an examination room for a prescribed period of time on a particular date. This may pose problems where a visually disabled student has a guide dog, or needs to dictate into a speech recorder or to a helper. A ready solution might be to provide the student with a separate room, and this can normally be arranged provided that a request is made well in advance of the examination date. (This will probably require that the student discloses their disability, as discussed in section 3.3.5.) It might also be necessary to allocate additional time to the visually disabled student, and this is more easily accommodated if they are sitting their exams in a separate room.

The exam scripts may also pose further difficulty, and large text, coloured paper or braille versions may need to be produced on request. (See the discussion of handouts in section 7.3 for further details on the production of suitable printed material for visually disabled students.) An alternative, and perhaps more radical strategy, might be to replace a written exam with an oral exam.

6.12.4 Posters

The increasingly popular poster presentation may be a challenging form of assessment for the blind or partially sighted student, who might find it considerably more difficult to do well in this presentation medium. Consequently, a verbal presentation may be more appropriate. A web-based presentation could be both challenging and rewarding for the visually disabled student, and should not be beyond their reach. Many aids are available to assist in the creation of web documents. (See the discussion of web design in section 7.4.)

6.13   Course evaluation

Most forms of teaching and learning are evaluated nowadays, increasingly by formal feedback mechanisms to satisfy QAA quality requirements. In GEES, some courses tend to be subject to perhaps more evaluation than others. For example, field courses are heavily evaluated because of the resource implications of this form of learning. For visually disabled students, it is important that all their learning experiences are debriefed, so that lessons can be learnt and applied to subsequent courses. Some of this debriefing may be undertaken during the course itself, either informally with the individual visually disabled student, or as part of a more structured feedback session held with all students. However, care needs to be taken so that students are not over-burdened with extra tasks of this kind.

- **Intermediate evaluation.** With visually disabled students, it may be advisable to solicit their views of their learning experiences on a continuing basis rather than at predetermined checkpoints. This might make it possible to make fairly rapid adjustments, or maybe perhaps on a daily basis during block learning experiences and field courses. Where a GEES department has had little previous experience of managing the progress of visually disabled students, the intensive use of feedback can be a valuable learning experience for the tutors involved.

- **Summary evaluation**. Formal course evaluation questionnaires are often distributed to students near the end of a module, following long-established practice in North America. One of the problems of these questionnaires, or their online equivalents, is that they tend to be generic across all courses in the institution. This not only poses problems for the evaluation of special forms of teaching, learning and assessment in particular modules, but it may also fail to address the concerns of students with visual (and other) disabilities. Where this is the case, GEES tutors and department should consider asking these students to submit additional evidence of their learning experience

from the point of view of their disability.

- **Post-course evaluation.** When visually disabled students graduate, some form of feedback or other contribution could be valuable to subsequent students with similar impairments. Clark and Higgitt (1997) provide an example of a research study that elicited the views of geography alumni. Another way of benefiting from the experience of visually disabled graduates is to invite them to participate in future courses, either as a guest speaker, or as a design consultant.

It may also be worth trying to determine whether any of the graduates' course experiences, and particularly the coping skills they developed, were subsequently transferred to a work context. In particular, did they benefit from those learning activities that provided them with opportunities to operate autonomously in complex and/or challenging environments in order to solve ill-defined problems? By exploring the subsequent use made of course-related skills in a job context, it might be possible to make further modifications to the design and organisation of the learning opportunities to further increase the employability of later cohorts of visually disabled students.

8 Conclusions

Among the general issues indicated in this guide, four can be singled out as being particularly significant for visually disabled students. The first is the switch from analogue to digital in the provision of learning resources. The second is the gradual change in emphasis from dealing with special cases (e.g. disability) to dealing with generalities (as in inclusiveness). The third is the shift from a *table d'hôte* mode to an *à la carte* mode in designing and delivering the curriculum. The fourth is the change from a reactive to an anticipatory mindset, especially when considering the needs of visually disabled students.

