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ABSTRACT

A 2-year project examined ways of improving the skills base of British industry by making higher education at the Universities of Durham and Leeds accessible to the technician work force. Data were collected from the following sources: records regarding the numbers of mature students admitted in recent intakes; interviews with admissions officers in 22 departments/schools of both universities and 3 administrators regarding their attitudes toward mature students; and 402 questionnaires designed to ascertain the educational achievements and aspirations of technicians employed on Teesside and in Leeds. The data were analyzed and used in devising a two-tier modular mathematics course tailored to the needs/competencies of the local technician work force and a multidisciplinary science access source that was successfully pilot tested on Teesside and in Leeds (England). Quality standards were set by referring to exemplars of existing good practice and through extensive consultations with practitioners in training, further education, and higher education. Quality control was effected by course coordination, tutor and student feedback, and external evaluation with respect to rigorous educational standards. The project was found to be a very valuable experience for student and staff participants alike. (Appended are lists of project steering committee members/staff. Contains 16 references.) (MN)

The best of both worlds

Linking learning in science-based industry and higher education

The Best of Both Worlds: Linking Learning in Science Based Industry and Higher Education is the final report of a project entitled 'The Universities of Leeds and Durham Accelerated Access from Science Based Industries into Higher Education Project'. It has been written by John Dodd, in consultation with the Project Steering Committee and project staff. The project was funded by the Department of Employment.

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THE BEST OF BOTH WORLDS

LINKING LEARNING IN SCIENCE-BASED INDUSTRY AND HIGHER EDUCATION

Contents

EXECUTIVE SUMMARY

Introduction

This is a summary of the main issues arising from a project which sought to investigate how to improve the skills-base of industry by opening up Higher Education (HE) to the technician workforce. The project designed and developed an Access course to Science HE, tailored to the needs and abilities of employees, particularly technicians, in science and technology-based industries.

The work was carried out by the Departments of Adult Continuing Education in the Universities of Leeds and Durham. It was funded by the Employment Department and located on Teesside at the Leeds University Adult Education Centre. The active support of British Steel, ICI Chemicals and Polymers, and Tioxide (UK) was central to the success of the Project. A wide variety of other industrial organisations in both Leeds and Teesside co-operated in the investigation, as did the science and engineering faculties of both universities. The project extended over a two-year period from 1990.

Why was it done?

Although there is a continuing increase in the number of students in HE, the proportion following science and engineering degree courses is declining. Statistics suggest this decline is likely to continue in respect of the 18 year-old group. In the long-term, this is a serious threat to the highly-trained scientific manpower-base of British industry, the replenishment rate of which by new graduates is lower than in France, Germany, U.S.A. and Japan.

What was done initially?

The educational achievements and aspirations of technicians were determined by means of a questionnaire. The attitudes of science and engineering admissions tutors towards mature applicants and those having non GCE 'A'-level qualifications were ascertained by extensive discussions in the two universities.

With what result?

- Almost 60% of the technicians expressed an interest in continuing their education but for the majority it would have to be on a part-time basis, mainly because of financial and family reasons, but also because of the fear of losing their present employment. Admissions tutors were willing to accept mature students and those with BTEC or similar qualifications, but pointed out that although such students were qualified to matriculate, they did not necessarily have the specific entry requirements for particular degree courses and they feared they would be at a significant academic disadvantage compared with other students. Although the tutors were aware of Access Courses they were uncertain about their relevance to their own particular degree courses. They expressed, on the basis of previous experience, disquiet about mathematical skills.

- Historically HE has often been unresponsive to the needs and potential of "non-standard" applicants to science and engineering courses. Yet these are frequently drawn from the very parts of the industrial workforce where the skills and knowledge base is most in need of updating.

- In the course of the project it became clear that there was a significant demand from technicians to up-grade their qualifications through degree-level study. It is also clear that the current options available - giving up a job to study full time, or a protracted part-time route to and then through a degree programme - are either not feasible for financial reasons, or unattractive because of the lengthy time commitment. The project sought to smooth and accelerate the route into HE for such students.

- Employers for their part, welcome initiatives which relate their employees' learning more closely to the work-place and reduce the amount of time away from work.

The First Phase: Action and Findings

- The project investigated the educational achievements and aspirations of technicians, a key sector of the industrial workforce.

- Almost 60% of those questioned expressed a wish to continue their education to degree level. Finance, family commitments, and employers' policies meant that most could do so only on a part-time basis.

- Even getting into HE was perceived as presenting practical problems.

- An in-depth survey was carried out to ascertain the admissions policies of science and engineering departments in HE. Admissions staff generally welcomed mature students. But they were uncertain about Access courses, and critical of the mathematical skills of many "non-standard" applicants even where, as in the case of BTEC, they were generally qualified to study science or engineering at degree level.

The Second Phase: Action

- To resolve "the Maths Problem" a two-tier mathematics course was devised, acceptable to all science and engineering courses.

- Building on this a complete multi-disciplinary Science Access course was designed. The course was successfully piloted on Teesside and in Leeds. The first students are now moving on to HE.

The extensive experience of the collaborating institutions in delivering Continuing Education was combined with extensive consultations with admissions tutors, and the advice of the Industrial Partners. Key features of the Access Programme were:

- a modular structure - so no wasteful repetition of students' previous learning.

- tailoring to the needs and competencies of the technician workforce.

Quality standards were set by reference to exemplars of existing good practice and through wide consultation with practitioners in training, further and higher education. Quality control was then effected by course co-ordination, tutor and student feedback, and external examination to rigorous HE standards.

The development of the Access Programme led to the creation of some useful subject based networks. Many of those involved attached a high degree of personal value to this outcome. It offered an opportunity to share expertise, and was an important staff development function.

And The Future? Key Lessons

- The project was designed and implemented by the partner institutions in a highly collaborative manner. This was crucial to its success. Two features are stressed:

    - Collaboration at the strategic level through active participation by senior representatives from industry as well as HE.

    - Collaboration at an operational level by admissions tutors from HE in Access Course curriculum design.

- Significant unrealised potential among the technician workforce for degree-level study. Realising this asset can help meet industry's and the nation's needs for a high skill-level workforce.

- A need for developmental work in the Science Access field which both *involves* HE admissions staff and is *sensitive* to the needs of students and their employers.

- How "the maths problem" can be overcome by an imaginative approach to curriculum development and delivery.

- There is a trade in knowledge between mature students and younger students which can be exploited in the teaching situation.

- And finally

    - Mature students with an industrial background are an asset to their employers, and to higher education.

    - HIGHER EDUCATION IS FLEXIBLE: Effective access programmes, modular course structures, credit transfer, and accreditation of work-based learning can ease the path to a degree and enhance the industrial knowledge base.

PROJECT AIMS

- To increase the entry of mature students into full and part-time HE in science and technology.

- To provide a flexible, modular access programme for such students, especially technicians employed in science-based industries.

- To enhance both individual career prospects and the availability of staff, skilled at professional levels, to science based industry.

The Project aims have been in keeping with the common mission of the Universities of Leeds and Durham and the Employment Department to open up HE to a wider audience. The attention paid to this by the Departments of Adult and Continuing Education is shown by their setting-up of this project, which can be seen as the sequel to the Leeds/Bradford project on *Developing Wider Access to Universities* with which the Leeds Department was also associated.

INTRODUCTION

The project A two-year action research programme by the Departments of Adult Continuing Education in the Universities of Durham and Leeds, funded by the Employment Department, with the active support of Teesside and Leeds Training and Enterprise Councils and the three major employers of technicians on Teesside. A much greater number of industrial and public authority employers on both Teesside and in Leeds have co-operated in various aspects of the work of the project.

