Global J. of Engng. Educ., Vol.4, No.3
Published in Australia

Economic and Strategic Issues Relating to Work Based Learning*

George R. Burns
Business School, University of Glasgow, 20 Western Court, Glasgow G12 8SQ, Scotland, United Kingdom
Colin U. Chisholm
Willie A. McKee
Glasgow Caledonian University, Cowcaddens Road, Glasgow G4 0BA, Scotland, United Kingdom

Education that delivers skills for the benefit of individuals and employers has always been recognised as part of the infrastructure of an industrial society. Society provided the opportunities for education through university, further education colleges and schools. One common characteristic of all of these was that they decided what the courses were and when they were available. The industrial revolution is being replaced by the knowledge revolution, that is the access to knowledge in a *just in time* mode. This approach has changed the educational needs of individuals and employers. The paper examines some strategic drivers of social and economic changes that have contributed to the increased educational diversity that is a feature of modern society. Analysis of the demands these changes have produced is used to support the proposal that the provision of education is changing and needs to change to reflect the needs of a much greater community of learners and more sophisticated expectations of individuals and employers. The paper reviews examples of models of provision that can be used to address these needs and in particular discusses a general client-server model that facilitates the conservation of all the attributes that define quality while providing for flexibility of undergraduate and postgraduate workplace learning.

INTRODUCTION

National and global economies are continually changing and being changed by the knowledge revolution. The effect of this has been the development of the *knowledge based economy*, a description of how social and economic forces that affect everyday life have been and continue to be shaped by this knowledge revolution. Individuals, organisations, social and economic thinking and implementation have all been changed by the significantly improved access to knowledge [1].

The advances in science and technology that have enabled this will not stop. Therefore it is evident that developments will have a wider and greater impact across society. It is globally recognised that as the technology base increases, the level of skills and knowledge required of the work force has to increase for an economy to remain competitive and sustain economic growth. To support the availability of and participation in education by all is essential; hence education is de facto identified as fundamental in any strategy to enable the workforce to maintain, upgrade and acquire new skills and the knowledge necessary to maintain economic performance. The revenues generated provide the basis from which actions to support this view of education provision can stem.

Ever since the conception of the *university*, the prevailing model has been that of study on campus where the university controls and decides the style and context of learning. In recent years, pressure has been increasing to broaden the definition of who the end-users are – to recognise, especially in the vocational areas, that the employers' needs and the graduates' skills should complement each other [2].

It is now recognised that the university is no longer the only environment in which new knowledge is

*A revised and expanded version of a keynote address presented at the *2nd Global Congress on Engineering Education*, held at Hochschule Wismar, Wismar, Germany, from 2 to 7 July 2000.

generated or that undergraduate and graduate education can be delivered. In the UK, political and commercial policy developments actively support the implementation of off-campus learning as a methodology that meets the new needs of the economy and as such clearly needs to be recognised and developed by educational institutions [3].

THE CHALLENGE OF NEW APPROACHES

Strategies for the provision of wider access to education have been proposed through, for example, the concept of life long learning [4], the establishment of The University for Industry, The Scottish University for Industry and wider access programmes supported by higher education institutions.

Post-school vocational and professional education is mainly delivered by the Further and Higher Education (F&HE) sectors. F&HE institutions have a key role in widening the availability of learning for the updating of skills, technology transfer and commercialisation in response to the needs of organisations and industrial sectors. In responding to these needs, F&HE institutions have to consider new and innovative processes for the provision of access, the delivery of programmes and recognition and accrediting of workplace learning. Life long learning is in principle the conceptual model that encompasses access to learning as part of a continuous life long process that can accept learners at the time of need.

However, industry in general usually identifies specific needs to support performance and economic growth and looks for specific responses. Thus, educators have to recognise the importance of relevance to and impact of the workplace. Work based and workplace learning (WB/WPL) is a deterministic strategy that has been developed over the last ten years by some F&HE institutions [5][6]. These developments are education's response to the needs of organisations and industrial sectors faced with the challenges of rapidly changing economic conditions derived from globalisation and the knowledge revolution.