(These trends are discussed in more detail in sections 8.1 to 8.4 in the web version of this guide.)

8.5   From inclusive curriculum to inclusive culture

The idea of an inclusive curriculum, equally accessible to all students regardless of their disability, has surfaced from time to time in this guide. The Further Education Funding Council (FEFC) offered this definition in its 1996 report on *Inclusive Learning*:

> *'Inclusive learning is the greatest degree of match or fit between the individual learner's requirements and the provision that is being made for them.'*

The final question posed in this guide is whether a curriculum that focuses primarily on disability issues is the best way to achieve inclusiveness, or whether a broader approach is needed. In the near future, as government funding for disability becomes less project-based and more institution-based, it is possible that the work of the National Disability Team and other specialist units at the national level will be rolled into campus-based units that combine a responsibility for disability with a remit to widen participation and access. This convergence was presaged in 2001, when HEFCE suggested in Circular 01/36 that:

> *'We would encourage institutions to include strategy and policy relating to disability in both their widening participation and learning and teaching strategies.'*

It is therefore important that GEES departments foster working relationships with these other units, not only to ensure continuity of support in the years ahead, but also to work towards a more integrated approach to achieving the inclusive curriculum.

Perhaps the greatest current challenge for us as academics is to move beyond the inclusive curriculum and attempt to develop an inclusive culture in our courses, our departments and our institutions. An inclusive culture would recognise, value, celebrate and question all forms of diversity, among both students and staff, and seek to harness this diversity to the cause of effective learning. When an inclusive culture has been developed, we should no longer have to create special projects that pick off and address individual differences between people. Why, for example, should we have to look in entirely different places for guidance on how to handle the overseas student who has a combination of low vision, difficulty in expressing themselves in English, and experience of being raised in a very different educational culture? This student does not only present a set of disparate disabilities, or deficits, each of which has to addressed separately, but is a normally complex individual and should be treated as such.

An inclusive culture might mean no longer having separate policies for disability, inclusiveness, diversity, widening access and other 'issues'. Moreover, as our learning culture increasingly embraces diversity, and our approaches to dealing with students as individuals become more sophisticated, the need for special systems to identify, measure, monitor and appraise difference may become less and less necessary. As Jenni Dyer (no date), the Policy Director of SKILL (the National Bureau for Students with Disabilities) once put it when discussing the issue of disabled student disclosure:

> *'If your curriculum is truly inclusive, do you always need to know?'*

9 Resources and bibliography

A considerable variety of resources is available to support visually disabled students while studying GEES, and there is an extensive literature on the subject. Some of this wealth of material is indicated below.

NB: All web addresses in this guide checked February 2006.

9.1 Internet resources

Ability Net <www.abilitynet.org.uk>
This charity provides a major set of resources on all aspects of disability, through its website, its helpline, home visits and training courses. Particularly strong on visual disability and 'get around' technology for computers, for which it has produced a number of detailed technical factsheets.

A Blind Net <www.blind.net>
A guide to resources for blind people.

Blind Mobility Research Unit (BMRU)
Based at the University of Nottingham; now defunct.

Blindness Resource Center <www.nyise.org/blind.htm>
Information and guidance for blind people from the New York Institute for Special Education. (Good example of a website available in several formats: graphics, text-only, large print, and frames.)

Blind Ring <www.ringsurf.com/netring?ring=blindandvi;action=list>
A web 'ring' (connected set of thematic websites) relevant to blind people.

British Computer Society Disability Group
<www.bcs.org/server.php?show=conWebDoc.1252>
Undertakes a range of activities aimed at giving disabled people a better quality of life, especially in relation to the use of IT.

National Clearinghouse on Education and Training for People with Disabilities (NCET)
An Australian website launched in September 2000 as a centralised source of information on tertiary education and training opportunities for people with disabilities.

NBLUK (2000) National Library for the Blind
A UK gateway to library services for visually disabled people.

Oedipus (2000) Blindness-related resources on the web and beyond,
<www.hicom.net/~oedipus/blind.html>.
An extensive collection of links to international sources on the web.

