DART: Assisting academic tutors to meet the needs of disabled students within the Engineering disciplines

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This paper focuses upon Loughborough University's DART (Disabilities: Academic Resource Tool)Project, which seeks to enhance the experience of disabled students within Engineering by developing a web -based auditing and diagnostic tool for use by academics .In the UK, under the Special Educational Needs an d Disabilities Act (SENDA) 2001 Higher Education Institutions have to make all reasonable adjustments to ensure disabled students have access to all aspects of the curriculum. This places additional burdens upon academic staff who may have little knowledge or experience of the needs of such students. The DART tool provides academic tutors with a ready made and instantly accessible resource to access general advice on the needs of students with a specific disability, and specific advice on how the needs of s uch students can me met within a range of learning and teaching contexts. It also includes a number of student case studies to provide academics with a more holistic awareness and appreciation of the needs of disabled students, and the barriers that can li mit successful access to the curriculum.

In addition to describing the design, development and primary features of this tool, this paper highlights the initial findings of a qualitative survey of engineering students with a range of disabilities carried out as part of this project. The paper details the students' experiences and examines critically the methods used by both the students, their academic tutors, and disability support staff to help resolve or ameliorate the difficulties encountered by these students. Attention is given to a range of learning and teaching contexts including lectures, group -work, laboratory work, fieldwork, site visits, resource - based learning and assessment. Barriers to effective access to the curriculum are identified and exa mined. Moreover, this paper offers, on the basis of the experiences noted and the barriers identified, advice to academics on how to respond more effectively to the needs of disabled students in Engineering.

Accessible curriculum, auditing and diagnostic tool, disabled students, learning and teaching.

BACKGROUND

The Special Educational Needs and Disability Act of 2001 (SENDA)

The Special Educational Needs and Disability Act of 2001 (SENDA) [1] means that UK higher education is no longer exempt from the Disability and Discrimination Act of 1995 [2]. From September 2002 it has been unlawful for a university, or department, to discriminate against a disabled person. The principle behind this legislation is that disabled people have the same opportunities as non-disabled people to benefit wherever possible from whatever education or other related provision is available[3].

This focus within SENDA on learning and teaching provision places an onus on departments, and indeed individual academic tutors, to take positive steps to make the learning and teaching experience accessible to all. This includes the requirements to be 'anticipatory' with regard to the needs of disabled students, and to make 'reasonable adjustments' to ensure that a disabled student is not disadvantaged.

To assist university departments and individual academic tutors to meet their obligations under that SENDA legislation, the Higher Education Funding Council for England (HEFCE) set aside up to £5.4 million to support a funding programme over three years (2003-05). DART is one of 24 projects funded through the second strand of this initiative.

The DART Project

Focusing on Engineering and the Built Environment, the aim of this project is to enhance the experience of disabled students by enabling institutions, departments, and individual academic tutors to assess their current level of provision in terms of how accessible it is for disabled students, and by offering clear guidance on how to improve accessibility.

The primary objective of this project is to develop a web-based auditing and diagnostic tool for use at various levels within Institutions, to address the quality of provision offered to disabled students. At present, academics have to rely, in the main, upon paper-based diagnostic guides. Whilst useful, these lack the accessibility and immediacy of a web-based option. Such an option would provide immediate feedback, access to appropriate case-study materials, and specific advice to academics seeking to meet the needs of their disabled students. Furthermore, a web-based tool could be updated with fresh material, examples of good practice, evolving case law etc..

In addition to this, the other objectives of this project are to:

- to develop case-study material on the experiences of disabled students, through an extensive student survey
- implement, monitor and evaluate the auditing and diagnostic tool in a range of Higher Education Institutions
- disseminate both work-in-progress and outcomes throughout the higher education (HE) community
- offer the transfer of the auditing and diagnostic tool and implementation strategy across non-engineering disciplines

A comprehensive and up to date account of the progress of the DART project can be found on the project's website at: http://dart.lboro.ac.uk/

THE DART AUDITING AND DIAGNOSTIC TOOL

Most academics do not have sufficient experience of working with disabled students to confidently respond to their needs. This is probably even more so in Engineering where the nature of the activities involved is likely to discourage disabled students from pursuing degree programmes.

There is a growing literature of guidance and advice to academics on how to meet the needs of disabled students, largely driven by the SENDA legislation. Most of this, however, is quite generalised, and there is little specifically targeted at the engineering academic, the LTSN Engineering guide, 'Working with Students with Disabilities' [4] being a notable exception.

