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Quality Assurance Issues Relating to the Delivery of Work Based Learning Programmes*

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The term *work based learning* is generally understood to refer to a process whereby activity carried out in the workplace can result in learning. The identification and accreditation of that learning makes it possible to consider the award of credit points leading to recognised qualifications. The programmes of study have to meet quality standards judged by internal quality audits and external peer review. This paper first suggests a definition of work based learning and describes how programmes of study have been constructed using various examples developed at the Glasgow Caledonian University in Scotland, the UK. Quality is usually defined by a set of metrics that are measured through procedures defined by the institutional quality systems. The paper suggests a set of metrics typically used to assess whether a programme meets institutional standards and examines how appropriate these procedures are in relation to the work based learning programmes. The concept is extended to reflect the quality assurance (QA) necessary to ratify that workplace delivery of an already validated Bachelor of Engineering programme can be effectively established. The paper concludes by proposing some modifications to enable existing QA systems to accredit work based learning programmes within institutional quality systems and identifies some issues related to delivering work based learning on a global basis.

INTRODUCTION

A major change in the structure of programmes throughout the UK education system has occurred in the last 10 years through the introduction of modular systems and a much greater emphasis on traceable quality assurance (QA) procedures. The modular system allows programmes to be structured through the definition of academic content into modules that identify learning outcomes, assessment modes and assessment time scales. A major effect of this has been the introduction of validation events that are used by all institutions as an internal means of satisfying QA procedures designed to assure that the proposed programme meets the institutional standards. Additionally, validation events may be staged that involve external subject experts as part of the process to ensure that the standard of a proposed programmes is comparable to that offered by other institutions in the same discipline area.

Professional bodies, such as those associated with the health service and engineering also accredit programmes of study in order to assure that the academic standard is appropriate for acceptance of graduates into a grade of membership. How should a programme of study that is work based be examined to satisfy the challenges of these QA systems at institutional level and thereafter satisfy professional institution accreditation?

MODULAR SYSTEMS

The modular system defines a programme in terms of a set of modules that, when taken together, provide a

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programme of study leading to an award. Typically for a degree programme, various levels of award are defined. For example, under the Scottish Credit Accumulation and Transfer Scheme, SCOCATS at first year S1 level, an award of a Certificate of Higher Education is made, at second year S2 level, a Diploma of Higher Education is made, at third year S3 level, a Bachelor degree is awarded and at fourth year S4 level an Honours degree is awarded [1].

To achieve this, a student at Glasgow Caledonian University (GCU) in Glasgow, Scotland, the UK, undertakes six modules per year with a credit value of 20 SCOCATS credit points per module. While the numbers of modules and credits will vary from one system to another the principle remains the same. To achieve this, each module has the following aspects defined in the module descriptor: Learning outcomes, assessment modes, assessment time scales, formal contact structure such as lectures, laboratory studies, tutorials and seminars. A total notional student effort required to deliver the Learning outcomes is also included.

The QA procedures associated with approval of a modular programme will examine at least the following areas:

- Academic content.
- Appropriateness of assessment structure.
- Student support, resources available to deliver the programme.
- The regulations framework within which the programme operates.
- The research that underpins the programme.

The methodology adopted for this type of programme delivered in an institution defines a programme that is suitable for a group of learners who will become students of the institution. The end point of the process of study is the completion of a degree programme and graduation. The final award will be validated by the university and possibly accredited by a professional body. However, if the workplace is not an institution of higher education how does the QA model determine if the programme of study meets the QA requirements for an off-campus location?

LEARNER NEEDS RELATED TO DEVELOPING A PROGRAMME

The institutional approach assumes that all learners who register for a programme of study have a set of educational needs that are met by the delivery of a pre-defined set of modules that form programmes offered by and within the institution. In the workplace, the prescription of a predefined learning package is not always appropriate as it may be that some level of customisation is required.

