
The Role of Work-Based and Workplace Learning in the Development of Life-long Learning for Engineers

Colin U. Chisholm

George R. Burns

Glasgow Caledonian University, Cowcaddens Road, Glasgow G4 0BA, Scotland, United Kingdom

The paper reviews the rapid rate of development relating to life-long learning with higher education having to place much more emphasis on the development of learning models to support life-long learning. It is shown that with engineering technologies changing rapidly there is a need to place greater initial emphasis on a broad training for engineers, followed by life-long learning to allow engineers to update and learn as their job role changes and as the technologies change and develop. The paper discusses the role of off-campus learning for engineers as an effective and efficient learning model to support life-long learning where engineers are able to access continued learning through work-based learning and workplace learning. It is shown that a Postgraduate Learning Contracts Framework can be an effective model for achieving life-long learning for engineers who wish to progress their learning off-campus.

INTRODUCTION

The economic future within Europe and worldwide increasingly depends on our ability to continue to provide improved living standards, which in turn depends on our ability to add value to products and services continuously. To achieve this, employers increasingly need to look to engineers throughout their organisations to come forward with innovative and creative ideas for improving the way business performs and equally to take greater responsibility within their work areas through personal development on a life-long basis. To compete in the rapidly changing global markets it has become essential for organisations to recognise that they can no longer depend on an educated elite but, increasingly, must maximise the potential of the workforce within the organisation by harnessing all available brain power to assure economic survival and success. Life-long learning will provide for the development of a more cohesive society much more able to operate within a cross-cultural diversity.

For some time it has been recognised that workers from lower social groups are less likely than those from middle and upper groups to apply to a higher education institution even if they have achieved an identical or similar educational performance. For example, it was shown in 1993 that only 8% of young

people from the lower social groups went to university, while for middle and higher groups at that time figures of 16% and 39% were recorded [1]. With too few people from the lower social groups being attracted into higher or further education, it is obvious that this is a particular impediment to achieving mass life-long learning to establish the level of skills, wealth and job-creating capabilities which are needed worldwide. Much has been done recently within the higher education sector to address social exclusion and the numbers entering higher education have risen considerably in the past few years, but there is still a large number of people within organisations who will not access either further or higher education in their lifetime unless new learning models are developed.

This is particularly true in relation to engineering where the numbers being attracted into engineering disciplines for the past decade have either fallen or stayed constant. Therefore, with regard to life-long learning for engineering, there is a vital task to be addressed in the establishment of learning models which can provide life-long learning for all those who have not considered approaching either further education or higher education. This is accentuated by the fact that within the last decade the rate of change in engineering technologies has significantly accelerated and this has led to a situation where much of the informa-

tion provided within a first qualification in engineering becomes rapidly obsolete, and therefore without a mechanism to provide life-long learning for engineers there is no way to update engineers in these emerging technologies continually.

Participation rates show little or no correlation to the proximity and to the availability of a higher education institution. In the Highlands and Islands of Scotland there is one of the highest participation rates in the UK at 49%, yet currently it has only an emerging University of the Highlands. By comparison, participation rates in Glasgow have been recorded at 15% and in inner Liverpool between 2 and 5% despite the fact that both cities have a range of old and new universities [2]. More recently, the Higher Education Funding Councils have supported a number of initiatives to address the high levels of social exclusion through developments such as innovative part-time patterns of learning. It is well accepted that higher education should be available to everyone who has the necessary competence and capability and who might wish to benefit from it. Thus higher and further education have a major role to play in achieving a seamless delivery of life-long learning.

WIDENING ACCESS

There are significant barriers to achieving life-long learning as many people from either semi or unskilled manual backgrounds first have to improve their self-confidence such that they are both confident and capable of achieving learning; equally, they have to realise that the learning will enrich their life and expand their horizons. For many the ease of entry and exit into and out of further and higher education becomes a key issue where attendance is related to domestic, financial or career circumstances. To overcome these aspects it is important to look at a learning model that will address the needs of achieving a much wider participation of engineering personnel in life-long learning. One approach is an off-campus model that would be effective within the organisations in which people are employed, rather than bringing candidates on-campus.

In this respect a model that utilises either workplace learning and/or work-based learning associated with the use of CIT methods would allow confidence and an understanding of the value of learning to be built up in the workplace, an environment where most engineering employees would feel comfortable. Workplace learning will enable those who have not traditionally attended either further or higher education to see the value of learning and it would provide a model which would allow workers to exit in and out of life-long learning.