RNIB (Royal National Institute of the Blind) <www.rnib.org.uk>
*The main UK organisation representing the needs and interests of blind and
visually impaired people. Provides a wide range of information and advice, and
lobbies on behalf of the community it represents. Its factsheets
<www.rnib.org.uk/xpedio/groups/public/documents/code/
public_rnib001974.hcsp> are particularly helpful, as is its extensive advice
on designing accessible websites <www.rnib.org.uk/xpedio/groups/public/
documents/PublicWebsite/public_articles.hcsp>.*

Scottish Sensory Centre
*Promotes and supports new developments and effective practices in the
education of children and young people with sensory impairments. Provides an
excellent summary of the characteristics of a wide range of visual impairments
and makes recommendations on how best to use video with visually disabled
students.*

TechDis <www.techdis.ac.uk>
*This JISC service aims to improve provision for disabled staff and students in
the further, higher and specialist education sectors through technology.*

**VIG (2000) V. I. Guide: a guide to internet resources about visual
impairments for parents and teachers** <www.viguide.com>
*A structured guide to resources on the web for blind people, with an educational
slant.*

Web links

Here are some websites which provide extensive sets of links to sites dealing
with various aspects of blindness and visual impairment:

Adaptive Technology <www.seidata.com/~marriage/rbadapt.html>.

Disabled People's Association (Singapore) websites: blind and visually
handicapped: <www.dpa.org.sg/>.

New Zealand Resource Guide for the Visually Impaired
<www.hicom.net/~oedipus/blind.html>.

Resource Sites on Blindness <www.nyise.org/blindness.htm>.

Web Accessibility Forum <www.webaim.org>
*Provides a range of resources for those designing accessible websites, and
includes an online forum <www.webaim.org/discussion/>.*

UK Government disability website <www.disability.gov.uk>.

Other resources

Disability Information Systems in Higher Education (DISinHE)
<www.computing.dundee.ac.ukac_research/
projectdetails.asp?=is=33&source=all>
Based at the University of Dundee, provides information and advice on how information systems can be used to support staff and students with disabilities.

Disability Information and Resource Centre, South Australia
Provides useful information on topics ranging from legislation and travel rights to fact sheets and resource links.

Disability Rights Commission (DRC) <www.drc-gb.org>
Set up to police the working of the Disability Discrimination Act of 1995; came into force in April 2000.

eQuip <www.natdisteam.ac.uk/equipsite/eQuipHome.htm>
A team funded by HEFCE to enhance the quality of provision for disabled students in England.

HEFCE information relating to disabled students
<www.hefce.ac.uk/widen/> and <www.hefce.ac.uk/widen/sldd/>.

National Bureau for Students with Disabilities (SKILL)
<www.skill.org.uk>
Provides information and advice on good practice for disabled students.

National Centre for Tactile Diagrams (NCTD) <http://www.nctd.org.uk/>
Based at the University of Hertfordshire, this provides a subsidised tactile diagram production service for further and higher education. It also holds open days, runs training courses, provides consultancy to organisations, and is developing an archive of tactile diagrams.

The **National Disability Team (NDT)** <www.natdisteam.ac.uk>
Funded by HEFCE, and based at Anglia Polytechnic University, the NDT provided a range of services aimed at improving provision for disabled students in higher education. The NDT was disbanded in December 2005, but the website is available for archived information.

Project ASSIST, Iowa Department for the Blind
<www.blind.state.ia.us/assist/>
Special tutorials and keyboard guides are available to help people learn to use general Windows applications programs.

Sensory Disabilities Research Unit (SDRU) <www.psy.herts.ac.uk/sdru/> *Based at the University of Hertfordshire, this carries out research into visual disability.*

Since all work and no play makes Jack (and/or Jill) a dull person, it might be worth mentioning the Audyssey website, which is a discussion forum dedicated to computer games that are accessible to blind players <www.tsbvi.edu/technology/games.html>.