Science and engineering admissions tutors from both Universities were involved in the investigation as were various members of administrative and teaching staff, especially from Adult Continuing Education Departments. Helpful discussions were held with staff from the (then) Teesside and Leeds Polytechnics and from local Colleges of Further Education (FE). The patience of 400 technicians in Leeds and on Teesside in completing lengthy questionnaires was invaluable.

What happened?

- The educational achievements and aspirations of technicians were evaluated through substantial questionnaires.
- The attitudes of science and engineering admissions tutors towards mature applicants, and those having 'non-standard' entry qualifications was ascertained.
- Mathematical competency was a particular focus. A two-tier course, acceptable for entry to all science and engineering courses, was established.
- A complete multi-disciplinary Science Access course was developed, the modular structure of which allowed students to avoid repetition of previous learning.

This Report sets the investigation against the background of the changing pattern of HE, especially modularisation of degree courses and the introduction of Credit Accumulation and Transfer Schemes (CATS). It also considers the impact of changes in the content of science degrees, the usefulness of the Assessment of Prior Learning (APL), the introduction of National Vocational Qualifications (NVQ) and their relationship to educational patterns. The financing of Access Courses and of mature students in general are discussed.

THE BACKGROUND TO THE PROJECT

3.1 CHANGING PATTERNS OF HIGHER EDUCATION

Increase in Student Numbers

Higher Education is committed to increased accessibility and this is accompanying dramatic increases in student numbers. Whilst individual institutions are subject to physical and resource constraints, institutional plans indicate firm proposals to achieve this aim.

The University of Leeds is committed to increasing its student population from the present figure of 14200 full-time equivalent students to 20 000 by the year 2000 in accordance with a ten-year expansion programme started in 1989. This plan also commits the University to a major development of part-time degree programmes, which will be facilitated by modularisation of its undergraduate courses in 1993/94.

The University of Durham proposes to increase its student population from 5061 in the 1991/92 session to 7630 by 1995/96, by expansion of existing departments and the establishment of a new residential college and an additional non-residential society. In a separate development, the University has co-operated with the University of Teesside in establishing a Joint College on Teesside, thus giving it a presence in the Cleveland conurbation. Student numbers are projected to grow from 240 in its first year 1992/93 to 1500 by 1995/96.

Both Universities are committed to a policy of widening access, including increasing the proportion of mature students and of those having non-conventional entry qualifications. Departments of Adult Continuing Education, because of their history and mission, are well-placed to contribute towards this process by focusing on groups not historically associated with the undergraduate population and facilitating their entry into the institution. Developments relevant to implementing this policy are reviewed below, with particular reference to science and engineering students.

Access Units

These have been established in many institutions, especially the former polytechnics, and are being developed in others. In Durham there are plans to bring together all aspects of external relations, including Access, and enhanced industrial liaison associated with the establishment of a major Science Park. In Leeds, funding is being provided from 1992/3 for an Access Unit. The Unit will incorporate the Office of Part-Time Education, the Schools Liaison Office, the Foundation Year Office and various welfare and guidance services, thus providing a central information and advice point concerning courses, entry requirements and enrolment procedures.

Access Courses

All over Britain, the number of these has increased at an unprecedented rate during the last decade. Despite their previous history of preliminary or intermediate years, the longer-established universities tend to lag behind the former polytechnics in being associated with the design of such courses and enrolling students who have successfully completed them.

Although there have been difficulties in the definition of an Access Course and there is a wide variety of specific groups for whom they were individually designed, with consequent variations in structure and content, the establishment of regional Access Consortia (or Federations) and a national regulatory body (the Access Courses Recognition Group), following the CNAA/CVCP recommendations of 1989 on validation procedures, has produced a nationally coherent system. Current trends are towards courses designed jointly by HE and FE institutions with the teaching franchised to the latter.

Ultimately, the success of such courses in widening access is dependent upon how they are perceived by admissions tutors. Representation of the universities on consortia committees has helped in this respect, but the refusal of some consortia to award graded passes, and appointments of a single external examiner for a variety of subject areas, has not been helpful in this respect. The establishment of consortia has tended to discourage courses designed for entry to a specific degree at a specific university but there are examples of 4-year degree courses within HE institutions. In 1989/90 the University of Leeds introduced a full-time *Foundation Year* for overseas students wishing to study engineering, utilising a number of first-year courses designed as subsidiary studies for conventional undergraduates, augmented by an English Language programme.

The recent announcement by the Department for Education, that in future home students on four-year courses with a Foundation Year at an FE College will be eligible for mandatory awards, is an important step in widening Access.

A major innovation which could be of very considerable benefit to mature students is the Special Technology and Engineering Preparatory Studies Scheme, (STEPSS), sponsored by the Conference of Engineering Professors for entry to engineering courses. This was introduced on a small-scale in 13 universities in 1988 with a total of 150 students but has since been extended and will be available in Leeds from 1993. By integrating a Foundation Year with the degree programmes, funding has been obtained for a 4-year course. It is intended for demonstrably able students who have progressed academically since the age of 16, either by obtaining the "wrong" 'A'-levels or following other courses. In the former Polytechnics the Employment Department funded HITECC initiative has parallelled the STEPSS approach.

Problems in Science and Engineering Student Recruitment

Despite the continuing growth in overall student members, the proportion wishing to enter science and engineering courses is declining, thus affecting both the funding of such courses and the maintenance of standards: at least one applied science course at Leeds is in danger of closing despite a continuing demand from industry for its graduates. The continuation of this trend with respect to recruitment from schools is confirmed by the 1992 provisional GCE 'A'-level results which show reductions in candidate numbers of 3.9%, 4.9% and 3.5% compared with 1991 in the key areas of chemistry, physics and mathematics. These figures must be regarded as significant with respect to graduate output, despite the increase recently reported in the number of mature students entering higher education, the majority of whom currently enrol for sub-degree level courses.

Many science and engineering undergraduate courses are perceived as being too demanding by potential students and to lead to careers which are not highly regarded by the public at large and do not offer good prospects, either in terms of job satisfaction or financial reward. Whilst these views do not take account of managerial and business opportunities available to scientists and engineers, they are not wholly misplaced. An earnings survey showed that between 1979 and 1987 the

percentage by which scientists' earnings exceeded the average for the non-manual professions declined by 1.8% and those of engineers by 8.4% In the same period, accountants showed an increase of 2.8% whilst other financial services employees showed a 37.5% increase; medical practitioners recorded a 14.2% increase. Other surveys have shown science and engineering graduates often feel under-utilised, indicating a need for more effective management. The scientific and engineering professional institutions are attempting to improve the image of their members but there is obviously scope for some employers to re-evaluate career structures and financial rewards.

Curriculum Changes

There are a number of new initiatives in the design of science and engineering courses which seek to make them more attractive to students and relevant to the needs of industry. The Institute of Physics, the Standing Conference of Physics Professors and the Committee of Heads of Physics in Polytechnics proposed an alternative structure which is being implemented in a number of universities, including Durham. In general, the previous content of the first two years of an honours degree course is being extended into the third year and the more specialised aspects conventionally dealt with in the final year incorporated into a one-year, optional, taught master's degree.

A similar initiative has been proposed by the Conference of Engineering Professors, though an alternative structure of BEng and MEng degrees already exists in some institutions, including some departments in the University of Leeds. In this structure, the courses are common during the first two years and proceed either to a BEng after a further year or require a further two years for the MEng qualification. Another alternative in engineering is a unitary degree dealing with all branches of the subject, the Integrated Engineering Degree Programme: a similar course has existed in the University of Durham for a number of years. Leeds has a more limited version of this, combining mechanical and electronic engineering.