The implementation of WB/WPL is a process-based methodology that provides a framework that enables the delivery of programmes at postgraduate and undergraduate levels within the workplace. The key factors that make this approach a viable alternative to more formal education system are flexibility, relevance to the students' work experience and aspirations and the employer benefits as part of the process.

THE CLIENT-SERVER MODEL

The Department of Engineering at Glasgow Caledonian University (GCU), based in Glasgow, Scotland in the United Kingdom, has been serving the part-time education needs of the local engineering community for over ten years, and has detected a trend of lower application rates against a background of increasing demand for higher education of engineers [7]. Analysis of this conflicting evidence led to recognition that the fundamental problem was that the prospective students could not physically absent themselves from the workplace for long periods of time [8].

The model proposed to solve this was one which has been steadily replacing the traditional organisational dependence on large centralised computing facilities with a much more flexible approach utilising smaller, more flexible and largely autonomous clients (network terminals usually PCs), which are coordinated by a significantly reduced server (the network controller). In this model, an analysis is carried out that defines which tasks can be safely devolved to the client, and which are required to be carried out by the server due to scale, security or efficiency.

In an educational forum, the server is clearly the university itself and the client will be an organisation, individual or group of individuals that negotiate access to the resources available from the server to deliver specific educational requirements. The resources that are available may take the form of computer based teaching, lectures delivered in the workplace, work based learning and other combination that are appropriate to the educational objectives of the client.

An example of this has been the development of specific modules, not as short training courses, but as part of a formal qualification by educational providers for specific areas of manufacturing technology.

More recent has been the development of *workplace* teaching of the fully-accredited Chartered Engineer level BEng programme by the Department of Engineering at GCU, and praised as an exemplar by David Blunkett, Minister for Education and Employment, in a recent speech on the future of education [9]. With the application of the client-server model, it can be seen that the teaching environment created in the workplace is the *client* [10].

Using this client server model, education in the workplace becomes the client and the university the server. The flexibility such a model offers enables educators to consider hitherto unlikely modes of delivering education or serving the client needs.

For example, the existence of multiple clients all interacting via the university server provides many

opportunities to evaluate new technologies, tools and methods that ensure teaching is up-to-date and relevant. Even the smallest client in the most specialised field now has access to a network of collaborators (and competitors) in a non-commercial environment. Resource sharing can occur whereby a costly resource may be loaned between clients or the cost shared between them.

Since each client is education in the workplace, appropriate attendance models can be arranged at almost a personal level, removing the rigidity of the on-campus central timetable, as well as minimising travel and maximising availability. Numbers can be monitored to ensure that the peer support mechanisms are still available at the client site.

Quality assurance is maintained by the fact that the curriculum and assessments are defined by the university and delivered either at the client site or through interaction with server resources by properly chosen staff, fully qualified in the appropriate areas.

Using mail and electronic technology, library materials can be made available to the students at the client organisation almost as easily as on-campus. Modern communications technologies mean that student support is highly efficient.

A significant development that still needs further work is the concept of *clustering*. Clustering involves allowing potential client sites unable to connect directly with the server to access existing connections in other workplace sites. Using this extension of the model, employees of nearby companies that share technologies in a non-competitive area may also share in developing their skill base through client server systems. This clustering of students will serve to reduce the overheads involved in setting up and maintaining a client site. This is currently being developed for a cohort of students using Motorola Plc as the centre of the cluster. Once tested, it will be rolled out to the wider area in future years.

WORK BASED AND WORKPLACE LEARNING PROGRAMMES

The work based and workplace learning (WB/WPL) programmes are developed through a partnership between representatives of the host organisation, an academic institution and the student. Students are involved in the design of the programmes, thus ensuring relevance to workplace needs while maintaining academic standards. Programmes can be structured for individuals, groups of students or students from a cluster of companies that share the same industrial sector but are not competing, such as electronics.