THE ROLE OF THE EMPLOYER AND EMPLOYEE

If workplace and work-based learning are to be effective means through which life-long learning can be achieved, then employers will need to recognise the value of harnessing and developing the skills and capabilities of older engineering employees. In this respect employers need to be encouraged to conduct proper skills audits to improve their understanding of the needs of their workforce. This would facilitate the development of assessed prior learning (APL) and its accreditation and would then further support the development of additional capabilities through work-based learning. There is still a significant barrier to be overcome in having people accept that valuable forms of learning can take place in the working environment as opposed to academic institutions. While many employers now encourage a culture of continuous learning and individual motivation, it is still insignificant in real terms and there is a need to get much greater commitment, particularly in small to medium enterprises.

Work-based and workplace learning are very much the minority learning model worldwide and if life-long learning is to be properly achieved for engineers, then it has to become an objective of all organisations in private and public sectors. Taking learning off-campus will facilitate one of the most important aspects needed: that of allowing learning to be available at a time and in a place and in a form which suits the individual employee, as opposed to attending an on-campus programme which does not provide for the same flexibility. Integrating the learning within the organisation, will provide for a partnership between employer and employee to establish life-long learning partnerships. As the demand for unskilled and semi-skilled workers decreases, there is an increasing requirement for life-long learning. As we approach the millennium a relatively high proportion of the workforce will still not have a formal qualification in engineering, far less be involved in life-long learning. Employers will essentially have to adopt a much more radical approach to learning and training and be prepared to recruit and manage their workers to ensure that learning takes place. It will also be important for the individual to develop a different approach to their career and working life as the structure and patterns of employment change. Individuals in the future will need to take charge of their own career development and ensure that they acquire the right balance of high level skills. They are much more liable to do so if they are able to achieve the learning within the workplace environment.

To address the issues of social exclusion a variety of models which encompass off-campus learning in

the workplace are needed. By doing this, a much greater achievement can be obtained in widening access, and the stimulation of life-long learning is possible as there is a much greater number of people not attending further or higher education but simply completing a job in an organisation. It is interesting to examine the statistics for the UK population of working age through to the year 2025, in which it has been shown that the number of people in the labour force is on average increasing by around 100,000 a year with continued growth through the millennium and with a peak around the year 2011 of around 35 million [3]. Thus for people involved within the broad range of engineering disciplines, there is a projected increase in the number of people in the workplace available to access life-long learning and on this basis it would seem logical to concentrate on the development of off-campus learning models.

LIFE-LONG LEARNING

The rapid pace of technological change has highlighted the need for continuous learning and training to provide a much more flexible workforce for the future. Already, many employers are increasingly pointing out that they do not have a workforce with the range of skills to meet the needs of tomorrow particularly in relation to technological, information technology and business innovation skills. Concern has been expressed in the UK at the need for the workforce to be more inventive and creative and to take an entrepreneurial approach within the workplace to deliver new products and services. The present state results from much of the short-term cutbacks which were made during the last recession. There is now strong government support for life-long learning in the form of a number of initiatives and the opportunity is now available to advance and develop models of learning suitable for use off-campus.

Employers and individuals need to accept a much greater share of the responsibility for developing learning in the workplace and in this respect work-based learning could be taken forward with establishment of either learning partnerships or learning contracts where the company, the individual and the education establishment would sign up to deliver learning in the workplace. There are already some excellent examples of this kind of development. Bovis Europe developed a postgraduate programme with Middlesex University National Centre for Work-Based Learning which resulted in a highly flexible and successful CPD form of learning [4]. Work-based learning places responsibility for the delivery of learning where people work and are trained. By moving off-campus the higher education system is demonstrating its ability to

be flexible and able to deliver learning integrated to the world of work. In the 1990s the government set out to change the higher education system to give much more relevance to working life and to have higher education become much more responsive to the rapidly changing demands and opportunities provided in the labour market [5]. The development of learning models which take undergraduate and postgraduate learning off-campus and into the workplace environment is an example of higher education's response to this challenge. Increasingly, employers are thus assuming active leadership in preparing and maintaining a skilled workforce and responding to these learning models which in turn are creating a climate highly conducive to further business development. Work-based learning offers a clear vision for stretching beyond existing academic programmes and traditional methods of delivery, and for engineers it can provide learning and training in the workplace where the engineer can develop within a much broader context of economic and industrial development.