Combined Studies degrees embracing two major disciplines have existed in many institutions for a number of years, more commonly in the former polytechnics, and extend across all faculties. Leeds already has a substantial programme covering some 45 combinations, and development of the system envisages the possibility of some 20% of the student intake registering for those courses. Durham has a popular natural sciences degree which allows for various combinations of disciplines and plans to have a university-wide system of Joint or Combined Studies degrees catering for 1000 students by 1995/96.

All of these developments could result in concentrating the bachelor's degree on the fundamentals of a subject, allowing the specialisations and research-related topics to be dealt with in a taught master's degree which would equate with the longer European degree programmes such as the German "Diplom".

Modularisation

The modularisation of existing undergraduate courses, usually accompanied by the introduction of a two-semester year, is being pursued in many institutions. In some cases a Credit Accumulation and Transfer Scheme is being introduced simultaneously. Modularisation will be effective in Leeds from October 1993. Its implementation is one of the objectives listed in Durham's Corporate Plan to 1995/96. This development will be useful to mature students, particularly if it is used to introduce part-time modes of attendance. (Some part-time degrees already

exist in Leeds, and they are included in the development programme for the Joint University College on Teesside). It could also allow accreditation towards a degree from BTEC courses.

Co-operation with the Open University (already quite popular with technicians) will be facilitated. Leeds has an agreement on mutual accreditation of courses and Durham is planning a system whereby OU students can complete their degrees by attending a full-time final year at Durham.

Also facilitated will be other joint courses such as are operated by Leeds at its Middlesbrough Adult Education Centre, whereby successful completion of a two-year part-time humanities certificate has permitted many candidates to enter the second-year of an appropriate degree programme at the University of Teesside.

Co-operation with Training and Enterprise Councils

Science training and access are high on the national agenda. A primary objective of TECs is to improve the skills base of their areas. HE has an important role to play here, but its full potential remains unrealised. Leeds and Teesside TECs facilitated the work of this project. In conjunction with the Leeds TEC and the former Leeds Polytechnic, funding has been obtained for a major new project aiming to link the modularised provision in both institutions with the specific needs of employers and their employees.

Conclusions

Opportunities for mature persons to enter undergraduate courses in science and engineering are improving through the various type of access courses which are now available. The students are likely to find the structure and content of the courses more amenable.

3.2 THE INDUSTRIAL LANDSCAPE

Industry's Training Needs

The industrial scene is changing as well as the educational one and this seems likely to be a continuing process, although which aspects will become permanent is unpredictable. The recession and the tension between longer term values and short-term needs have created a difficult situation in which to make judgments about training and education. Small and even medium sized firms have always had difficulties in this area but the pooling of their efforts under the patronage of the TECs helps improve their position. Only a short time ago industry suffered from a shortage of graduates and this situation may well recur with the ending of the recession. A recent (1992) report issued by the Engineering Council showed the UK lagged behind its industrial competitors in terms of output of engineering and technology graduates with 206 per million population compared with 362 (USA), 363 (Germany), and 523 (Japan).

Undergraduate support

Many major firms make a contribution to undergraduate support by means of sponsorship, although the numbers involved are relatively small. In some cases, entry is directly into university from school, the firm providing vacation employment. Concentrating attention on local schools can improve relationships with the local community. In other cases, existing employees are sponsored at a suitable stage in their career development. The former method aims to identify "high flyers" and the latter does so in certain cases, but not all.

Attitudes towards mature graduates

Some employees choose to enter HE without sponsorship, accounting for most of the 10% of the undergraduate population who were aged 25 or over on enrolment in 1988. A report issued by the Association of Graduate Careers Advisory Services in 1991 showed the majority of mature graduates were satisfied with the enhancement of their career prospects, although a minority were not. The reason for this could be a failure to realise that educational achievement is not the only criterion for promotion and the qualities sought in graduate recruitment are not the same as at technician level: personal qualities are a major factor.

Release for training/education

Most employers encourage release for short-term training courses but the reduced manning levels combined with the complications of operating a shift system in many major industries have forced re-appraisal of day-release for BTEC courses, formerly widespread, as well as more prolonged concessions. One response to this is to transfer to Open Learning methods. Although these are generally acknowledged to be less efficient than normal classes, the effect of the change can be mitigated by the provision of on-site tutorials.

Financing of studies

Most employers provide financial support for part-time studies. Usually the decisions on which courses to fund are made individually, taking account of both their relevance to the industry and the personal development of the employee. A modified approach, adopted notably by the Ford Motor Company, is to make a fixed annual sum available to each employee for training/education purposes: this

has resulted in increased emphasis on personal development. Discussions with employers suggest the Science Access Programme developed as part of this project would qualify for support.

Support for students on part-time courses is provided in some cases by local TECs. The Inland Revenue allows tax relief on fees for some training courses that lead to NVQ qualifications up and including to level 4. The financial position of students transferring from industry into full-time courses is much more difficult. Whilst it may be possible for younger persons and some married women returners to survive on the present grant/loan scheme without sponsorship, this would not apply to the majority of employees with family responsibilities.

In-house training/education

The provision of on-site training/education programmes is common in many large industrial organisations and links with further and higher education are encouraged. The accreditation of these schemes is seen as important and their consequent incorporation into Credit Accumulation and Transfer Schemes possible.

National Vocational Qualifications

The introduction of NVQs is an important development for industrial training, involving industrial organisations as well as training and educational bodies in establishing competence-based criteria for the award of certificates directly related to functions performed in employment. In the White Paper *Education and Training for the 21st Century* issued in May 1991, general NVQs are proposed which would cover broader occupational areas and would, at Level 3, be comparable to GCE 'A' and 'AS' levels with the potential for credit transfer between the two systems. One of the intentions is to include the option of entering HE, but ensuring the entry levels for specific degree courses are achieved could prove difficult.

Conclusions

There is a general awareness in industry of a potential shortage of science and engineering graduates and a willingness to see employees obtain suitable sub-degree level qualifications. For the vast majority, however, part-time undergraduate courses are the only practicable path to a degree, given the financial constraints on full-time education.

PROJECT ACTIVITIES

4.1 ADMISSIONS TUTORS' ATTITUDES TOWARD MATURE ENTRY

Preamble

The co-operation of admissions tutors in the science, applied science and engineering departments of both universities was essential to the work of the project at various stages. In all 34 tutors were involved (27 from Durham and 7 from Leeds) the distribution reflecting the number of relevant departments in each university. They were consulted by means of individual interviews and questionnaires concerning not only this section of the report but also changes in degree structure and content and in the knowledge and skills of applicants. The tutors were also involved in consultation with their departmental colleagues in the design of the Science Access from Industry Programme and the selection of relevant modules for entry to their degree courses. Because of organisational and personnel changes, the numbers involved in the various phases of the project varied.

Aims

This fundamental part of the investigation was designed to ascertain departments' attitudes towards applications from mature students, especially those having non-GCE 'A'-level qualifications, examine their potential for achieving "advanced standing" and their perceived performance in undergraduate courses. Data were also obtained on the numbers of such students admitted in recent intakes. The overall aim was to determine how the entry of such students could be facilitated.

Scope

Individual consultations were held with admissions tutors in 22 departments or schools of the universities covering 58 single-subject honours degrees as well as various combined studies options. Discussions were also held at Leeds with the Directors of Combined Studies and of the Foundation year in Science and Engineering and with the Mature Matriculation Officer. At Durham the President of St. Cuthbert's Society was also consulted, as most mature students are members of the Society rather than of individual residential colleges. 27 admissions tutors also completed a questionnaire towards the end of the project.