Postgraduate

Typically programmes for individual students are at the postgraduate level and lead to the award of a Master of Science or Doctorate in Professional Practice. Programmes of this type involve identifying the strategic objectives of the organisation: (technology transfer, applied research commercialisation or advanced skills updating), the learning needs of the student and the academic objectives necessary for the delivery of the strategic objectives.

Once these are identified, a programme of knowledge acquisition goals and applied research and development goals is developed that defines the activities and learning necessary on the part of the student to deliver the strategic objectives within the host organisation. In certain circumstances, it is possible to develop a programme that is based on a common core of knowledge acquisition goals and individually designed research and development goals. Typically this type of programme is designed for groups of students with a common origin but different specialist interests who can then complete a thematic learning contract.

It is normal in these programmes to include a reflective goal. This goal requires the student to complete a portfolio submission of previous experience. The portfolio gives the potential student an opportunity to reflect on recent experience and identify the learning experiences that have contributed to their development and shaped the proposed programmes of study. In the case of candidates who wish to undertake the doctoral programme, it provides an opportunity to assess the proposed research and development goal against the descriptors used for defining the characteristics that are expected at this level of study.

Undergraduate

At undergraduate level, the programmes are typically for groups of students and lead to an exit award such as an Honours degree. The model may serve various purposes and may have different time frames for delivery depending on the ultimate objective. Two examples are considered:

- Delivery in same time frame as a full-time student.
- Delivery intended to satisfy the modem apprenticeship scheme.

Delivery of programmes in the workplace that lead to the award of an undergraduate qualification at the same rate as a full-time undergraduate qualification

involves meeting quality assurance standards. As well as all the normal quality assurance requirements, it is necessary to assure that the notional hours effort that can be delivered by the employed student is equivalent to the full-time student and is a practical possibility. Assessment of the support provided by learning from activities in the workplace in delivering the learning outcomes of the programme modules has shown that workplace learning supports this notional hours effort. Programmes of study can therefore be delivered without loss of academic rigour or quality.

Recruitment of students to technology based programmes is poor in the UK, Europe and globally. One approach to this problem that has been adopted by many technology-based organisations is the modern apprenticeship. The scheme involves part-time study combined with practice in the workplace, giving the student an income, professional practice and an appropriate academic education. The academic studies therefore match the practice over a longer time frame but once complete, the student has both practical and academic knowledge – the objective of the employing organisation.

In addition to these models of WB/WPL, a further development for consideration is partnership between F&HE institutions. The FE institution delivers a two-year programme that the HE institution has validated against entry requirements to the 3rd year of the appropriate undergraduate programme. The student gains an exit award (such as HND or University Diploma in Higher Education), which enables articulation (transfer) to the HE component, leading to an undergraduate exit award. It is essential that the awarding body (ie the HE institution) retains quality control of the entire process. The main issues in this cover the validation of engineering programmes to meet the accreditation requirements of the appropriate engineering institutions. These approvals are essential if graduates are to be able to proceed to Chartered Engineer status.

FOUNDATION AND ACCESS

In a modern economy, the skills to acquire knowledge and use it are becoming increasingly essential. In the UK, the government has recognised that the potential for social division, resulting from the lack of basic skills to achieve these aims, could result in a two-tier society with respect to employment opportunities [11][12]. A key aspect of social policy is the need to address the socially excluded groups in society.

Generally, these groups are disaffected with formal education and do not respond well to initiatives that are based on school, college, etc. Work Based Learning that is established in the workplace offers an alternative route for these students to have recognised core skills that they have gained through work. Once the level of core skills has been determined, a programme of work can be devised that will enable the student to achieve the necessary standard for entry to a more formal route of education at F&HE institutions.