Most guides lack the sophistication to enable academics to both audit their current provision and to diagnose specific action to enhance the learning experience and academic progress of their disabled students. Moreover, the available guides are not necessarily readily accessible, being in paper rather than electronic (web-based) format.

This gap in accessible support for academics in Engineering is one that we seek to remedy. The web-based auditing and diagnostic tool will enable academics in Engineering to audit their current provision, identify effective practice for a given context, and record action undertaken to meet the needs of their disabled students. Furthermore, the tool will offer academics advice based on the real-life experiences of disabled students within engineering.

The DART auditing and diagnostic tool enables users to access advice through a searchable data-base.

The DART tool has been developed using PERL and a MySQL database. All pages generated are validated as XHTML 1.0 Transitional, and has been developed with the consideration of all users, by checking their compliance with the WAI Content Accessibility Guidelines 1999/05/05 [5]. All pages are compliant at support level Triple-A [6].

Table 1 illustrates the basic design framework for the searchable database. The user on accessing the tool and entering the searchable database is offered three main search options: 'Barriers', 'Context', and 'Disability'. Each search option contains a range of criteria. The user may choose a criteria from either one or two of the search options on offer.

If the user opts for a criteria from one search option, he/she is offered:

- some general advice based on the criteria selected
- links to related Case Studies

- links to related sites of interest on the web
- the remaining search options' criteria to allow him/her to refine the search further

Tables II and III demonstrate these interactions.

DART: Design Framework / Matrix: Searchable Data-Base		
Search Options: Maximum 2 from 3	**Stage 1 Interaction** (Based on the use of 1 search option)	**Stage 2 Interaction** (Based on the use of 2 search options)
BARRIERS: 'Social' Criteria (e.g. inaccessible teaching materials, inappropriate teaching methods etc.)	General Advice + relevant web links + related Case Studies + remaining search options	Specific Advice + relevant web links + related Case Studies
CONTEXT: 'Educational' Criteria (e.g. lectures, group work, laboratory work, assessment etc.)	General Advice + relevant web links + related Case Studies + remaining search options	Specific Advice + relevant web links + related Case Studies
DISABILITY: 'Medical' Criteria (e.g. hearing impaired, dyslexia etc.)	General Advice + relevant web links + related Case Studies + remaining search options	Specific Advice + relevant web links + related Case Studies

TABLE I
DART AUDITING AND DIAGNOSTIC TOOL: DESIGN FRAMEWORK / MATRIX

Interaction 1 - Search Option
To enter the DART data-base you can: * Select ONE criteria from ONE of the search options offered below e.g. you may choose 'hearing-impaired' from the DISABILITY option This will provide you with general advice (relating to your choice of criteria), access to related web-sites and Case Studies, and the option to refine your search further. * Select ONE criteria from TWO of the search options offered below e.g. you may choose 'hearing-impaired' from the DISABILITY option **and** 'lectures' from the CONTEXT option This will provide you with specific advice (relating to your choice of criteria), and access to related web-sites and Case Studies. Three selectable options (with a range of criteria per search option): BARRIERS CONTEXT DISABILITY

TABLE II
DART AUDITING AND DIAGNOSTIC TOOL: INTERACTION 1 - SEARCH OPTION

Interaction 2 – Response to Search
For general advice on XYZ (option / criteria selected) please use the following link: Web-link to 'General' advice on XYZ For information on XYZ from other sources, please use the following links: Web-link to related website A Web-link to related website B Web-link to related website C etc. To view Student Case Studies relating to XYZ, please use the following links: Web-link to related Case Study 1 Web-link to related Case Study 2 Web-link to related Case Study 3 etc. To refine your search further choose ONE criteria from ONE of the following options: Remaining 2 option buttons presented vertically (with a drop down menu of a range of criteria per search option): (2 from) BARRIERS CONTEXT DISABILITY

TABLE III
DART AUDITING AND DIAGNOSTIC TOOL: INTERACTION 2 – RESPONSE TO SEARCH

If the user opts for criteria from two search options, he/she is offered:
- specific advice based on the criteria selected
- links to related Case Studies
- links to related sites of interest on the Web

THE STUDENT SURVEY

The survey of disabled students – undertaken as part of the DART project - is designed to develop up to thirty detailed student case studies (or case histories) for inclusion within the auditing and diagnostic tool, and to identify sound 'good practice' guidance based on students' experiences. The initial results arising from this survey offer a significant insight into these experiences and highlight critical advice on how academics could respond more effectively to the needs of disabled students in Engineering.