Customisation in this context would reflect a bias towards applications and case studies that are related to the organisation's needs within the core academic objectives of the programme. It is this interaction between the employee, employer and institution that will shape a work-based programme of study. It is therefore necessary to determine the organisational objectives and individual learner needs and expectations. The organisational needs will be derived from strategic considerations that are then translated to educational objectives for the workforce. Individual needs will arise from appraisal or self-motivation and any proposed programme has to address these individual needs. Ultimately the development of a work-based programme of study will involve partners recognising each other's needs and expectations.

In additional to the drivers identified above, the current status of learners will not usually be defined by the same qualifications as applicants to a university programme. Access to the programme must therefore be designed to assure that the potential students have the equivalent qualifications of those accepted into the university programme. The current attainment of prospective students is generally a combination of qualifications obtained previously (Accredited Prior Learning) and credit for previous experiential learning as determined through Accredited Prior Experiential Learning (AP(E)L) [2].

The difference between the current status and the objective that the learner seeks will define the learning needs. The programme of study may require additional elements in order to address any deficiency that would inhibit the award of a qualification. The learning outcomes derived from the learning needs have to be structured in order to gain credit to meet the criteria for the award of a qualification. To achieve this, the learning outcomes should:

- Be relevant to the qualification sought whereby the content reflects a coherent programme.
- Be at a level that satisfies the criteria for the award.
- Be measurable through appropriate assessment.

On this basis, the definition and structure of the learning outcomes should have regard to:

- The student and the level of study.
- Requirements of other accrediting bodies.
- Is the programme for an individual or a group?

THE LEARNING PROCESS

The learning process can be conveniently divided into two categories: undergraduate and postgraduate. Both are characterised by the discussion above in relation to structure and access. In the undergraduate process the programme will normally be a currently accredited degree for delivery in the university and will require additional QA processes for delivery in the workplace. Postgraduate programmes that are accredited for delivery in the university can also be considered using similar criteria. Typically programmes considered for this delivery will be established for groups of students.

Alternatively, programmes of study may be designed for individual students at the postgraduate level. The delivery of work based learning in this mode will normally be defined by the use of a Learning Contract (LC) or Module Action Plan (MAP). The LC will normally define a complete programme of study while a MAP will normally describe a part or module of a programme. The LC or MAP defines in a formal manner how learning outcomes will be delivered. Whatever form is used to define the learning process, it will be required to describe the following learning support mechanisms:

- Timescales.
- The assessment process.
- Library resources.
- Computing resources.

QUALITY ASSURANCE OBJECTIVES

The objectives of a QA process are to provide procedures by which programmes submitted for approval can be judged to have met institutional standards, to advise remedial action through peer review in order to correct deficiencies, to monitor and assure performance throughout the delivery and to define standards that are required for the award of a qualification.

The functions of QA processes are to provide a set of documentation that shows how a proposed programme has been deemed to meet institutional standards, to monitor delivery procedures to assure all elements have been delivered, to assure that assessment has been fairly performed, to interact with staff and students during the delivery process and to propose and/or require changes as matters arise. The QA function should deliver a traceable path that shows the development, implementation and conclusion of a programme. In less formal terms, the objectives of a QA system are to assure that the student has an effective educational experience supported by all the resources of the institution. The management, monitoring and correction of problems are an essential part of the QA function.

QA - MODULAR PROGRAMMES AND WORK BASED LEARNING

The objectives of a QA system as shown will broadly remain the same whether the programme is institutional or work based in an organisation. The processes that are involved in delivering the QA objectives are described below.

Modular Programmes (Undergraduate and Postgraduate)

Department Level:

- *Subject Quality Group (SQG)*: Has responsibility for ensuring the academic content of the modules comprising the programme is appropriate.
- *Programme Board (PB)*: Has responsibility for monitoring all aspects of the programme within the department.
- *Staff Student Consultation (SSC)*: Forum for discussion of student issues relating to the programme
- *Examination Boards (SAAB/PAAB)*: The Subject Area Assessment Board (SAAB) considers results for individual modules. The Progression and Awards Boards (PAB) considers the overall student performance and recommends progression to the next year or confirms the award.

Faculty Level:

- *Academic Quality and Standards Committee (FAQSC)*: Is responsible for the QA of new programmes and for corrective actions based on the analysis of programme board reports.