9.2   References and further reading

Ananova (2000a) *Blind Antarctic explorer in high spirits* <ananova.co.uk/news/story/sm_125505.html>.

Ananova (2000b) *AOL to adapt software for blind people* <www.howstuffworks.com/news-item125.htm>.

Arditi, A. (1999) *Effective colour contrast* <www.lighthouse.org/color_contrast.htm>.

Arnheim, R. (1969) *Visual thinking*.

Atkinson, R. (2004) It might help if I didn't wear high heels, *The Guardian*, 29 March 2004.

Beresford, D. (2002) A leap in the dark, *The Guardian*, 30 July 2002.

Boyd, W.E. (1993) The blind leading the blind? Teaching geography to students with vision impairment, *Australian Geographical Studies*, 31(1), pp.91-96.

Brookman, J. (2000) Teamwork brings gift of sight, *Times Higher Education Supplement*, 21 July.

BSI (2000) Blind Sailors International, <www.blindsailing.org>.

Buultjens, M., Aitken, S., Ravenscroft, J. & Carey, K. (1999) Size counts: the significance of size, font and style of print for readers with low vision sitting examinations, *British Journal of Visual Impairment*, 17(1), pp.5-10.

Carvel, J. (2000) Minister of sound, *The Guardian*, 25 May.

Chalkley, B. & Waterfield, J. (2001) *Providing learning support for students with hidden disabilities and dyslexia undertaking fieldwork and related activities* (Cheltenham: Geography Discipline Network).

Challis, B.P. & Edwards, A.D. (2000) Good tactile diagrams can look bad, Abstract, *International Conference on Tactile Diagrams, Maps and Pictures*, October 2000, University of Hertfordshire, <www.nctd.org.uk/Conference/Conf2000/Conf2000_Proceedings.htm>.

Chong, C. (1997) *Microsoft takes a big step backward* <www.nfb.org/bm/bm97/Bm971202.htm>.

Chong, C. (2000) *Web accessibility: making your web site accessible to the blind* <www.nfb.org/tech/webacc.htm>.

Christian, K. (2000) *Design of haptic and tactile interfaces for blind users* <www.otal.umd.edu/UUGuide/kevin/>.

Clark, G. & Higgitt, M. (1997) Geography and lifelong learning: a report on a survey of geography graduates, *Journal of Geography in Higher Education*, 21(2), pp.199-213.

Clark, G., Wareham, T. & Turner, R. (2006) *To a degree: a guide for students with specific learning difficulties, long-term medical conditions or impairments* (Cheltenham: Geography Discipline Network).

Clark, J. (2000) *Flash access: unclear on the concept* <www.alistapart.com/articles/unclear/>.

DDA (1995) *Disability Discrimination Act Part IV* <www.drc-gb.org/thelaw/thedda.asp>.

DfES (Department for Education and Skills) (no date) *Providing work placements for disabled students*.

DfES (Department for Education and Employment) (2005) *Bridging the Gap: a guide to the Disabled Students' Allowances (DSA) in higher education* <www.dfes.gov.uk/studentsupport/formsandguides/> and also: <www.dfes.gov.uk/studentsupport/uploads/bridgingthegap2005.doc>.

Diamond, M. (2000) *Public transport entitlements for blind and vision impaired people throughout Australia* <www.bca.org.au/news0005.htm#_Toc480607420>.

DRC (Disability Rights Commission) (2005) *DRC disability briefing* <www.drc-gb.org/publicationsandreports/ briefing.asp?cats2show=6&section=ddb&sectionid=10>

DRC (Disability Rights Commission) (2004) *Code of Practice: employment and occupation* <www.drc-gb.org/documents/employment_occupation.pdf>.

DSS (Department of Social Security) (1998) *First findings from the disability follow-up to the Family Resources Survey*.

Dyer, J. (no date) *Current and future issues in inclusivity in HE*, Powerpoint presentation slides.