Survey Methodology

The survey seeks to build a holistic picture of each student's experience by interviewing not only the student in question but others who have experience of working with the student. In such a way, corroborative evidence is established, and a range of perspectives informs each individual case study. The use of ethnographic survey techniques, such as student observation and work shadowing provides further perspectives to help establish a multi-layered picture of each student's experience. The focus of these case studies is very much trained upon the experience of students in terms of learning and teaching situations. In such a way the case studies should provide academics with specific advice on what practices and processes students find accessible and what specifically they may find difficult or inaccessible.

The methodology used includes:
- A detailed interview with each student, typically lasting at least one hour
- Interviews with significant others, such as personal tutors, programme leaders, academic helpers, involved in the learning and teaching experience of that student

- Where appropriate, and agreed with the student in advance, observation or work shadowing of the student in a given learning environment

A strict protocol is followed in the process of surveying students. Once a student has been identified and has agreed to be interviewed, an initial meeting is set up to discuss the parameters of the survey. The full process is explained to the student, and he/she can opt out of any survey activity that he/she does not wish to be involved in. Moreover, the student is engaged throughout the process with the completed case study finalised only when the student is fully happy with the content.

At the time of writing, five Case Studies have been finalised and published on the project website (http://dart.lboro.ac.uk/case.html), with a further fifteen under development. The published Case Studies reveal a rich mix of experiences. The insight from even such a small sample is of particular value to the academic community at large.

Survey Outcomes

The students in the published Case Studies are all following undergraduate or post-graduate degree programmes in either Engineering or Science at a campus-based university in the UK. All five students are male and all were in their final year of study, at the time when the survey was conducted. A summary of the outcomes from each student survey are as follows:

Student 1 (John)

John is a post-graduate student in the final year of his PhD research within Engineering. He had previously successfully completed his undergraduate degree at the same University.

John has cerebral palsy, and receives support from an academic helper, who acts as a note-taker and scribe in examinations, and assists the student's mobility around campus.

John's cerebral palsy affects the co-ordination of his limbs, causing involuntary shaking. The physical effects of this on the student is that it requires considerable time, effort and energy for him to complete all physical tasks, including walking, reading and writing / typing.

Given the costs in time and energy to complete even the most basic of tasks, John has had to very carefully plan and organise all of his academic activity to enable him to produce coursework within the given deadline, revise adequately for examinations, and complete research activity, as required for his PhD studies.

John has experienced difficulty within a number of learning and teaching situations. The provision of a note-taker helped in making lectures accessible, but the provision of paper-based (as opposed to electronic-based) notes was not particularly helpful. John required assistance to take part in laboratory work. The student would have to explain to his helper the process of using machinery that he could not himself physically operate. In the Library, accessing reference material from books and journals is also difficult and time consuming. Examinations required a great deal of prior preparation, and even the extra time provided was barely adequate where answers dictated to a scribe would have to be checked and often double-checked.

The impact of all this on John's learning experience and academic progress has been considerable. His current PhD supervisor, who has taught him throughout his time at university, feels that his examination results have probably not reflected his true academic capabilities, and that the same might well apply to him in regard of drafting, revising and writing up his final thesis, with the effect that his final submission will not fully do him justice.

It is recognised by all concerned that John's success owes much to his motivation, attitude, determination, and ability to think ahead, plan, and organise his activities.

Student 2 (Oliver)

Oliver is a final year Engineering student who is registered blind and has no sight. He is a Braille user, and also has specially adapted 'screen-reader' software (JAWS for Windows) that enables him to use a personal computer. He has the assistance of an academic helper, who acts as note-taker and scribe, and assists with his mobility around the campus.

Oliver experienced considerable difficulties during transition into Higher Education. Having embarked on a degree course in Mathematics at another university, he had to abandon his studies. Oliver was subsequently offered the opportunity of enrolling on an engineering degree course at his current university.

Oliver experiences a number of difficulties in accessing the curriculum. Whilst notes are provided in electronic format and he has the assistance of a note-taker, notes have to be translated into Braille. Notes involving graphical representation, tables and mathematical equations are difficult to translate into Braille. Accessing on-line and paper-based reference material involving graphs etc. pose similar problems. Laboratory work has also proved exceptionally difficult. Activities that include experiments involving graphical interfaces and visual interpretation of data arising are almost totally inaccessible. Consequently, Oliver has on occasions been offered alternative coursework to enable him to complete specific modules. Examinations involve the production of exam papers in Braille, and tutors have occasionally had to exercise flexibility regarding coursework deadlines.