The Way Forward

Education is one of the fundamental keys to improving performance and competitiveness in the knowledge based economy but traditional methods of delivery do not meet the needs of organisations and individuals within a modern society. WB/WPL offers a new model that recognises the objectives of organisations and individuals where it can be flexible in delivery, retain focus on identified organisational and individual needs, yet not sacrifice rigour.

Implementing WBL/WPL into the fabric of education provision will involve changing the culture of institutions and staff to recognise the value of experience and practice in the workplace. Furthermore, it will include devising methods for delivery that involve the use of WB/WPL for entire programmes or part of a programme.

The Department of Engineering at GCU has undertaken many of the initiatives discussed and has found that the process of change requires careful management. The Department has developed and delivered workplace programmes for students who wished to obtain a Bachelor of Engineering degree as previously described. A second programme, a Master of Science in Maintenance Engineering, was delivered for the Royal Mail.

In addition to these innovative strategies a Post-graduate Learning Contract Framework, which has been in existence for some eight years at the university, has graduated a number of students at the Master of Science level. The Framework will soon be extended to include a Doctorate in Professional Practice based on the same philosophy.

The off-campus (workplace) provision (MSc and BEng) has been successfully delivered in the workplace although the modes of delivery and quality assurance issues produced by both were unique and required careful consideration before allowing the programmes to be implemented.

UNDERGRADUATE DEGREE PROGRAMMES: CASE STUDIES

The Department of Engineering has delivered their Bachelor of Engineering programme for British

Aerospace and Motorola Ltd where both programmes had the objective of providing students with the skills necessary to function as a professional engineer while satisfying a company strategic objective of increasing the professional engineering capacity and satisfying individual career aspirations. In both cases, the proposed delivery mode required validation by the university.

Case Study 1: British Aerospace

In the case of British Aerospace, the opportunity for workplace learning arose due to an internal company reorganisation that placed significantly higher availability constraints on employees who were already undertaking the traditional part-time (day-release) BEng programme at GCU. The work-place learning model developed here was intended to mimic as closely as possible the experience of the final two years of the campus-based student. Changes to the learning outcomes were limited to the practical sessions, which were tailored to match the required competencies and the local tools and resources.

This method allowed the students to undertake exactly the same loading as those on the highly successful campus-based programme that has been running at GCU for over ten years. This ensured that all existing approvals and quality standards were maintained. To date, two cohorts of students have progressed through the programme, with three students gaining Ordinary and 11 gaining Honours degrees.

Case Study 2: Motorola Ltd

The programme to be delivered for Motorola Ltd presented an entirely new challenge to the Department and the University. It was proposed to deliver this programme in the same time frame as undergraduates taking the corresponding programme in the University.

The most significant issue to arise from this decision centred on whether the students could deliver the required personal effort as defined in the programme module specifications and whether appropriate personal support could be put in place for off-campus students. To establish that this was a realistic possibility, the contribution of the work-place to the delivery of learning goals defined by module descriptors was investigated. A model that made use of a mapping procedure was devised to establish a relationship between work activities and learning goals.

The model involved constructing a table for each module that comprised workplace activities and module learning goals. The contribution of workplace activities to the learning goals of the module was assessed by examining the job description of students and involving the senior engineering staff of the company to advise on the proportion of time the student would be expected to spend on relevant workplace activities. Once these tables were completed, it was practical to assign an equivalent personal effort hours figure for the workplace contribution to personal student effort for each module. Using this procedure, the Department was able to establish to the satisfaction of the University that it was practical for the students to deliver the required personal effort; hence the programme was allowed to proceed.

Primarily a tight management structure was put in place with a responsible person in both the workplace (a representative from the Training Dept.) and the University (a member of staff appointed as Deputy Programme Manager). Their responsibilities were defined as follows:

- Act as a single point of contact for their respective establishments.
- Act as a conduit between the establishments.
- Ensure a suitable teaching environment was provided as required.
- Arrange the logistics of delivery (staff, times, places).
- Ensure quality assurance mechanisms were adhered to.
- Provide student support services as required.