Institution Level:

- *Academic Quality Standards Committee (AQSC)*: Has institutional responsibility for ensuring the implementation of quality standards.
- *Validation /Accreditation (V/A)*: The formal approval of a programme involving external peer review.

Work Based Learning (Postgraduate)

- *Academic Staff Role*: Responsible for agreeing the academic content of the proposed programme.
- *University/Employer*: Responsible for establishing that programme meets academic standards for

the proposed award and that resources are available in the workplace and the university to support the proposed programme.

- *Academic/External Assessor*: Responsible for the peer review process of assessment.

The organisation of these processes to monitor the QA objectives for modular and work based programmes is shown in Table 1.

Table 1: QA and related processes.

QA Objectives	Process	
	Modular programme	Work based learning
Academic Content	SQG	Academic
Assessment	SQG	Academic
Staff/Students	SSC	Univ./Employer
Resources	Dept/Univ.[1]	Univ./Employer
Regulations	Dept/Univ.	Dept/Univ.
Examination	Dept/Ext. Ass[2]	Academic/Ext.Ass
Research	Dept	Dept

Note: [1] University; [2] External Assessor

This simple model of QA objectives and the responsible QA process shows immediately some basic differences. Typically, these are resolved by using processes for work based learning that are similar to the modular programme but are responsive to the QA needs in relation to work based learners.

The division of the processes in relation to undergraduate and postgraduate programmes is shown in Table 2. The processes generate the evidential base for traceability. Note that module programmes are taught programmes at the postgraduate or undergraduate level, and work based learning is a postgraduate programme.

Postgraduate work based learning is intended to enable individuals to prepare a programme of study that meets personal aspirations, fulfils company strategic objectives but still satisfies the appropriate QA standards. No matter what level of programme is being considered, the student must satisfy the specified academic requirements and the institution must ensure that their experience is no less than students studying on-campus. In addition, a QA review of work based learning programmes must establish the equivalence of student experience. Table 3 illustrates the distribution of effort in maintaining the QA function across the range of institutional processes that underpin the QA function.

Methods of Delivering the QA Objectives

The current arrangements for QA generally require some considerable effort in the preparation of documents and it is difficult to modify processes to respond to situations that arise through interaction with industry. The development of company-based universities adds further pressure for institutions to respond to the changing demands that are placed on educational institutions with QA processes that recognise these challenges.

The process of QA is often viewed by academics as an imposition on the process of development. Usually they complain that the QA is applied at the end of the development process. QA that is embedded in the development process offers the possibility of a more flexible approach. Programme development is an abstract process that results in a set of learning objectives that are organised into modules and deliv-

Table 2: Evidential base for quality assurance.

QA Objectives	Student Group	
	Modular programme	Work based learning
Academic Content	SQG	Peer Review
Assessment	SQG	Peer Review
Students Support	Dept/Univ.	Academic/ Mentor
Resources	Dept/Inst.	Univ./Mentor
Regulations	Dept/Inst.	Dept/Univ.
Examination	Dept/ Ext. Ass	Academic/ Ext. Ass
Research	Dept	Dept

Table 3: QA objectives and the processes responsible.

	Process Responsible						
QA Objectives	SQG	PB	FAQSC	AQSC	SSC	V/A	EB
Academic Content	☐	☐	☐	☐		☐	☐
Assessment	☐	☐	☐	☐		☐	☐
Student Support		☐		☐			
Resources	☐	☐	☐		☐		☐
Examinations	☐					☐	
Regulations				☐			
Research	☐					☐	

ered as a programme of study. A comparable abstract process is that of software development where it is costly to rectify errors which occur during the process of development. Software engineers have developed a quality factor approach that is used during the development phase as part of process reviews [7].

The development of a similar process for programme QA that allows for factors other than the standard university processes to be considered is suggested. For example, if one considers student support then generally this would be satisfied by statements such as:

- Department operates a personal tutor scheme.
- Student services are available on campus.
- Resources are available for students to meet with staff.
- Processes are in place to deal with student complaints.