SMALL TO MEDIUM ENTERPRISES

While many of the larger organisations are now seriously addressing work-based learning models, there is still a need to promote learning models in the small to medium enterprises where traditionally it has been much more difficult to sustain this type of learning. It is essential that the small to medium enterprises take ownership of developing life-long learning in their own workplace environment. The argument put forward by employers in the small to medium enterprises is that they have only a few engineers to train and that it is not practical to take this forward. However by using work-based and workplace learning, life-long learning could be stimulated by bringing together like groups in a geographical area where the academic partner could work with a cluster of small to medium enterprises to take forward the training of a group of engineers using an off-campus model. Alternatively, some of the larger organisations who are committed to off-campus learning could make available a number of places for employees from small to medium enterprises who are close to the organisation and again this would allow for economic delivery of the off-campus learning to both the main organisation and the cluster around them.

USING ENTREPRENEURSHIP AND TECHNOPRENEURSHIP

It is important that as well as technological skills engineers develop a set of business skills which will prepare them for their future careers. Again this can be

best achieved through the life-long learning process where experiential learning in the workplace environment, combined with structured studies of business, will take forward their development in professional practice. Encouragement has now been given to the development of entrepreneurship where engineers trained in their first discipline learn how to be inventive and creative, to look forward to the development of either new products or services within employment or alternatively to create their own business at some point in their careers.

At Glasgow Caledonian University such a programme has been developed involving a learning contract at postgraduate level on enterprise and commercialisation [6]. This learning model enables highly qualified technologists to integrate their technological knowledge with business acumen, allowing them to develop an entrepreneurial mindset through the themed learning contract. This learning contract model has been shown to be highly successful, with all parties agreeing that the knowledge gained in the process had not only improved participants' abilities to contribute to commercial discussions but had influenced the way they thought in terms of matters commercial and entrepreneurial as opposed to simply technological. This form of learning model has total transferability worldwide and could be used to stimulate new business development on a global basis.

On this basis the University has developed another model for life-long learning for engineering graduates based on technopreneurship through workplace learning using a learning contract [7]. This development addresses the fact that while engineers who have taken a first degree are well educated in the principles and applications of engineering, as they move into career development and extend their learning through life-long learning there is a need for them to develop a range of advanced transferable skills related to creativity and innovation and to be capable of delivering high technology and entrepreneurship within the workplace. This model has been developed to MSc level using a mixture of modules on entrepreneurship combined with a set of learning goals related to high technology innovation.

LEARNING MODELS AND PEOPLE IN EMPLOYMENT

While highly suitable for those who are graduates, learning models which involve life-long learning at postgraduate level do not provide a suitable model for those who have entered employment without educational qualifications. One of the main problems facing both employers and employees today is the fact that

most people employed in an engineering job probably will not be doing the same job in a few years time and will need to be re-trained. Many of those within the present workforce left school and have not completed any further educational qualifications. Most have had little further training or have not gone through any learning process. It is now accepted within industry and commerce that we are facing increasing international competition in a rapidly changing world and our competitive success primarily depends on training and developing all our existing workforce. There is thus a large mature workforce within the UK who require some form of life-long learning and models to support this type of learning need to be further developed.

In recent years a growing number of employers and education establishments have begun to look at assessed prior experiential learning and to provide credit for this form of learning in the workplace as a base recognition of learning which can then lead to further development. There is little doubt that learning models which are underpinned by prior experiential learning are vital in allowing people who are in the workplace environment and who have no formal qualifications to enter the learning process. Off-campus learning will be much more attractive to many in the workplace as opposed to returning to a formal academic environment where many will feel uncomfortable and their learning will probably be inhibited. The full potential of the workforce can only be realised by creating off-campus learning as an underpinning means of achieving life-long learning for all engineering employees.

Below the small to medium enterprises are the many people either self-employed or who own a small business and it is important that the life-long learning process is also available to engineers in these situations. A learning model based in the workplace which is highly relevant and flexible and supported through good communication via the use of Information Technology is needed. For busy owner/managers, learning off-campus will be essential and interest will only be stimulated if the learning provided is directly relevant to the business objectives of the company.

The type of learning model which will be required for mature workers within organisations who have no formal engineering qualifications will again be based on taking the learning off-campus. Supervision of this type of learning will require the support of good IT communication and one of the essential features of the life-long learning required for a mature group of workers will be the development of a range of IT skills. Using assessed prior experiential learning will demonstrate to mature workers the learning process through which they have gone in the workplace and will lead to further stimulation of interest in more for-

malised learning through a work-based learning contract supported by IT communication. If life-long learning is to succeed, then it must underpin the older worker in particular. The problem in the UK is that ageing is primarily regarded as a process of gradual decline, with the process of continuing maturity being ignored. Most older workers unfortunately are conditioned to believe that basically after the age of 50 everyone suffers from a rapid decline in capability and competence. If life-long learning is to be successful, then this unfortunately established view of ageing will need to be re-thought and re-modelled to accept that ageing brings maturity, wisdom and capability [8].