Earl, C. & Leventhal, J. (1999) *A survey of Windows screen reader users: results and recommendations* <www.csun.edu/cod/conf/1999/proceedings/session0052.htm>.

Edman, P.K. (1992) *Tactile graphics* (New York: American Foundation for the Blind).

Edwards, A.D.N. (ed.) (1995) *Extra-ordinary human-computer interaction* (Cambridge: Cambridge University Press).

Edwards, A.D.N. (ed.) (1995) *The rise of the graphical user interface* <www.rit.edu/~easi/itd/itdv02n4/article3.htm>.

eWiC - Electonic Workshops in Computing (1998) *International Conference on Auditory Display '98*. Selected papers available online at: <http://ewic.bcs.org/conferences/1998/auditory/index.htm>.

FEFC (Further Education Funding Council) (1996) *Inclusive learning*.

Fisher, P.F. (1994) Hearing the reliability in classified remotely sensed images, *Cartography and Geographic Information Systems*, 21, pp.31-36.

Foulke, E. (1986) *Report of the Working Group on Mobility Aids for the Visually Impaired and Blind* <www.nap.edu/books/POD250/html/R1.html>.

Gibbons. A. (2004) Senses working overtime, *The Guardian*, 28 May 2004.

Gollege, R.G. (1997) On reassembling one's life: overcoming disability in the academic environment, *Environment and Planning D: Society and Space*, 15, pp.391-409.

Gollege, R.G. (1993) Geography and the disabled: a survey with special reference to vision impaired and blind populations, *Transactions of the Institute of British Geographers*, 18(1), pp.63-85.

Golledge, R., Loomis, J., Klatzky, R., Flury, A. & Yang, X-L. (1991) Designing a personal guidance system to aid navigation without sight: progress on the GIS component, *International Journal of Geographical Information Systems*, 5, pp.373-396.

Guardian (2000a) Website 'discriminated against blind', *The Guardian*, 28 August.

Guardian (2000b) Help them to see, *The Guardian*, 21 November.

Guardian (2000c) Musical key to 'sight' for blind, *The Guardian*, 22 September.

GVU (1998) *GVU's WWW user surveys: disability*, <www.gvu.gatech.edu/user_surveys/survey-1998-10/graphs/general/q12.htm>.

Hall, T. & Healey, M. (2004) The experience of learning at university by disabled students in geography, earth and environmental sciences and related disciplines: report on the Inclusive Curriculum Project (ICP) student survey (Cheltenham: Geography Discipline Network).

Hall, T., Healey, M. & Harrison, M. (2002) Fieldwork and disabled students: discourses of exclusion and inclusion, *Transactions of the Institute of British Geographers*, NS, 27, pp.213-231.

Hall, T., Harrison, M. & Healey, M. (2000) T*he experience of academic departments and disability units in providing learning support for students undertaking fieldwork and related activities: reports on surveys*, GDN Draft Report.

Healey, M., Jenkins, A. & Leach, J. (2006) *Issues in developing an inclusive curriculum: examples from geography, earth and environmental sciences* (Cheltenham: Geography Discipline Network).

HEFCE (2001) *Strategies for widening participation in Higher Education: a guide to good practice*, Circular 01/36 (London: HEFCE).

Hess, R. (2000) *Can color-blind users see your site?* <http://msdn.microsoft.com/library/default.asp?url=/library/en-us/dnhess/html/hess10092000.asp>.

Heyes, T. (no date/a) *Electronic travel aids - why bother?* <http://web.aanet.com.au/tonyheyes/pa/quest.html>.

Heyes, T. (no date/b) *The Sonic Pathfinder: an electronic travel aid for the vision impaired* <http://web.aanet.com.au/tonyheyes/pa/pf_blerb.html>.

Hinton, R. (1994/5) *Tactile graphics in education* (Edinburgh: Moray House Publications).

IBSA (2000) International Blind Sports Federation <www.ibsa.es>.