One approach can be developed as shown in the example in Table 4. By incorporating responses that represent a standard expectation, this can be converted into a factor/standard response sheet. For example, in a personal tutor scheme, the initial response would be to identify whether or not such a scheme is operated and so the response is *Yes* or *No* (Y/N). Additional aspects of this can then be requested such as the number of students per tutor and meetings per term. The standards define the range of responses that are available and recording these gives a measure of conformance to the overall standard.

Table 4: Factors and standards.

Factor	Standard	Response
Personal Tutor Scheme:	Y/N	Y
Number of students per tutor	8 Max.	4-8
Meetings per semester	1 Min.	1
Student Services:		
Welfare arrangements:	Y/N	N
Financial advice	Y/N	No response
Health advice	Y/N	No response
Academic Standards:		
Module approved	Y/N[1]	Y(SQG)
First Year approved	Y/N[2]	Y(PB)
Second Year approved	Y/N	Y(PB)
Third Year approved	Y/N	Y(PB)
Fourth Year approved	Y/N	Y(PB)

Note:

[1] Y/N response is accompanied by a reference to the approving committee, eg Subject Quality Group (SQG) in the department hosting the programme.

[2] Y(PB) identifies that the Programme Board of the host department has approved the structure of year one.

These are examples of how the process works. The advantage of this is the definition of items associated with a particular metric and a simple definition of the required conformance.

The example is an illustration of how this approach might involve subject quality groups and programme boards in delivering QA processes as a part of the programme development. In this model, the Subject Quality Group (SQG) and the Programme Board (PB) are participants in the programme development, as well as fulfilling QA tasks. The resulting submission to faculty then has appropriate quality factor sheets authenticated by the required departmental committees in conformance with QA procedures. The most significant advantage of this approach is the ability to define a metric that addresses given situations. Although a general system might at first sight appear more prescriptive than many currently in use, it has the advantage that it can be readily implemented as part of the process of programme development.

QUALITY ASSURANCE FOR WORK BASED PROGRAMMES

To determine equivalence of provision in the workplace involves ensuring that the academic content is appropriate, that resources are available and that the student can devote the required amount of notional effort to complete the programme of study. Fulfilling these conditions will produce different challenges depending on the exact nature of the proposed programme. Some examples of these are drawn from programmes already being delivered at the GCU.

Postgraduate

A postgraduate work based learning programme, such as the *Postgraduate Learning Contract Framework* at the GCU, allows the development of programmes of study that reflect the aspirations of an individual employed by an organisation [3][4]. The QA systems required for this programme are very similar to that used for research degrees.

The outcome of the system is an approved programme of study, agreed assessment targets, an approved external assessor, an industrial mentor and a monitoring system to ensure student support and feedback. An example of a taught Master of Science delivered off-campus is the MSc in Maintenance Management delivered to staff of the Post Office at sites in the UK [5]. This MSc is a validated programme using modules drawn from the university module catalogue. Because the programme is not delivered within the university, a QA procedure was required to

validate the training centres to be used. The process was invoked under the issues of resources and equivalence of student experience.

The two programmes described here present the QA system with different challenges compared to a conventional university modular programme. The key issue for both is the provision of a student experience that can be verified equivalent to that of a student on an equivalent programme delivered within the university.

Undergraduate

Within the GCU, a number of different work based programmes are delivered. The most comprehensive of these is delivered in the workplace that enables students to study for a Bachelor of Engineering degree. This programme is delivered to a group of students who work for Motorola Plc.

The timescale of delivery is the same as for normal full-time students within the university. The programme is validated and conforms to all the necessary university regulations relating to QA. The delivery mode raises two additional issues, namely resources available within the workplace and the ability of students to deliver the required notional effort to complete the programme in the same time as full-time students in the university. The issue of resources was resolved by arranging a visit to the company site by a QA team from the university, who were able to confirm that the resources available within the company were appropriate for the students.