To achieve this, a comprehensive communications structure was established, ensuring everyone had all the information they needed to contact anyone via phone, fax, mail, e-mail and videoconferencing.

Finally, a full approval event by the Faculty Quality Assurance unit was invoked, which included a visit to the workplace and interviews with the students. This was a complete success, with very few modifications to the programme required for full approval.

Results

Statistics from both cohorts at British Aerospace and Motorola Ltd show that not only are the students able to keep up with their campus-based colleagues, but further that their average grades are higher than the class average. This validates the projections made by the development team and proves conclusively that the reduced contact time is more than compensated for by the students' greater experience and the effect of the workplace environment on active learning.

POSTGRADUATE PROGRAMME: CASE STUDY

Case Study 3: Royal Mail

The Department of Engineering was contracted by the Royal Mail to deliver its Master of Science in Maintenance Management. The programme was already successfully delivered in the university as a full-time programme, thus there were no significant issues in relation to the content of the programme. The delivery mode used involved one week of intensive lectures followed by directed and personal study supported by staff for a further period of two weeks. This was essentially the same as that used for full-time students.

In the case of the Royal Mail group of students, the important issues were concerned with support. The students are geographically dispersed around the UK, thus supporting them involved encouraging them to make use of technology solutions for communication as previously described as the basis of the Client Server Model. E-mail was agreed as a major tool for communication with staff. As the next project phase is beginning, the use of Internet videoconferencing, such as Microsoft NetMeeting, is being introduced to further improve communications between client and server.

CONCLUSION

The Client-Server Model has been shown to be an effective model for the successful development and delivery of work based and workplace learning at both undergraduate and postgraduate levels, thus providing an effective solution to the relevant economic and strategic issues.

REFERENCES

1. Scottish Office, Scotland towards the knowledge economy. Edinburgh: HMSO (1999).
2. The New Deal. Department of Trade and Industry, July (1998).
3. The Scottish Office, Devolution (etc). Edinburgh: HMSO, September (1997).
4. NAGCELL, Learning for the 21st Century, First report of the National Advisory Group for Continuing Education and Life Long Learning (1997).
5. Burns, G.R. and Chisholm, C.U., Factors relating to the incorporation of workplace learning at undergraduate and postgraduate level. *Proc. Global Congress on Engng. Educ.*, Cracow, Poland, 69-72 (1998).
6. Chisholm, C.U. and Burns, G.R., Learning contracts – a modern postgraduate programme. *4th World Conf. on Engng. Educ.*, St Paul, Minn., USA (1995).
7. Garrick Report on University Provision. The Stationary Office (1995).
8. McKee, W. and Burns, G.R., A workbased degree programme (1997).
9. *The Times Higher Education Supplement*. 25 February (2000).
10. McKee, W., Working while studying. *Proc. of Industry and Educ.*, Santorini, Greece (1999).
11. Scottish Office, Social inclusion – opening the door to a better Scotland. Edinburgh: HMSO (1999).
12. Scottish Office, Social exclusion – a consultation paper. Edinburgh: HMSO (1998).

BIOGRAPHIES

George R. Burns has a first degree in Applied Physics from Strathclyde University and a Doctor of Philosophy from the Department of Electrical and Electronic Engineering at Strathclyde University gained for thesis-based research into low frequency conduction properties of insulating liquids. Since leaving University, he has followed a career in education starting by teaching physics and maths in high school, then physics in the Life Sciences Department of a local College. He left there to take up a lectureship at The Scottish School of Non-Destructive Testing (SSNDT) at Paisley University where he stayed for six years. During this period, his research interests were in computer data management systems. He left there to become senior lecturer in the Department of Engineering at Glasgow Caledonian University, where he continued with his research interests in computer based data management and the use of artificial intelligence software (neural networks and genetic algorithms) to model business and manufacturing systems as well as developing an interest in work based learning. During the same period, he was the University Project Manager responsible for establishing the Caledonian College of Engineering in the Sultanate of Oman.