ICTDMP (2000) *International Conference on Tactile Diagrams, Maps and Pictures*, October, University of Hertfordshire <www.nctd.org.uk/Conference/Conf2000/Conf2000_Proceedings.htm>.

Iowa (2000a) *Iowa Department for the Blind: legal questions* <www.uiowa.edu/infotech/WebAccess.htm#Legal Questions>.

Iowa (2000b) *How does a screen reader work?* <blind.state.ia.us/access/how.htm>.

Kaczmarek, K.A. (1991) Electrocutaneous and vibratactile displays for sensory substitution systems, *IEEE Transactions on Biomedical Engineering*, 38(1), pp.1-16.

Kay, L. (1984) Electronic aids for blind persons: an interdisciplinary subject, *IEEE Proceedings*, Part A, 131, pp.559-576.

Keeler, R. (2000) *IBM's talking Web browser allows blind and visually impaired people to do e-business* <http://domino.research.ibm.com/comm/pr.nsf/pages/news.20001026_talk_browser.html>.

Kent, M. Gilbertson, D.D. & Hunt, C.O. (1997) Fieldwork in geography teaching: a critical review of literature and approaches, *Journal of Geography in Higher Education*, 21(3), pp.313-332.

Kurze, M. (1995) Giving blind people access to graphics (Example: Business Graphics), in *Proceedings Software-Ergonomie '95 Workshop 'Nicht-visuelle graphische Benutzungsoberflachen'*; Teubner, Stuttgart, 22.02.1995.

Leroi, A.M. (2003) *Mutants: on the form, varieties and errors of the human body* (London: Harper Collins).

Loomis, J., Golledge, R. & Klatzky, R. (1998) Navigation system for the blind: auditory display modes and guidance, *Presence: Teleoperators and Virtual Environments*, 17, pp.193-203.

Lowney, G. (1998) *But can they read it?* <www.empowermentzone.com/coloracc.txt>.

Maguire, S. (1998) Gender differences in attitudes towards undergraduate fieldwork, *Area*, 30(3), pp.207-214.

Mann, K. (no date) *Disabilities and their characteristics* <www.wmin.ac.uk/ccpd/uow/dict.htm>.

Marek, B. (2000) Making sense of spatial relations: tactile graphics for first time users, Abstract, *International Conference on Tactile Diagrams, Maps and Pictures*, October, University of Hertfordshire <www.nctd.org.uk/Conference/Conf2000/Conf2000_Proceedings.htm>.

McEwen, L. (1996) Fieldwork in the undergraduate geography programme; challenges and changes, *Journal of Geography in Higher Education*, 20, pp.379-384.

McLuhan, M. (1967) *The Gutenberg Galaxy* (London: Routledge & Kegan Paul).

McKendrick, J.H. & Mooney, E. (2001) Teaching geography to non-geographers at Glasgow Caledonian University, *Journal of Geography in Higher Education*, in press.

Meijer, P. (2000) *Sensory substitution* <www.visualprosthesis.com/sensub.htm>.

Microsoft (2000) *New MSN Explorer provides the most accessible online experience* <www.microsoft.com/presspass/press/2000/Oct00/ExplorerAccessPR.mspx>.

Milsom, C., Anwar, N. & Thompson, S. (2006) *Developing an inclusive curriculum for students with mobility impairments* (Cheltenham: Geography Discipline Network).

Morley, S. (1995) *Window concepts: an introductory guide for visually disabled users* (London: RNIB).

National Guidance Research Forum (2005) <http://81.4.66.124:8080/ngrf/EG/equal-opps/EOD1/indexfolder_printall>.

National Library for the Blind (NLBUK) (no date) *The number of visually impaired people in higher and further education* <www.nlb-online.org/ mod.php?mod=userpage&menu=60&page_id=370#content>.

Neustadt-Noy, N. Merlin, S. & Schiff, Y. (eds) (1988) *Orientation and mobility of the visually impaired* (Jerusalem: Helliger Publishing Co.).

NFB (2000a) Ama Dablam 2000 NFB expedition <www.nfb.org/amadablam.htm>.