In considering how students, who are normally in full-time employment in industry, may undertake the same programme of study as traditional full-time students, it is necessary to consider the practicability of how those students deliver 175 hours of notional effort per 20 credit module as prescribed within the validated on-campus degree. In the main, the lecture and tutorial activities are delivered in line with the standard module descriptor. It is the balance of the notional hours that requires further consideration within the context of this programme and the contribution of workplace activities to learning.

WORKPLACE LEARNING

Workplace Learning is considered to impact on the student in a number of diverse ways that support the development of knowledge, understanding and skills, as well as insight and relevance of the subject matter being studied. Development of this type will assist the student in their reflection upon and consideration of the academic content of the programme, application in a real engineering environment, and preparation for assessments and examinations. Using the concept of metrics, identifiable relations between the work environment, the academic content and the learning outcomes of the modules being studied have led to a mapping procedure being developed. The objective of this mapping procedure is to quantify the contribution of the work environment to the notional effort required by the student.

To determine the equivalent notional effort resulting from workplace learning an analysis of how the workplace activities support the learning outcomes for each module using the concept of quality metrics was prepared. The factors represented were the workplace activities and the learning outcomes. The impact of the workplace varies from module to module depending on the subject material. The allocation of notional benefit to the student was determined through discussion with senior engineers from Motorola who offered advice on the relative importance of workplace activity to the academic content of each module. In this way, using the guidelines outlined below, a quantitative contribution towards the notional student hours effort may be established.

GUIDELINES FOR THE ALLOCATION OF NOTIONAL HOURS

Two general headings were considered for the allocation of notional hours:

- Support of the learning outcomes of modules through reflection based on workplace activities.
- Development of interpersonal skills such as teamwork, report writing and presentation skills through specific learning outcomes and workplace activities.

To assist in the notional hours allocation, each learning outcome for an individual module is rated against workplace activities as:

- Highly supportive of the learning outcomes.
- Supportive of the learning outcomes.
- Limited support for learning outcomes.

To assist in this analysis, a mapping grid was developed as shown in Table 5, which allows learning outcomes to be assigned ratings in respect of workplace activities developed. The support of the workplace for the notional effort of the student in delivering the learning outcomes of the modules is assessed in terms of the activities listed. Based on these mapping grids, a rating for the module under

consideration is assigned from the grading table, as shown in Table 6.

The allocation of a rating to a module involves the construction of the mapping grid that relates the impact of the workplace activities on the learning outcomes of that module. Once the grid is complete, it is examined to determine the number of learning outcomes that are supported by the workplace and to what extent the workplace activities support them. The mapping grid for the module ENG320 is shown in Table 5. The grid shows that six of the seven learning outcomes are supported by the workplace. For this module, the workplace is deemed as highly supportive for four of the learning goals and supportive of the learning outcomes for two others. Thus, for this module, more than 85% of the learning outcomes gain direct support from the workplace, hence the rating of five. Table 7 shows a comparison of several modules.

Using these ratings in conjunction with Table 8 and incorporating a base allowance of 10 hours for the interpersonal skills that all students will develop as a result of their work activities, a total notional hours contribution from the workplace for each module was derived.

CONCLUSIONS

The development of modular programmes has allowed the development of uniform QA systems that have consistency and traceability when used in conjunction with standard university programmes. Workplace education is not a standard delivery system. Typical QA systems are designed to process standard evidence of compliance.

The examples used in this paper illustrate that in some cases the existing QA processes can be used

Table 5: Typical example of a mapping of the support of work activities for learning outcomes for the module: Casework and Design Studies, ENGE320.

Workplace Activities	Learning Outcomes									
	1	2	3	4	5	6	7	8	9	10
Management										
Leadership										
Teamwork										
Presentation										
Communication										
Planning										
Engineering Practice										
Development										
Specification										
Design										
Build										
Research										
Investigation										
Analysis										
Application										
Business Issues										
Marketing										
Quality & Reliability										
Monitoring										
Continuous Improvement										
Analysis										
Reporting										

~~Learning Outcomes~~

On completion of this module the student should be able to:

- Demonstrate a creative approach to the problem presented.
- Use the technical knowledge gained in other modules to justify decisions.
- Demonstrate an awareness of business factors that determine the marketability of a product.
- Assess where they lack knowledge and how that knowledge might be acquired.
- Retrieve information from a library and know the range of information that can be accessed.
- Work independently and in groups. Plan a course of action to achieve a goal in conjunction with colleagues where appropriate.
- Communicate information to other engineers through a short report, talk or poster presentation.