Oliver's disability has clearly had a considerable impact upon his learning experience and academic progress. The opportunity to make instant recognition of facts – especially diagrams - by visual confirmation is not open to him. Consequently many processes take considerable time to complete. Furthermore, observation of Oliver during a group-work activity revealed that he is unable to react or respond to other students' use of non-verbal means of communication. Oliver's academic helper feels that successful support for such a student depends to a large extent upon the level of communication between the helper, the student, and the academic tutors concerned.

Student 3 (Paul)

Paul is a final year Science student who is 'dyslexic'. He has a note-taker for lectures, and has specially adapted software on his personal computer.

Paul's dyslexia affects the way that his brain processes information presented in written / textual format (letters, words, language). He currently has a reading age of 13. Paul's ability to present written information is also affected, and causes short-term memory loss.

When reading Paul finds it difficult to digest pages of continuous text. By comparison, information presented in 'flow charts' or 'spider diagrams' are easy to digest. Paul often finds that while reading letters blur while it is easy to miss lines of text. When writing he spells words phonetically. This has considerable impact on the presentation of his work. Particular problems occur with words which have silent letters (e.g. b<u>u</u>ild). Paul has designed a system for himself to eliminate errors. He has to tailor his strategies to meet different situations. Paul estimates that the use of his strategies means that it will take him three times as long as other students to produce a written report.

Problems with short-term memory has considerable impact upon preparation for exams. Paul has to put in lots of work into revision, using a strategy involving the use of cards to summarize essential facts, the use of different coloured texts to differentiate headings, sub-headings, text, notes, and the use of flow charts to describe processes. In short, he needs to have essential information in the simplest, shortest form if he is to retain the information for exam purposes. Despite this sophisticated strategy Paul feels that he is "not even close" to having a truly effective strategy. Once more the added time involved in this creates real difficulties.

The difficulties encountered by this student impacts upon a number of learning and teaching contexts. Lectures, especially if they are not highly structured, are difficult to follow. Following instructions for laboratory work and writing-up results is difficult, while examinations are particularly problematic.

Paul is fully aware that his dyslexia has created considerable difficulty for him in terms of his educational experience, and has had a profound effect upon his academic progress. He is convinced that the difficulties he has encountered in examinations has meant that his results do not truly reflect his understanding of the subject. By contrast, Paul's work placement year in a research and development environment was very successful as he was able to organise his own work, and deadlines were much more flexible.

Student 4 (Mike)

Mike is a final year Engineering student. He has been classified as 'severely deaf' since birth. Mike uses hearing aids in both ears, and lip reads. He also has the use of a note-taker during lectures.

Mike has experienced difficulties within a number of learning and teaching situations. Lectures pose a number of difficulties. Background noises, tutors with unfamiliar accents, low lighting (e.g. when OHPs are used), the use of video material, and unstructured class discussions can all be problematic. Whilst the use of a note-taker helps this does not resolve all the issues that he faces. Laboratory classes can be difficult as the building accommodating the labs tends to echo, and informal instructions are delivered in verbal format. Site visits can be difficult due to background noise (especially traffic), and wind affecting the performance of his hearing aids. Mike has also experienced difficulty in using the phone, something that he was exposed to during summer work experience.

These difficulties have impacted upon Mike's learning experience and academic progress. Extra reading is required to ensure that all material delivered in lectures has been captured, whilst participation in class discussions has been difficult. Nevertheless, his tutors comment most favourably upon his mature attitude. They recognise that while there may initially have been a certain lack of confidence, that he has developed coping strategies that have effectively enabled him to 'overcome' his disability. In this respect they draw attention to the fact that Mike was confident enough to engage in a year long work placement in Botswana, where his responsibilities included managing a group of construction workers.

Student 5 (Oliver)

Oliver is a final year of Science student. Oliver was assessed as having 'hearing loss' in his early teens. His hearing impairment involves difficulty in hearing in the middle range of sound frequencies. He also suffers from 'tinnitus', a constant ringing in the ears. Oliver uses hearing aids and uses lip reading to some extent.

As a result of his hearing-impairment, Oliver experienced a difficult transition into Higher Education. At school he had been accustomed to small classes in relatively small classrooms. At university, he was in an environment involving large classes being taught in large cavernous lecture theatres. The acoustic features of these lecture theatres posed an unanticipated difficulty for him. Initially he found little appreciation of the difficulties he was facing. Eventually Oliver was able to transfer courses, and became a student within a department where small class sizes and smaller lecture theatres were the norm. A note-taker was also provided at this stage.