General Attitudes

Comments by supporters of Access Courses and mature student entry have in many cases been inclined to label admissions tutors as obstructive to widening access. At the Universities of Durham and Leeds the evidence shows this to be unjustified. A temptation towards confining entry to those having conventional 'A'-levels exists where departments receive ten or more applicants for each available place, but even these departments are willing to accept other applicants. However, such popular departments are often avoided by mature students, who perceive them as being filled by "high-fliers". Within departments in the two universities the number of mature applicants accepted varied from an average of one per year to 20% of the total intake.

Admissions tutors are sensitive to the risks faced by mature students on re-entering full-time education with respect to job security and domestic circumstances, and are concerned that they should not be at a significant academic

vantage compared with other students. A sense of isolation is often felt by such students who are in a minority, perhaps of one, within a class. Whilst the existence of the Mature Students' Society at Leeds and of St. Cuthbert's Society at Durham can help, there is a problem to be addressed by personal tutors. There is a tendency for mature students to attend on a "nine to five" basis and miss the broadening aspect of the university experience.

Knowledge and Skills Required

Whilst admissions tutors are seeking a basic and up-to-date knowledge of the relevant disciplines pertaining to the proposed undergraduate course and, where appropriate, an adequate experimental skill level, there is also concern that an applicant should demonstrate an ability to undertake a period of sustained study. Of necessity this will probably be shown by previous successful part-time study by mature students.

In terms of actual knowledge, comparison with GCE 'A'-level entrants is possible. All departments specify particular subject requirements and suggest acceptable grades to be achieved at 'A/AS' level. These obviously vary with the department concerned and are in terms of school rather than vocational education subjects, which can make comparison difficult. The factual knowledge required for progression into undergraduate studies could probably be contained in relatively few 'A/AS' level courses but additional depth or a greater number of subjects are specified to ensure a satisfactory general level of educational achievement.

In many cases mature students with a vocational education background have an advantage in experimental work over 'A'-level students, and similarly on those courses, such as engineering, where major first-year studies are in areas not contained in the school curriculum. This frees the mature student to concentrate more on the academic aspects of the course. Several tutors spoke enthusiastically of a trade in knowledge between mature and other students.

The major problem area of competency, however, is that of mathematics which is widely perceived as a barrier to widening Science Access. This is considered in section 4.3. below.

BTEC Qualifications

ONC/D and HNC/D qualifications are accepted as meeting matriculation requirements and in most departments "good" results obtained in the examinations are regarded as a standard method of entry to the first-year of a relevant undergraduate programme. Departments tend to set their own definition of "good" in terms of pass, merit and distinction or to rely on the colleges for guidance on the suitability of individual students. In some cases close relationships have been established with specific FE colleges, extending to co-operation in the design of courses. In a few cases this has resulted in "advanced standing" being awarded to entrants with HND, exempting them from the first year of the degree programme. It was pointed out that because of the integration of HNC/D and degree courses, colleges of higher education and the former polytechnics are in a better position to accredit prior studies towards the award of a degree. Even with modularisation, the sequential nature of science and engineering courses constrains such developments, although the introduction of Credit Accumulation and Transfer Systems may ameliorate the situation. For example, it may be possible to introduce alternative modules into undergraduate courses which would both facilitate entry and extend the possibility of awarding advanced standing for holders of suitable BTEC qualifications.

The problems with mathematics apply with particular emphasis to BTEC courses, which are regarded as applied rather than fundamental.

Access Courses

Exposure to applicants from Access Courses is extremely limited in the science and engineering departments of both universities. Four were identified as having been admitted in 1990, increasing to nine in 1991 but twelve tutors reported an increase in the number of such applicants in 1992. This is in strong contrast to Arts and Social Studies departments at Leeds where a significant and increasing number of students come from Access Courses. This could be a reflection of the greater availability of such courses in non-science disciplines.

Other Qualifications

Four students were accepted in 1991 by virtue of their Open University qualifications. 125 entrants possessed overseas qualifications obtained in Europe, the Far East and Africa.

Advanced Standing

Direct entry into second year was granted to 10 students possessing HND qualifications from a specific technical college, part of a long-standing arrangement. Some other departments indicated a willingness to consider this concession. One other student having a similar qualification was given advanced standing, as was a student transferring from a Midlands Polytechnic. Under arrangements with Hong Kong Polytechnic and a Malaysian consortium, direct entry into second-year studies was arranged with a further 63 students.

Increase in mature student applications

15 admissions tutors reported an increase in the proportion of mature applicants for 1992 with an associated increase in the number of those having non-'A'-level qualifications.

Comparison with other undergraduates

Some admissions tutors felt unable to make comparisons between the performance of mature students and other undergraduates but most found there was no significant difference, three thought they performed better and two worse. (17 tutors considered undergraduate entrants in general to be less well prepared than previously).

Conclusions

Admissions tutors were found to be more flexible with respect to non-standard entrants than is generally supposed. Mature students were welcomed and a variety of qualifications accepted. Advanced Standing was granted in those cases where specific agreement concerning pre-entry courses existed. Access courses were acceptable but variations in course-content makes decisions difficult. An agreed syllabus would be helpful, particularly if the tutors could contribute to its design.

4.2 THE TECHNICIAN SURVEY

Aims

The survey was carried out in late 1990/early 1991 by means of a questionnaire designed to ascertain the educational achievements and aspirations of technicians employed on Teesside and in the Leeds area, and to determine the conditions under which they would continue into higher education on either a full-time or part-time basis. By comparing results in the two regions some measure of their validity nationally could be obtained: Teesside has a relatively small number of employers with a large technician work force, whereas Leeds has a large number of organisations each employing relatively small numbers in this category.

Scope

The industrial partners, Teesside and Leeds TECs and the personnel departments of individual companies and public education and health authorities, together with the Leeds branch of the Amalgamated Engineering Union, all participated in disseminating the questionnaire. A total of 35 organisations returned these out of approximately 72 approached. A simple definition of a technician as "a scientific or technical member of staff who does not have graduate or equivalent qualifications" served to identify the relevant personnel in the participating organisations. Because of the differing methods of distribution used in circulating the questionnaire, it is not possible to say what proportion of the technician population is represented by the returns: such data as is available suggest a figure of 20%. There is possibly a bias towards those interested in continuing education, as individuals in this category may have been more inclined to complete the questionnaire.

402 questionnaires were returned, 172 from Teesside and 230 from Leeds. 24 of these were eliminated in that they were from existing graduates.

Nature of Technician Work Force

Predictably, the proportion of women technicians (22%) is relatively low. There is no significant difference between Teesside and Leeds in this respect. The average age (32) is higher in Leeds (35) than on Teesside (29), as is the average number of years in their present employment (11 in Leeds, 7 on Teesside).

Existing Qualifications

The following percentages indicate the Teesside technicians are more highly qualified than those in Leeds, a possible reflection of their being both younger and employed by larger companies. Numbers studying for the relevant qualification are also included.

	Leeds	*Teesside*	*Overall*
BTEC HNC/D	48	60	53
BTEC ONC/D or 'A' Level	22	28	25
City and Guilds or similar	22	7	15

A further distinction between the two areas is apparent when the numbers studying for HNC at the time of the questionnaire are isolated - one fifth of the total on Teesside, one twentieth in Leeds.