The interest in engineering education and work based learning led to him being appointed Coordinator of the Caledonian Centre for Engineering Education

(CCEE), the first satellite centre of the UNESCO International Centre for Engineering Education (UICEE). He left Glasgow Caledonian University in May 2000 after 14 years to take up an appointment as Director of the Executive Doctoral Programme at the University of Glasgow Business School. As Director, he is responsible for the development and operation of this postgraduate work based learning programme on a local, national and global scale. His current research interests are related to quality assurance and knowledge management processes associated with work based learning.

During his career he has had some 70 papers published in conference proceedings and journals, as well as two books.

Colin Urquhart Chisholm graduated with a BSc Hons in Metallurgy from Strathclyde University and with a Doctor of Philosophy from St Andrews/Dundee University in 1962 and 1968 respectively.

From 1963 to 1965, he was a lecturer at Wolverhampton and Staffordshire College of Technology (now Wolverhampton University). From 1965 to 1971, he was a lecturer in Materials Science at Dundee Institute of Art and Technology (now Abertay University) where he researched in processes for alloy electrodeposition and the study of the structure of the deposited alloys. After spending a period as a Senior Lecturer at Robert Gordons Institute of Technology (now Robert Gordons University), he became Associate Head of Engineering at Paisley College of Technology (now Paisley University) and thereafter Head of School of Engineering at Glasgow College of Technology (now Glasgow Caledonian University) where he was awarded a Professorship. Since 1993, he has been Dean of the Faculty of Science and Technology at Glasgow Caledonian University (GCU) and a member of the Executive Management team.

Professor Chisholm is an acknowledged international researcher in the field of electrodeposition of alloys and leads collaboration as Chairman of Surface Technology International, which involves a group of European universities. Since 1985, he has maintained a major collaboration with a team of researchers at Eotvos Lorand University in Budapest, Hungary.

For the last decade, he has led action research and development relating to work based learning and at GCU has developed an innovative Postgraduate Learning Contract Framework for work based learning, which has been operational since 1992.

More recently, he negotiated on behalf of GCU with the UNESCO International Centre for Engineering Education (UICEE) leading to the establishment in 1998 of the first satellite centre of the UICEE, named the Caledonian Centre for Engineering Education (GCU).

He was awarded the UICEE Silver Badge of Honour at the *Global Congress on Engineering Education* in Cracow, Poland, in September 1998, and more recently at the *2nd Global Congress on Engineering Education* in Wismar, Germany, in July 2000, he was also awarded the UICEE Gold Badge of Honour for distinguished contributions to engineering education.

He has published over 200 scientific papers in refereed journals and conference productions and supervised over 35 PhD students. More recently, Professor Chisholm, in collaboration with the team for Surface Technology International, published the first paper regarding the successful deposition of tin-chromium and tin-zinc chromium alloys. Professor Chisholm has received a number of awards for published papers, the most recent as a co-author of a paper on work based learning programmes, which was given a Diamond Award (1st grade) at the *3rd UICEE Annual Conference on Engineering Education* in Hobart, Australia, in February 2000.

Willie McKee joined the Engineering Department of Glasgow Caledonian University in 1990 from Digital Equipment Co. where he was employed as a Senior Support Engineer in the Sales and Service division. He is currently Senior Lecturer and Electrical Cognate Area Manager in the Department of Engineering at Glasgow Caledonian University, and has completed various degress, including BA, PgC, PgDip, MSc, MBCS, and CEng.

His teaching fields cover computer technology, digital electronics, software engineering, and distributed multimedia systems. His research, consultancy and publication areas encompass electronics testing and maintenance technology, industrial automation and control of real time systems, distributed computing and networks, multimedia systems and technologies, and Computer Aided Learning (CAL) technologies and applications.

He is a committee member of the British Computer Society and a Chartered Engineer. He has published seventeen papers since 1995.