NFB (2000b) Blindness Statistics <www.nfb.org/stats.htm>.

Oaff, B. (2005) 'They need to be diplomats, ambassadors and networkers', *The Guardian*, 18 April (Janet Pickering quotation).

Odgaard, E.C. (2000) Listening to shapes: the cross-modal equivalence of vision and audition in the presentation of 2-D shapes, Abstract 45, *2nd Annual Multisensory Research Conference*, 6-7 October New York <www.uni-oldenburg.de/imrf/meeting00/abstracts.html>.

Padget, I. (ed.) (1999) *Visual spatial ability and dyslexia* (London: Central St Martins College of Art and Design).

Perkins, C. (2000) Touching the campus: student-led tactile mapping, Abstract, *International Conference on Tactile Diagrams, Maps and Pictures*, October, University of Hertfordshire <www.nctd.org.uk/Conference/Conf2000/Conf2000_Proceedings.htm>.

Petrie, H. & Gill, J. (1993) Current research on graphical user interfaces for visually disabled computer users, *European Journal of Special Needs Education*, 8(2), pp.153-156.

QAA (The Quality Assurance Agency for Higher Education) (no date) *Progress files for Higher Education* <www.qaa.ac.uk/academicinfrastructure/progressFiles/default.asp>.

QAA (The Quality Assurance Agency for Higher Education) (2000) *Subject Benchmark Statement for Geography* (Cheltenham: QAA).

QAA (The Quality Assurance Agency for Higher Education) (2000) *QAA Code of Practice: Students with disabilities* <www.qaa.ac.uk/academicinfrastructure/codeOfPractice/section3/default.asp>.

Rigden, C. (2000) *Safe web colours for colour-deficient vision* <www.btplc.com/age_disability/ClearerInformation/Colours/index.htm>.

RNIB (Royal National Institute of the Blind) (2001) *Accessible web design* <www.rnib.org.uk/xpedio/groups/public/documents/code/ public_rnib008789.hcsp>.

Rothberg, M. & Wlodkowski, T. (1998) Adapting multimedia software for blind students: choices and challenges, Paper presented to *CSUN 99 Conference*, <www.dinf.ne.jp/doc/english/Us_Eu/conf/csun_99/session0156.html>.

Runcie, J. (2003) How I learned to love my myopia, *The Guardian*, 18 February 2003.

Ryan, B. (1999) Commentary: the low vision challenge, *British Journal of Visual Impairment*, 17(3), p.93.

Sacks, S.Z. & Silberman, R.K. (eds) (1998) *Educating students who have visual impairments with other disabilities* (Baltimore: Paul H Brookes Publishing Co.).

Schiff, W. & Foulke, E. (1982) *Tactual perception: a sourcebook* (Cambridge: Cambridge University Press).

SciVisum (2004) *Accessibility report* <www.scivisum.co.uk/report/accessibility/>.

Shakespeare, T. & Watson, L. (2000) The social model of disability: an outdated ideology? *Research in Social Science and Disability*, 2, pp.9-28.

Shams, L., Kamitani, Y. and Shimojo, S. (2002) Visual illusion induced by sound, *Cognitive Brain Research*, 14, pp.147-152.

Shaw, S. (2000) *Teachability: creating an accessible curriculum for students with disabilities*, University of Strathclyde <www.teachability.strath.ac.uk/original/downloads/teachability.doc>.

Shepherd, I.D.H. (2002) *Providing learning support for blind or visually impaired students undertaking fieldwork and related activities*, (Cheltenham: Geography Discipline Network) <www2.glos.ac.uk/gdn/disabil/blind/index.htm>.

Shepherd, I.D.H. (1995) Multi-sensory GIS: mapping out the research frontier, in: Waugh, T. (ed.) *Proceedings of the 6th International Symposium on Spatial Data Handling*, pp.356- 410 (London: Taylor & Francis).

Shepherd, I.D.H. (1999) *Teaching and learning geography with ICT* (Cheltenham: Geography Discipline Network).