Hopes and Aspirations

A statement concerning the project and an explanation of the opportunities, both current and potential, available within HE were issued with the questionnaire. A surprisingly high number commented in their response that until they had read the statement they had not realised they were already qualified to enter HE. At the time the distinctions between polytechnics and universities were still apparent and a preference for the former existed. Of those interested in continuing education, 32% expressed a preference for polytechnics compared with 18% for universities, the remainder being indifferent. This, in part, could be accounted for in terms of geographical location, but an assumption that "universities are not for us" was discernible in the replies.

Four of those completing the questionnaire intended to proceed immediately into full-time undergraduate courses closely linked to their BTEC qualifications, having obtained good results in these and been awarded bursaries by their employers. 24 were following Open University courses, mostly beyond foundation level.

Overall, 59% of those replying were interested in continuing education, comprising 52% of the Leeds cohort and 69% of those on Teesside. Three-fifths of these already had, or expected to achieve within two years, BTEC HNC/D qualifications, with a further fifth in a similar position with respect to BTEC ONC or GCE 'A'-levels.

Most wished to continue along the lines of their previous or current studies, which were overwhelmingly job-related, but a few wished to change direction, e.g. into mathematics, law or economics. Although this means the favoured undergraduate courses are in science, engineering or computing, 80% wished to include management or economics topics as part of their studies.

Modes of Study

Relatively few technicians interested in HE were willing to commit themselves to full time study (14% overall, 20% on Teesside, 8% in Leeds) and of these only half would do so without sponsorship from their employers. However a further 38% would consider doing so, mainly on condition that they could continue to live at home and they obtained financial security commensurate with their domestic commitments.

Perceived Attitude of Employers

The questionnaire did not attempt to ascertain employers' attitudes toward continuing education but in a few cases, noticeably where the questionnaires were being returned directly, respondents volunteered some comment. The most adverse reactions were reserved for HE institutions which were accused of being deliberately unhelpful in their technicians' attempts to enhance their qualifications.

Conclusion

There is a significant number of technicians in both Leeds and on Teesside who are interested in achieving graduate status, mainly by part-time attendance.

4.3 THE MATHS PROBLEM

Mathematics is widely perceived as a barrier to widening Science Access

- By potential students who see it as being particularly "difficult".
- By HE admissions tutors faced by applicants with apparently low levels of mathematical competence.

The project was concerned to identify precisely why maths is seen by staff and students alike as a major barrier to widening access, and to make recommendations as to how this could be overcome.

Nature of the Subject

Maths has long been identified by students as being different from other subjects. Attempts have been made to disprove this but it remains a firmly-neld view. Whether or not it is correct is irrelevant. What has to be disproved is that it is more difficult to learn to apply maths to studies in science and engineering. What is required is the acquisition of relevant skills at the appropriate level. Regarded in this way, some skills become self-evident. First, as with many skills, there is an intrinsic level which the individual can achieve, few having the capacity to attain the status of, say, a concert pianist, but many being able to achieve an acceptable competence. Secondly, the skill can only be acquired by practice which increases confidence. Finally, without use the skill will be lost.

Methods

Discussions were held with mathematics tutors, specialists in maths education, potential and actual students within the two universities, with local FE colleges and through attendance at national conferences. Pilot short courses at two identified levels were provided for staff from the industrial partners on Teesside. These were used in establishing content and methods of presentation of a series of mathematical modules, which were incorporated into the Science Access from Industry Programme (Section 4.4). Admissions tutors in science, applied science and engineering departments were consulted as to the suitability of these modules for their undergraduate programmes.

The Mature Student

Sixth-formers studying maths at 'A'-level immediately before entry to HE are not subject to the difficulties experienced by many mature students. Their skills can be built up over two years and there is no interval in which they can be lost. Mature students are in a different category: even those with 'A'-levels have probably obtained them some time ago.

The major problem identified by university tutors was with those applicants having BTEC qualifications. Concern was expressed that the content of mathematics courses, at both ONC and HNC levels, did not cover the range of skills required for undergraduate studies. Whilst students were able to deal with specific problems related to their main subject areas, they lacked the ability to identify the mathematical technique required when faced with a novel problem. As a result, admissions tutors tended to seek marks of 75%+ as an indication of potential. This

can result in the loss of otherwise suitable students, and even then many who were admitted tend to struggle and need to devote a disproportionate amount of their first year to the maths content of their course, thus detracting from their overall performance. In the case of engineering students the problem was mitigated by their greater knowledge of the more applied subjects in the first year programme. Some departments arranged additional classes to help with the maths whilst other spread the first-year content over two years. The latter could lead to difficulties with university regulations concerning re-sit examinations, however.

How Much Maths is Required?

Some tutors expressed the view that an unrealistic level of mathematics was included in their own courses because of the requirements of the professional institutions that the subject be studied for two years. When this was raised with a member of staff of the Council of Engineering Institutions, it was claimed that the relevant education sub-committees were, in general, controlled by the academic representatives. It would seem, therefore, that this problem is resolvable within the institutions themselves. Its resolution could make more realistic the required standard of entry.

Continuing discussion with departments identified the maximum level of mathematics required under present circumstances as a GCE 'A'-level course in which pure maths is a major component or an A/AS level devoted to pure maths. It was emphasised that whilst all first-year undergraduate courses in the subject contain some element of revision, it tends to be nominal and they proceed quickly into new work. For many undergraduate courses, a lower level of achievement at about GCE 'O'-level was considered adequate, but doubts were expressed about the adequacy of the GCSE level. Some tutors deprecated the multiplicity of 'A'-level courses with their varying content, although a common core has now been agreed by the various 'A'-level examining boards, referred to below.

Designing Suitable Courses

A consultancy was funded to design suitable maths Access Courses, acceptable as a basis for entry to science and engineering courses at both universities. An experienced member of staff of the Department of Pure Mathematics in the University of Leeds who had relevant experience in first year undergraduate teaching, and with mature students, undertook this. His enthusiasm to do so was based on the belief that there was a maths problem for mature students in science and engineering: although validated Access courses met the general requirements for matriculation, including literacy and numeracy, they did not necessarily meet specific course entry requirements.

Pilot courses were designed at the two levels previously identified and were delivered as "revision courses", each of 30 hours duration, to students wishing to enter HE from the industrial partners on Teesside. The size of the classes was limited to 6-8 students so as to maximise the amount of interaction between the consultant, tutors and class members. The consultant acted as co-ordinator for the courses and detailed content was decided on a weekly basis depending upon diagnostic questionnaires and the marking of regularly submitted course-work. Students could communicate directly with the co-ordinator, allowing their views to be incorporated and weekly discussions were held between the co-ordinator and the tutors. The co-ordinator generally suggested directions for each tutorial but only after discussion - the role of the tutor being paramount in most respects. Thus the teaching syllabus and pedagogy were developed by co-operation.

Because a 3-hour class-contact time was involved for such meetings, class activity was varied to include individual/group work, set-work review periods and a break, as well as an exposition of an element of the course. Students were expected to devote an equivalent amount of their own time to the work of the course and this was used for course-work, filling gaps in their previous knowledge and extra revision where needed.

The course-work was considered essential for student progress and the building of confidence. It was conscientiously done and although a qualification could not be awarded, the final examinations were taken seriously by the students who achieved good results, thus further increasing their confidence. All students expressed enthusiasm for the course and its tutors, found the examination to have been helpful and almost all commented that it had raised their confidence in coping with mathematical concepts.

After further discussion with the departments, higher and lower level maths courses were designed, using the experience of the pilot schemes. Each was broken down into 30-hour modules, two for the lower level and three for the higher one. (The two courses could be followed sequentially but this would require two years' study). Admissions tutors were then asked to designate which course, and which modules within it, were required as entry for their undergraduate programme. Predictably, the higher level course was designated as being appropriate to the physical science and engineering degrees, although not all required all three modules; the lower level course was deemed adequate for life, earth and materials sciences as well as for some of the applied sciences, such as those in biotechnology and food science.