Table 6: Module Grading Scale.

Assessment of Contribution	Graphic/Rating
Related to general development of Professional Engineering Skills	1
Directly related to general development of Professional Engineering Skills	2
Work related contents offers limited support for learning outcomes	3
Work related contents supports learning outcomes	4
Work related contents is highly supportive for learning outcomes	5

Table 7: Comparison of modules.

Module Title	Module Code	Comment	Rating
Casework and Design Studies	ENGE 320	*Highly supported*	5
Electronic Engineering	ENGE 327	*Supported*	4
Signals and Communication	ENGE 428	*Highly supported*	5

Table 8: Allocation of notional hours contribution.

Module Rating	Workplace Allocated Notional Hours	Interpersonal Skills Base Allocation	Workplace Total Notional Contribution
1	5 10%	10	15 20
2	10 15%	10	20 25
3	15 20%	10	25 30
4	20 25%	10	30 35
5	25 30%	10	35 40

almost unchanged, as has been acceptable for specific modules in a programme, whereas others pose issues that are not readily addressed within existing procedures. The problem here is not helped by the fact that recent information from the Quality Assurance Agency suggests that work based learning does not fit readily into the benchmarking process for subject groups.

As work based learning is not specifically subject based, it is not surprising that it cannot be benchmarked in the same way. Thus, an alternative way of benchmarking will have to be developed to allow comparison across universities. Most probably, benchmarking will be required to take the form of generic descriptors at different levels.

The implementation of the modular system in programme design has led to the requirement for a more rigorous QA system in academic institutions. Programmes of study within the institution are subject to requirements to conform to these QA procedures. The emergence of a wider acceptance of the learning opportunities in the workplace has led to work based programmes. Work-based programmes do not always fit readily into established *in-house* university QA procedures that have primarily been developed to meet the needs of on-campus programme delivery.

The general features of this approach can be applied to any work based programme. However, it must be noted that the work environment that offers direct support for the principal areas of academic study is the best environment. In the case of the Bachelor of Engineering programme, the QA procedures involved all of the stages described in Table 3.

Additional evidence to support the proposed equivalence of student experience was presented in the form of the mapping shown in Table 5 and the analysis of notional effort shown in Table 9. These mappings provide the necessary evidence to establish the equivalent notional effort that can be attributed to the students' workplace environment within Motorola Plc.

Other undergraduate programmes make use of work based learning in specific modules. To accomplish this, they are required to present the modules to a Subject Quality Group to approve the processes to be used, the assessment, the delivery and supervision of students. The development of similar mapping procedures for single modules using the approach outlined in this paper would offer an acceptable QA process for work based learning components of undergraduate programmes.

The QA systems and procedures developed as part of the work based learning paradigm at the GCU and described here have a transferability across different programmes that involve workplace environments in the delivery of learning.

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Table 9: Notional effort analysis.

Module Title:	CASEWORK AND DESIGN STUDIES

Module Code:	ENGM320

Module Structure

Learning Methods	Notional Hours in Module				
	In-House Students	Motorola Students			
		Study Centre*	Workplace Contribution	Other Study	
Lectures		5			
Practical					
Seminars	12	4			
Tutorials		10			
Directed Learning					
Independent Learning	56	16	25	15	
Assessment	4	1	4		
Private Study	103		40	55	
Total Notional Effort		36	69	70	
Notional Student Effort	175	Motorola Total Notional Student Effort			175

* *Study Centre: at the GCU or accredited site*

Weekly Hours		3	4	5	
				Total	12

Weekly hours do not include time spent on assessments, as this tends to be concentrated towards the end of the semester and students are given leave to attend these.

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 also received a number of awards for published papers presented at international conferences.