Shore, D.I., Spence, C. & Klein, R. M. (2001) Prior entry: previous confounds and novel findings using an orthogonal design, *Journal of Experimental Psychology: General*, 130(4), pp.799-832.

Sight Savers International (2000) Reverse blindness: the work of restoring vision to the world's needlessly blind, *The Guardian* supplement.

Silver, P., Bourke, A. & Strehorn, K. (1998) Universal Instruction Design in HE: an approach for inclusion, *Equity and Excellence in Education*, 31, pp.47-51.

Silverstone, B., Lang, M.A. & Rosenthal, B.P. (eds) (2000) *The Lighthouse Handbook on vision impairment and vision rehabilitation* (Oxford: Oxford University Press).

Sortit (2000) *Shaping the future survey* <www.sortit.org.uk/survey.htm>.

SWANDS (2002) *SENDA compliance in higher education: an audit and guidance tool for accessible practice within the framework of teaching and learning* (Plymouth: The University of Plymouth).

Tasker, N. (2000) DOTS before your eyes: a tactile map design resource, Abstract, *International Conference on Tactile Diagrams, Maps and Pictures*, October, University of Hertfordshire, <www.nctd.org.uk/Conference/Conf2000/Conf2000_Proceedings.htm>.

Tasker, N. (2000) DOTS before your eyes: a tactile map design resource, Abstract, *International Conference on Tactile Diagrams, Maps and Pictures*, October, University of Hertfordshire, <www.nctd.org.uk/Conference/Conf2000/Conf2000_Proceedings.htm>.

Tufte, E.R. (2001) *The visual display of quantitative information*, 2nd edition (Cheshire, CT: Graphics Press).

Tufte, E.R. (1997) *Visual explanations* (Cheshire, CT: Graphics Press).

Tufte, E.R. (1990) *Envisioning information* (Cheshire, CT: Graphics Press).

UMNDS (University of Minnesota Disability Services) (2000) *Vision impairments* <http://ds.umn.edu/disabilities/Visual.html>.

Ungar, S. (2000) How do you read a tactile map? Abstract, *International Conference on Tactile Diagrams, Maps and Pictures*, October, University of Hertfordshire <www.nctd.org.uk/Conference/Conf2000/Conf2000_Proceedings.htm>.

Van Valkenburg, D. & Kubovy, D. (2000) Auditory and visual objects, Abstract 53, *2nd Annual Multisensory Research Conference*, 6-7 October, New York <www.soundobject.org/Helsinki_presentations/DVV_ICAD2001.pdf>.

Wareham, T., Clark, G. & Laugesen, C. (2001) *Providing learning support for d/Deaf or hearing impaired students undertaking fieldwork and related activities* (Cheltenham: Geography Discipline Network).

Warren, D. & Strelow, E. (eds) (1985) *Electronic spatial sensing for the blind*, NATO ASI series.

Waterfield, J., West, B. & Chalkley, B. (2006) *Developing an inclusive curriculum for students with dyslexia and hidden disabilities* (Cheltenham: Geography Discipline Network).

Watts, S. (2004) Developing an approach to supporting small numbers of students with sensory impairments, presentation made at the *Embedding Project Gains* workshop, Aston University, 2 July 2004.

Williams, G.J. (1998) *Vision, reading and computer users* <www.webword.com/interviews/williams.html>.

Wareham, T., Clark, G. & Turner, R. (2006) *Developing an inclusive curriculum for students with hearing impairments* (Cheltenham: Geography Discipline Network).

Wray, J. (2004) (Personal communication: email dated 26 April 2004).

Further Reading

Roy, A.W.N. (2003) Students with visual impairment, in: S. Powell (ed.) *Special teaching in Higher Education: successful strategies for access and inclusion*, pp.77-95 (London: Kogan Page).

The *Journal of Visual Impairment and Blindness* contains regular contributions on all aspects of visual impairment and blindness, including reports on developments in assistive technology.