Factors Underlying the Design of the Modules

The foregoing discussion has centred upon the content and delivery of the maths courses, based on the knowledge perceived to be necessary for entry into the relevant courses. (For the higher level course, this is in accord with the "Common Core for Mathematics" published by the Working Party reporting to the GCE 'A'-level Examinations Boards which was set up to consider the dissatisfaction in higher education concerning the diversity of knowledge possessed by potential undergraduates). In addition to ensuring the students acquired the requisite mathematical knowledge and skills, they should also

- be excited about doing mathematics
- be consciously involved in the learning process, eg to know learning maths involves the acquisition of concepts, facts and skills and that these are learned in different ways
- be able to think mathematically
- be able to think independently, thus improving their chances of being able to solve unseen problems
- be confident of their abilities so that they are not afraid of maths.

4.4 THE SCIENCE ACCESS FROM INDUSTRY PROGRAMME

Preamble

Despite the increase in the number of Access Courses, including those in science, both nationally and in the two regions concerned, it was considered that these did not meet the needs of the persons identified in the Technician Survey as wishing to enter HE from the science-based industries and who wished to qualify in the shortest possible time, without repetition of their previous learning. It was important that they should follow a course which met the specific entry requirements for individual undergraduate programmes in science and engineering offered by the two universities.

Aims

The project team sought to devise a flexible one-year access programme which would enable students to qualify for entry into any science or engineering degree course without further delay and with the minimum of repetition of previous learning. The course would enable students to acquire the necessary knowledge and skills and would demand a sustained period of study of the type associated with HE. During the course the students would become familiar with the teaching and assessment methods used in undergraduate courses. By appropriate counselling before, during and after the course, the student would be made aware of the opportunities available in HE and how they could be used.

Method

The experience gained in designing the mathematics courses described in Section 4.3 was used in devising the full Access Programme. Indicative syllabuses of about A or AS standard were drawn-up in conjunction with the relevant departments in both universities. Admissions tutors were then asked to classify the modules as "essential" or "desirable" for their specific courses and to confirm that they would consider applicants completing the appropriate modules for admission to their courses alongside candidates having conventional GCE 'A'-levels. Almost all tutors did so.

Programme Structure

Four subject disciplines were identified as necessary to obtain entry to all science and engineering courses - mathematics, physics, chemistry and biology. Consideration had been given to including vocational studies but staff felt these were more usefully taught by integration into the undergraduate course. As with mathematics, the subjects were broken down into modules requiring 30-hours class contact, consisting of either 10 x 3 hour or 15 x 2 hour teaching sessions, with an equivalent amount of private-study time. Additional time was provided for "laboratory days" in the form of 4-hour sessions per module and a study-skills days arranged for all students. Unlike the mathematics, differing levels of modules were not considered necessary. In view of the wide availability of short computing courses in both FE and HE institutions, these were not included in the programme. In fact, many admissions tutors considered this subject to be adequately covered in their undergraduate courses.

The arrangement of modules is shown in the diagram on page 23. It will be seen that although there are three modules in both chemistry and physics, one of these is common. There are only two modules in biology, but at least some of the chemistry modules are considered essential for study in the life sciences.

Course Organisation

The minutiae of the organisation and administration of the Science Access from Industry Programme are given in the Validation Document submitted to the Tees-Wear Access Federation, which received unconditional approval. Only aspects of particular relevance to the development of the course are recounted here.

Subject co-ordinators were appointed because of the necessity of providing the teaching programme in both Leeds and on Teesside, and because of the success of having such a person for the Pilot Mathematics Scheme. The maths lecturer was therefore joined by another University of Leeds staff member from the Department of Biochemistry and Molecular Biology, who accepted responsibility for the Biology component. Suitably qualified and experienced persons were appointed to co-ordinate physics and chemistry, from Durham and Leeds respectively. Their role followed the pattern established in mathematics, with responsibility for guiding the tutors on the weekly content of the course, and setting and marking of assessed course-work and the final examinations. These appointments were made for the initial year of the course only.

Course leaders were appointed for Leeds and Teesside, one being a member of staff of the Department of Adult Continuing Education at Leeds, on partial secondment to the Project, the other being the Project Manager.

Publicity and Recruitment

Publicity was directed towards persons already, or previously, employed in a scientific or technical capacity by the science-based industries, hospitals and educational institutions at technician level. This included those not currently in employment, especially "women returners". Of 42 of interviewed, six had been contacted directly following their participation in the technician survey, and a further sixteen through their employers, including the industrial partners. Nine had seen news items following a local press release and the remaining eleven were contacted through general publicity sent to libraries, job-centres and training shops.

Detailed information concerning the Programme was given to those making initial enquiries with the result that approximately half decided the course was unsuitable. The remainder were interviewed by the course leaders on the basis of admitting those demonstrating an ability to profit from the course and showing a high degree of motivation. Most were offered places but approximately 20% withdrew on realising the effect of the commitment on their domestic arrangements, problems associated with shift-working and a lack of support by their immediate managers.

Enrolments and Retention

Twenty-one students enrolled on the programme on Teesside, and 27 in Leeds. After 20 weeks, numbers settled at 12 and 17 respectively. One of the Teesside students had used his attendance to prepare for an OU course and withdrew. Allowing for this, the retention rates were 62% and 63% respectively. By the end of the 30-week course the Teesside number remained at 12 but that for Leeds had fallen to 15, reducing the retention rate to 57%. This compares with a reported figure of less than 50% for the OU Science Foundation Course. Approximately half of the withdrawals were explained in terms of increased pressure on time, either at work.

PROGRAMME STRUCTURE

Biology	Chemistry	Physics	Mathematics A	Mathematics B
B1 - Cell Structure & Biochemistry Heredity and Evolution	PC1 - Matter and Energy		M1A - Mathematical Foundations	M1B - Foundations and Basic Techniques
B2 - Interdependence of Organisms and Functioning of Flowering Plants and Mammals	C1 - Structure & Reaction	P1 - Waves, Vibrations & Fields	M2A - Development and Applications	M2B - Calculus and Related Topics
	C2 - Organic Compounds	P2 - Current Electricity Electromagnetic Induction and Electronics		M3B - Techniques and Applications

Mathematics A and B are alternatives, to be taken according to the mathematical skills needed for entry to specific undergraduate studies.

Each module contains 30 hours of class contact including lecture/tutorial, workshop and/or laboratory sessions at the discretion of the tutor and 30 hours of directed private study. The Biology and Mathematics A modules are presented as 15 x 2 hour sessions and the remaining modules as 10 x 3 hour sessions. The science modules also include a "laboratory-day". The teaching sequence is as shown, knowledge of PC1 being a pre-requisite for subsequent Chemistry and Physics modules.

Normally a students will be required to study two or three subject areas for entry to their subsequent HE course but may be exempted from specific modules according to their previous knowledge. Such studies involve attending classes on two-three evenings per week over a 30-week session.

(particularly related to variable shift systems) or at home, or in terms of personal or family illness. One found the time spent travelling excessive, three explanations blamed the demanding level of the classes and it would seem that unexplained withdrawals were because of this. In addition at least three students reduced the number of modules studied because of the overall demands of the courses.

Course Delivery

The courses in Leeds were able to use the facilities of the Department of Adult Continuing Education with back-up from subject-related departments. On Teesside, the more limited facilities of the Leeds University Adult Education Centre meant reduced opportunities for laboratory work existed and "laboratory days" were scheduled at a neighbouring Sixth Form College.