Oliver experiences similar problems to Mike in respect of lectures, laboratory work, site visits, verbal communication within large groups, and the use of telephones.

KEY ISSUES FOR AN ACCESSIBLE CURRICULUM

The experiences of the five students detailed above offers considerable insight into the key issues for an accessible curriculum in Engineering.

The areas of most concern reflect the nature of learning and teaching activity within Engineering. Laboratory work, producing and interpreting graphical material, using specialist computer software, site visits and fieldwork are all activities fundamental to engineering education. At the same time, these activities do on the face of it pose specific difficulties as far as disabled students are concerned. Indeed the experiences of the five students detailed in this paper confirm that these activities are critical as far as disabled students are concerned.

RESPONDING TO THE NEEDS OF DISABLED STUDENTS

On the basis of the evidence provided in this paper and the interviews we have conducted with students and staff, how can Engineering academics more readily respond to the needs of disabled students?

Key Factors:

Communication

In conducting our interviews with the students detailed above the most striking feature was the willingness of the students to detail their experiences. It appeared that for some of these students the interview provided a wonderful opportunity for discussing issues of real importance for them. It was a chance to 'get things off their chest'. Most had not had the opportunity to talk at such length, or depth, and with as much frankness before with any of the academics within their department. Given the enlightening advice that these students could offer on the basis of their experiences, it is clear that academics who wish to address the needs of their disabled students need to engage in meaningful communication with such students. Additionally, given the overwhelming commitment in time and effort shown by the students we interviewed, some recognition and praise from their tutors could be highly motivating.

Communication between tutor and student is clearly very important in the early stages of the student's university career. The problems encountered by two of the students surveyed during transition into higher education emphasises that this is a critical period for any disabled student.

Good Practice Procedure

The student interviews offer a number of good practice procedures that staff can readily adopt. These range from awareness issues (e.g. that shadows cast by artificial lighting, for instance from OHPs, can make lip reading difficult) to procedural issues (e.g. provision of written as well as verbal instructions for lab based activities) to presentational issues (e.g. presenting notes in a highly structured, bullet-pointed fashion to assist dyslexic students). We found that many of these practices and procedures are not detailed in general literature on responding to the needs of disabled students. Furthermore, the good practice identified by our students appears to reflect effective practice for all students. So, such activity as providing accessible material, making arrangements to cater for specific needs, and offering flexible means of achieving learning outcomes can be of benefit for all students, whether disabled or not.

Anticipatory Action

Some 'disabilities' such as visual-impairment and mobility restriction may be obvious. Others, such as hearing-impairment and dyslexia are less so. In any sizeable group of students, there are likely to be some students with such disabilities who have not made these disabilities known. It is advisable, therefore, that academics assume that they may be responsible for teaching such students. Moreover, they need to take anticipatory action to ensure that such students are provided with an accessible curriculum and an equivalent learning experience to their peers. Such action might have benefited Student 5 (Oliver) during transition to higher education.

Sharing Information

Academics often work in a teaching culture that isolates them from their fellow academics. It is clear that in providing positive learning experiences for disabled students that academic communities need to build up systems of good practice and a pool of effective strategies. Just as communication between academic and student is critical so is communication between academic and academic. Only by sharing information, knowledge, and practice can the academic community rise to the challenge.

CONCLUSION

Most academics do not have sufficient experience of working with disabled students to confidently respond to their needs. This is probably even more so in Engineering where the nature of the activities involved is likely to discourage disabled students from pursuing degree programmes within Engineering.

With new legislation (e.g. SENDA in the UK) impacting on the higher education sector, there is a growing literature of guidance and advice to academics on how to meet the needs of disabled students. However, most guides lack the sophistication to enable academics to both audit their current provision and to diagnose specific action to enhance the learning experience and academic progress of their disabled students. Furthermore, the available guides are not necessarily readily accessible, being in paper rather than electronic (web-based) format.

This gap in accessible support for academics in Engineering is one that the DART project seeks to address. The web-based DART auditing and diagnostic tool should enable academics in Engineering to audit their current provision, identify effective practice for a given context, and record action undertaken to meet the needs of their disabled students. Furthermore, the tool will offer academics advice based on the real-life experiences of disabled students within engineering. The use of the web-based medium enables both access to relevant links elsewhere on the Internet, and the ability to refresh content as and when required. By providing a tool that can provide immediate and relevant information based on the real life experiences of students, we believe that significant progress can be made to improve the accessibility of engineering courses for disabled students.

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