At present the view that capabilities for work begin to decay in the forties and fifties will inhibit investment in life-long learning unless an alternative view is taken. It has been shown that in the next millennium one of the most important issues will be to facilitate the means by which older workers can be economically productive by introducing a much greater and more flexible variety of methods for the continuation of employment in the workplace. In this respect new models of employment will need to be created which accommodate the older worker [8]. Much of this can be achieved by integrating more flexible workplace methods with learning models which accommodate life-long learning, and making these available to the older worker. In this respect older workers will much more readily respond to the concepts of work-based learning contracts where they are able to identify and negotiate learning which they consider relevant both to themselves and their career. Learning models which could be developed and made available to stimulate life-long learning could be a certificate or a diploma in work-based learning which could be taken forward using a learning contract agreed between the employee, the company and the academic establishment and which could form the basis for entry into more life-long learning.

WORK-BASED AND WORKPLACE LEARNING MODELS

Since 1992 GCU has been involved in the development of off-campus learning at both undergraduate and postgraduate levels, involving both formal learning and work-based learning. This has led to the development of a number of learning models which could facilitate life-long learning in the workplace for engineers. It is now increasingly accepted that self-directed and learner-centred studies are of equal value to formal academic learning on-campus. Work-based learning contracts are now seen as important tools to facilitate the learning process where employees can

begin by reflecting on their practice in the workplace and completing a professional portfolio which documents the developmental activities carried out in the workplace environment. Learning accomplished through learning contracts in the workplace brings the realism of professional practice, where the learning environment contains ambiguities and potential conflict situations. Of paramount importance in the development of models of learning of this type is the need for the employee to negotiate and develop their own learning in agreement with the employer and with the assistance of the higher education establishment. Academic supervisors thus become facilitators in terms of the development of the learning contract process particularly at the beginning of the studies in terms of defining the learning contract. Work-based learning contracts also provide an environment through which employees can develop a cognitive understanding of the continuous professional development process and can test and measure the development of CPD skills within the workplace environment.

The University has developed a successful Postgraduate Learning Contract Framework to facilitate work-based learning from postgraduate certificate level through to professional doctorate level. Each contract is made up of a number of learning goals which are directly related to the employee's workplace. Each goal is allocated credit points determined by the depth of learning and the notional student effort required to achieve the desired performance. These credit points are distributed across the learning goals of the contract and primarily depend upon the degree of learning effort associated with each. The Framework has been so designed to take account of either entry with advanced standing through the submission of an assessed prior learning portfolio or to facilitate the entry of mature employees without formal qualifications through the submission of an assessed prior learning portfolio for entry to the Framework at postgraduate certificate level. In this way the University offers a Framework which provides for maximum flexibility and maximum access for employees.

POSTGRADUATE LEARNING CONTRACT FRAMEWORK

In a recent review of the Framework, and taking into account research and employee feedback, each Learning Contract now has two compulsory goals as part of the total contract. All candidates entering the Framework are required to complete a core goal involving reflective practice and planning. This goal leads to the evolution of the complete learning contract through the candidates completing a reflective analy-

sis of previous practice and identifying the learning achieved, and directly relating this learning to their workplan and agreeing strategic and operational objectives with the participating organisation which leads to defining a set of learning goals which comprise the negotiated Learning Contract. To facilitate investigation and study in the workplace a second, compulsory learning goal is a work-based research methods goal, which involves employees in developing an indepth understanding of the use of research and investigative methods relevant to the workplace environment. These two goals are awarded credit points within the total learning contract according to the notional effort expended in developing the goals. In developing the remainder of the learning contract programme, employees are expected to show the relationship between the research/investigative methods within the work-based research methods goal to the remaining goals comprising the Learning Contract.

To extend the flexibility of the Framework an articulated Learning Contract programme has been developed for candidates who are unable, through a combination of either previous qualifications and assessed prior learning or through a combination of assessed prior learning and assessed prior experiential learning, to demonstrate the equivalence of an honours degree. The employee completes a foundation Learning Contract designed to take account of the credit points required to satisfy equivalence to an honours degree level for entry to the Framework. Introducing the foundation Learning Contract programme further extends the entry possibilities for mature candidates to life-long learning. Candidates who enter the Framework at postgraduate certificate level are able to progress through to the MSc level. For employees who wish to continue their life-long learning by continuing for a professional doctorate, a reflective research capability goal has to be completed successfully prior to transfer to the Doctoral Learning Contract programme. The Postgraduate Framework has been successfully operated over the last six years by GCU both on a regional basis and in Europe [9-11].