Demand for biology on Teesside was small but significant so an experiment in distance learning was carried out. Because biology students needed to study chemistry and mathematics as well, it was considered that a reduction in attendance requirements to two evenings per week, thus bringing them in line with students following the chemistry and physics options, would be attractive. Despite the provision of some tutorial support, the option was unwelcome and resulted in the withdrawal of one of the original four students from the biology course: a considerable increase in the number of tutorials proposed was necessary to retain the remainder.

Student Profiles

This analysis deals with only those students who presented themselves for examination, 15 in Leeds, 12 on Teesside. Exactly one-third of those in each location was female.

Ages ranged from 22 to 52 in Leeds, from 25 to 45 on Teesside, averaging 36 and 35 respectively.

All students entering the course had achieved some science subjects at GCE 'O'/GCSE or GCE 'A'-level. Five had BTEC ONC in science or engineering and one had an honours degree in biochemistry and another had failed a degree course in electronics. Two had done some courses towards a BTEC HNC and one held an equivalent qualification in Medical Laboratory Science. Nine entrants held City and Guilds qualifications, including coke-making, chemical plant operation, electrical/electronic engineering, fabrication and welding, painting and decorating, horticulture and teaching. One held a diploma in leather science, another in welding technology. Two had OU qualifications, one held professional qualifications in insurance, one in management and another in beauty therapy. One student had completed a three-year part-time course for educational technicians.

All but one student entering the course were in employment, the exception being a former technician interested in returning to employment when her family responsibilities were less onerous.

Choice of subjects

Most students elected to study maths at the higher or lower level along with biology or chemistry or physics: biology students, however, had to include chemistry in preparation for a HE course in life sciences or related subjects. Some students followed a restricted programme - in one case only one module - on the

advice of the admissions tutor for their chosen undergraduate courses. One student commencing an OU course in 1991 attended only until the OU course started and a 1992 OU entrant elected not to sit the access examination. (These two students are not included in the following data).

In mathematics, nine students followed the lower level course and twelve the higher level one. Thirteen attended the full chemistry course, seven the one in physics and seven in biology.

Assessment

60% of the overall mark was awarded for the examination and 40% for course-work, a minimum of 35% in each having to be achieved. The students were assessed in a total of 129 modules, resulting in 107 passes, 10 referrals and 12 failures.

The policy of the Validating Body (the Tees-Wear Access Federation) in not awarding grades was criticised at the Examiners' Meeting. The apparent grounds for the policy - that it would encourage admissions tutors to accept only the highest grade for entry - was regarded as pointless as they would require actual marks. It was pointed out that differing levels of achievement were required for different undergraduate courses. The external examiners regarded the papers set to have been fair and to have been marked justly: those obtaining results in the upper marks level would be acceptable for any undergraduate course and those passing at a lower level would be acceptable for certain courses. One of the examiners felt that in future greater care should be taken to ensure uniformity across the various disciplines and another felt that the papers in his subject could have covered the syllabus more equitably.

Student destinations

Seven of the successful students have made application to enter full-time undergraduate courses in 1992: the chosen subject areas include chiropody, health studies, environmental technology and management, mechanical engineering, life sciences, physiotherapy, plant science/management. One student is planning to qualify as a teacher through the "articled teacher" scheme. Depending on the availability of courses, six wish to pursue part-time degree studies, chosen subjects being chemistry/biochemistry, chemistry/chemical engineering, electronics, general engineering and plant science. If these courses are not available, the students will consider BTEC/HNC studies: another person wishes to do such a course in chemistry/chemical engineering. Three students intend to enrol with the OU. A further three of those completing the programme had done so to decide on the feasibility of re-entering education and now wish to continue in some, as yet unspecified, manner. One student wishes to extend the number of subjects studied in the programme. The remaining three, with a variety of existing qualifications, had enrolled to revise and extend their mathematical skills and were satisfied that they had been able to do so.

Review of the Programme

Students, tutors, co-ordinators and the course-leaders participated separately in an appraisal of the course. All were agreed that it fulfilled a need and should be continued beyond the life of the project.

Students found the course demanding but worth-while, only one thinking the demands were excessive. Four students would, however, have opted for the course

to be spread over two years, but others considered this would be too long to spend on access studies. Many students expressed their gratitude for being allowed a further educational opportunity, and their reaction to the course organisation and delivery ranged from satisfaction to enthusiasm. Some dissatisfaction was expressed concerning the use of open/distance learning texts in conjunction with some of the modules, a standard 'A'-level text being considered preferable. At least one student felt that, at times, too much material was referred to private-study, which was already well-occupied with the course assignments. Coincidence in the setting of these was remarked upon but a willingness by co-ordinators to extend deadlines mitigated the effect. Reactions to the study-skills days were not enthusiastic.

Two of the *co-ordinators* felt that the course was able to cover much of the material considered necessary for undergraduate entry but not necessarily at the depth achieved at 'A'-level, a view not shared by the other co-ordinators. (It is perhaps worth noting that the two more satisfied on this point were members of Leeds University staff.) All felt a problem existed in control of the teaching content: too much would interfere with the tutors' freedom and too little could cause diversity between the courses being run at the two centres. Co-ordinators varied in the control they exerted over the private-study content of the course, some being quite prescriptive and others preferring to leave it to the judgment of the tutors. Despite some clashes in the setting of the assignments, this aspect of student assessment worked well. Co-ordinators felt that most of the students were highly motivated, although the intensive nature of the course may have contributed to the number who failed to complete the programme. In continuing with the provision of the course, flexibility should be encouraged to take account of the experiences to date.

Tutors obviously played the key role in delivering the Programme and their reactions are of considerable significance in its assessment. The general criticism was that in most modules there was too much material for the time available, particularly in the case of the physics modules. This was compounded by the use of 3-hour sessions in which the class activity needed to be varied between lecture/tutorial, workshop and experimental work, reducing the amount of new material which could be presented. In particular, the amount of experimental work should be increased as the students' skills in this area were less well-developed than had been assumed in designing the Programme. It was suggested the teaching year should be lengthened and some of the time used to provide one or two "half-term" breaks. Mock examinations were recommended by some tutors and the possibility of having two examination periods considered, students being informed of the dates well in advance. Co-ordination between the sequence of the mathematical teaching and other subjects should be considered: this is particularly relevant to the use of calculators, a skill which few students possessed. Some co-ordination between chemistry and biology was desirable in teaching biochemistry.

Tutors were impressed by the attendance record of the students, often under difficult circumstances, but noted their aversion to week-end course activities.

It was felt that students from the course could be disadvantaged in that they would have had less practice in using the knowledge compared with 'A'-level students. The latter is the major criticism of the Access Programme and one which must be addressed.

The Course Leaders endorsed the points made by the tutors with the following additions and recommendations.

Tutors established good relationships with the students and supplied positive feedback to the course leaders. Despite this, three of the students following the higher level maths course should have transferred to the lower level one. In general it was felt that some of the students, particularly in Leeds, would have benefited from a "pre-access" course. This option is to be made available in co-operation with one of the Leeds FE colleges in future. To some extent this will mitigate what is perceived as a smaller cohort of technicians wishing to enter HE than exists on Teesside.

With respect to the comments of some of the tutors regarding the extent of the course-content, it was suggested that there should be a variation in the depth of treatment of certain topics, allowing some to be more fully developed.

Concern was expressed about the capability of students obtaining a marginal pass to be successful in HE courses. Attention needs to be paid to this point both with respect to assessment and post-course counselling. (A counselling session 4/5 weeks into the programme was also suggested).

Course Leaders were greatly impressed by the enthusiasm and dedication of the tutors in presenting a new course and contributing towards its development. The teaching load was heavy and exacting. Dealing so successfully with a wide variety of mature students required considerable skill. Even greater dedication will be needed in future when the setting of assessments and examinations is transferred to the tutors from the co-ordinators. Only by maintaining this tutorial standard and the continuation of small class numbers can a Science Access Programme be successful.

The Future

The Project generated a Science Access Programme which has smoothed and accelerated the path to HE for employees in science-based industry. It is now to be incorporated into the standard Continuing Education provision of the two Universities.

A joint board of the two Universities will be established to co-ordinate the delivery of the programme. Leeds will offer the course in conjunction with a pre-access course at the local Thomas Danby College and Durham will offer it on Teesside at the new Joint University College. Both will subsidise the provision but fees will still be substantial and, unless paid by the employers, could be a stumbling-block to potential students. Local authority grants for Access courses are not mandatory but the possibility of financial assistance via TECs is being investigated.

4.5 ASSESSMENT OF PRIOR LEARNING

Preamble

A considerable amount of activity has been generated, initially in the USA, by investigations into methods of Assessing Prior Learning (APL), including *Experiential Learning* (APEL). A considerable body of literature has been generated. However, this has been mainly in fields other than science or engineering. Courses are being provided in educational establishments to enable students to submit portfolios of their experience as a means of obtaining educational credit for activities which, whilst not specifically designed to educate, have nevertheless resulted in the acquisition of useful and relevant knowledge and skills.

Aims

Effectively many of the principles underlying APL/APEL were applied to the in-depth interviews for places on the Science Access Programme. In this way students were relieved of the obligation to undertake course modules which replicated their existing knowledge.

More generally it was decided to investigate the application of APL/APEL procedures to mature applicants for entry to higher education with a view to ascertaining whether they possessed the necessary background to undertake undergraduate study and possibly achieve advanced standing, in the science and engineering disciplines. These subjects present a particular difficulty because of their high factual content and dependence on sequential development.

Methods

Seminars on the subject were held in both Leeds and Durham, particularly aimed at admissions tutors. The Leeds seminar was led by Dr Cathy Hull, lecturer in APL at Goldsmiths College, and in Durham by Norman Evans, Director of the Learning from Experience Trust. Discussions were subsequently held with interested tutors and possible candidates for assessment.

Preliminary activities

In view of the lack of published information concerning APL in science and engineering, it was decided the best approach was actually to carry out the process. Ten admissions tutors from the two Universities expressed a willingness to be involved and the technician survey could be used to identify suitable student candidates. It was realised that the listing of "learning outcomes" as a basis of assessment would be a major commitment.

Developments

A training programme for the involvement of staff as assessors and accreditors was drawn up but was regarded by most of those who had previously volunteered as too time-consuming. Subsequently, co-operation was established with the (then) Teesside Polytechnic in arranging a shortened programme but this also was considered too demanding. Since then renewed interest has been shown within Leeds University and it is hoped to arrange a number of workshop sessions in conjunction with the Staff Development Office. The involvement of the regional FE Colleges is recommended, as at least one of which has produced a Resources Pack.

Feasibility of granting advanced standing through APL/APEL

This was investigated in a practical manner by two of the project team and discussed with other tutors. Despite the choice of a well-qualified technician with extensive experience he was unable to demonstrate competence at other than the practical level in most of the subjects studied in the relevant first-year undergraduate programme. However, remission of study time might be possible in the final year of a course which contained a project element. With the advent of modularisation and CATS, and the possibility of 'mixed-mode' (full and part-time) attendance, HE institutions could award credits at final year degree level for project work currently or previously undertaken at work. Both employers and employees would benefit from the reduction in time required to complete a degree. A feasibility study is urgently needed.

Conclusion

Although APL/APEL is expensive in terms of tutors' time and there is little published information concerning science and engineering experiences, there is interest by university staff in its application. It is recommended that the proposed Workshop Sessions should be held in the near future and the specific topic of its relevance to mature students undertaking a final year project should be investigated. The principles underlying APL/APEL can be applied to improving in-depth interviews of applicants for courses.

CONCLUSIONS

The Leeds-Durham Project has produced a high quality modular Science Access programme, suitable for employees in science-based industry, especially technicians. Its success is clearly demonstrated by the commitment of both Leeds and Durham Universities to continue running the course in future years.

In concluding this report on the project's work, the following suggestions are particularly stressed:

- There is massive unrealised potential among the non-graduate industrial work force. Flexible delivery of modular Access programmes is needed to help unlock this.
- Even in the present recession, industry should take a long-term view of technician training and the need to enhance the skills base.
- Finance is the key to tapping this resource of potential graduates - a policy review would be useful to determine how such students should be given support both at Access and HE levels.
- The perception of mathematics as a barrier to HE entry can be overcome by an imaginative approach to curriculum development and delivery.
- A national agreement on "the core curriculum" of science at 'A' and Access levels, similar to that achieved for mathematics, is needed.
- The quality of tuition is especially relevant to courses for mature students, as is counselling and guidance. Staff development is needed to encourage tutors to give students the support and understanding they need.
- Modularisation of Access courses is an opportunity to facilitate entry of mature students, not only by making part-time courses possible, but by taking account of their backgrounds in formulating individuals' programmes of study.
- Accrediting Prior Learning (APL) has been inadequately progressed in the science and engineering field. The potential for mature students with an industrial background to receive credit for final year project work should be explored. HE, employers and employees would benefit from the reduction in time required to complete a degree.
- The development of Access courses should involve admissions tutors more fully: not only is this good practice but it builds networks. The confidence of admissions tutors will be further enhanced by ending the widespread policy of appointing a single external examiner for multi-disciplinary courses.
- HIGHER EDUCATION IS FLEXIBLE! Effective Science Access programmes, modular course structures, credit transfer, and the accreditation of work based learning speed up the route to a degree, and enhance industry's skills and knowledge base.

ANNEX A

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ANNEX B

PROJECT STEERING COMMITTEE

Mr. T. Lough (Chairman)	Managing Director, Teesside Training Enterprise
Professor R.K.S. Taylor (Co-director)	Head of Department of Adult Continuing Education, University of Leeds
Dr. W. Williams (Co-director)	Head of Department of Adult and Continuing Education, University of Durham
Dr. C. Butler	Head of Science, Coventry Technical College
Dr. R. Chapman	Lecturer in Science, Department of Adult Continuing Education, University of Leeds
Mr. G. Grievson	Deputy Chief Executive, Teesside Training and Enterprise Council
Mr. J. Hudson	Training Manager, Teesside Development Corporation
Ms. B. Lillicrap	Head of Function (Technicians), Tioxide (UK) Ltd, Stockton on Tees
Dr. I. Pearce	Training Manager, ICI Chemicals and Polymers Ltd, Teesside Operations
Mr. D. Proctor	Training Manager, British Steel (Teesside)
Dr. V. Shelley	Lecturer in Science, Department of Adult and Continuing Education, University of Durham
Mr. G. Skipworth	Head of Access and Continuing Education, University of Teesside
Mr. M. Woods	Higher Education Branch, Department of Employment
Secretary	Dr. M. Chase, University of Leeds, Adult Education Centre, Middlesbrough

PROJECT STAFF

Dr. R. Chapman	(0.5 appointment)
Dr. M. Chase	(Administrator, 0.25 appointment)
Mr. J. Dodd	(Manager, full-time contract)
Mr. L. M. Smith	(Consultant, Lecturer in Pure Mathematics, University of Leeds)
Mrs. C. Whittingham	(Secretary, 0.5 appointment)

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