OFF-CAMPUS WORKPLACE LEARNING

An alternative off-campus model at undergraduate level has been developed over recent years to provide engineers and companies with a learning process which allows them to achieve a BEng (Hons). This model was successfully tested in British Aerospace Plc and more recently has been taught and implemented in Motorola Plc. It provides for life-long learning for mature candidates at the workplace of the company. The model involves formal academic learning which has been

displaced from the lecture theatre to the company and is underpinned by workplace learning. The mature students enter and articulate to the third year of the degree through an assessed prior learning portfolio or through qualifications which provide direct entry to the third year of the BEng degree. These mature students are able to complete the degree at the same rate as full-time students attending on-campus through the completion of workplace learning. The workplace learning is the notional learning which is achieved while the employee is working within their normal job within the company. The learning being achieved through normal working is mapped and correlated to the outcomes relating to the taught modules within the course and in this way the total notional learning required for each module is achieved. This provides a highly flexible and suitable method for mature entrants wishing to achieve an honours degree in engineering through the life-long learning process where they are able to complete a degree at the equivalent rate of those students attending full-time on-campus.

This model is now being extended and investigated with a view to developing a learning model which encompasses formal taught learning alongside work-based learning and notional workplace learning. The development of such a learning model will provide a life-long learning route for engineering personnel who have not previously been through a formal further or higher education course of study. The model is being developed to take account of experiential prior learning achieved in the work place as an entry qualification, followed by a combination of formal learning provided through either normal lecturing or CIT based methods integrated, with further experiential learning in the workplace and notional workplace learning being accomplished by the employee.

CONCLUSIONS

- A Postgraduate Learning Contract Framework which develops professional practice through work-based learning is an effective model for achieving life-long learning for engineers.
- A learning model involving work-based study relating to the theme of Technopreneurship for engineering graduates is an effective way of achieving life-long learning where a new range of advanced transferable skills are realised relating to creativity and innovation.
- Effective life-long learning can be achieved through an off-campus workplace learning model for mature engineering employees to complete a degree in an engineering discipline.

- Work-based learning will provide an effective way of learning for employees who have not previously benefited from more formal study at a further or higher education establishment.
- If life-long learning is to be successful as the millennium approaches, a significant change in the culture of society is required where it is accepted that all employees can benefit and where ageing is not considered as a loss of capability.
- The maximum widening of access to life-long learning can only be achieved by taking learning off-campus and into the workplace environment where employees are pursuing a life-long career.

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BIOGRAPHIES



Professor Chisholm has been Dean of the Faculty of Science and Technology at Glasgow Caledonian University, Scotland, UK since 1993 and was formerly the Head of the School of Engineering from 1985 till 1992. More recently he has been involved in the development of the Caledonian

College of Engineering in Oman. His research interests are the electrodeposition of metals and alloys and workplace learning. He has been closely involved with workplace learning over the past ten years and led the development of the University Postgraduate Learning Contract Framework for work-based learning. He has published over two hundred papers and supervised over thirty five PhD students.



George R. Burns graduated BSc (Hons) in Applied Physics from Strathclyde University in 1968, and then undertook a postgraduate programme in the Faculty of Electrical Engineering, graduating with a PhD in 1974. During this period he obtained a Diploma in Teaching Prac-

tice. After completing these studies he spent six years teaching physics, then moved to the Scottish School of Non-Destructive Testing at Paisley University. SSNDT was a specialist Industrial Unit that addressed training and research in NDT techniques. In 1986 he moved to Glasgow Caledonian University, Department of Engineering and pursued research interests in Manufacturing Systems Modelling using AI Techniques and the development of Work-Based Learning for Engineers. His current interests are now in Engineering Education research and development and the development of the Caledonian Centre for Engineering Education.

ALLTED - A Computer-Aided Engineering System for Electronic Circuit Design

by A.I. Petrenko, V.V.Ladogubets, V.V. Tchkalov and Z.J. Pudlowski

ALLTED is the fourth publication in the *Monash Engineering Education Series*. The series was established by the UICEE in 1995 in its on-going mission to undertake research and development, and to act as a clearinghouse on information on engineering education. The publication of this book is a joint effort of the UICEE and the CAD Department of the National Technical University (NTU) (Kiev Polytechnical Institute), Ukraine.

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