Learning about IT and learning using IT - A review of current practice on Higher Education AEC Programmes in Ireland

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ABSTRACT

There is a debate concerning the appropriate extent, content and delivery of IT education for AEC programmes. The aim of the research work described in this paper was to generate information to assist the debate, specifically in Ireland, but the results and conclusions may also be of relevance to other countries. A survey of the relevant Heads of Academic Departments in the Universities and Institutes of Technology was carried out in June 2006 with a response rate of 89%. The context to this survey has been the relatively unique development of Ireland over the past ten years (population, economy, IT, construction industry, and higher education) in comparison to other European countries. The recent implementation of the Irish National Framework of Qualifications (NFQ) and its relationship with the European Qualifications Framework (EQF) for lifelong learning is also an important contextual issue for this research. The survey results include the range of specific software training on the AEC programmes, as well as the extent of inclusion of basic IT training, understanding how computers work, understanding and writing computer programmes, consideration of Building Information Modeling (BIM) and the use of Learning Management Systems (LMS). A further interesting feature of the survey has been the identification of the record number of students on higher education AEC programmes in Ireland.

Key words – IT, AEC, higher education, qualifications framework, Ireland, survey

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1.0 INTRODUCTION

The appropriate extent, content and delivery of IT education on AEC programmes are important issues for those directly involved in higher education and indeed the wider AEC industry in general as it seeks to continuously improve. This topic is one of a number that the Construction IT Alliance (CITA) is addressing as part of its mission *'to actively encourage the Irish construction industry to take full advantage of current and emerging information and communication technologies'*. CITA was established in 2001 and although the focus to date has been on the use of IT by the various companies directly involved (designers, consultants, contractors, suppliers etc.), the role that the Universities and Institutes of Technology play is recognised as being critically important. Not only are they largely responsible for providing the undergraduate education and training for the participants in the industry, but they are increasingly involved in related post-graduate, research and CPD activities. An Academics Special Interest Group (SIG) has been established within CITA to promote IT–focused discussion and collaboration between the various higher education institutions in Ireland that run AEC programmes.

The main objectives of the research for this paper were as follows:

- To identify the specific number and type of AEC programmes in Ireland (National Framework of Qualifications Level 6,7,8,9,10) in Irish Universities and Institutes of Technology.
- To identify the extent of IT education and training that is incorporated in these programmes.
- To identify the extent of use of Learning Management Systems (LMS) in the delivery of the programmes.

Central to addressing these objectives was a survey of the relevant Heads of Academic Departments that was carried out in June 2006. The majority of the results of this survey are given later in this paper. Prior to the presentation and discussion of these results however there is some reflection on the context for the survey.

2.0 IRELAND IN A EUROPEAN CONTEXT

Ireland has experienced a number of significant and somewhat unique changes over the past ten years. The context to the extent and pace of these changes, including comparison with other European countries, are reflected upon in the following sections under three main sub-headings:

- Population, Economy and IT
- Construction Industry
- Higher Education

2.1 POPULATION, ECONOMY AND IT

The recent census calculated the population of Ireland at 4.235 million, the highest in more than 135 years (CS0, 2006). The approximate 400,000 (8.1%) rise in the four years since the last census corresponds to the estimated number of foreign nationals currently living in Ireland. It is interesting to note that approximately 40% of all migrant workers have a third level degree or higher, compared to just 16% of Irish workers (ESRI, 2006). Looked at from a ten year perspective 1996-2006, Ireland's population growth rate (annual average = 1.6%) has been the highest in the EU. The report 'European Population Outlook 2020' (NCB, 2006) identified that Ireland's population structure is unique in comparison with the rest of Europe. One of the more interesting statistics that relates to inward migration in 2006 was the estimated 5000 US citizens that applied for Irish work permits, about three times the equivalent number of Irish who have applied to live and work in the US (LaCapra, 2006).

The unemployment rate in Ireland has been consistently at about 4.2% for the past four years (CSO, 2006). The Irish GDP and GNP figures for 2006 were calculated as €176 and €149 billion respectively (DoF, 2006). There is a relatively large gap between GNP and GDP in Ireland because of profit

repatriations of the multinational sector and foreign debt servicing costs. In their most recent economic survey of Ireland, the OECD (2006) made the following summary: *'Ireland has continued its exemplary economic performance, attaining some of the highest growth rates in the OECD. After a remarkable decade, per-capita income has caught up with and overtaken the EU average. Further progress will require strong productivity growth and continued increases in labour supply. These challenges are familiar to most OECD economies. But it also faces some issues that are less common: it is going through a transition phase in upgrading its social services; infrastructure levels need to catch up with the boom in activity and population that has occurred over this period; and it has to manage some sizeable macroeconomic risks.'*

One of the challenges that the OECD referred to is the development of broadband infrastructure and services in Ireland. According to the European Competitive Telecommunications Association (ECTA, 2006), Ireland is a *'laggard'* when it comes to providing broadband access. Ireland ranks 14 of 15 in the ECTA Broadband League Table with the Scandinavian countries of Denmark, Finland and Sweden occupying three of the top four positions.

2.2 CONSTRUCTION INDUSTRY

The Construction Industry in Ireland 2006 accounted for close to a quarter of economic activity in the state as well as for one in every four jobs created in the economy (CSO, 2006). Table 1 below summarises the overall statistics for the industry and the comparable figures for EU25.

Construction Industry	Ireland	EU25
2006 Output	€36.5 billion which represented 24% of GNP and 20% of GDP	€1260 billion - The typical values fall in the range 12 to 14% of GDP
2006 Employment	277,800 directly employed which was approximately 14% of the total workforce	Spain and Cyprus have similar shares to Ireland while most of the EU 25 countries have construction employment shares of between 6% and 9%

Table 1: Summary of Ireland and EU25 Construction Industry statistics (adapted from DKM, 2006 and Craig, 2006)

The Irish figures represent a remarkable rise on those for 1996 (86,000 – DoE&LG, 1997) as in that ten year period the number of people directly employed has more than trebled. However after a sustained period of expansion, predictions for the short to medium term are more modest. A number of commentators have predicted a drop in the residential construction output in the medium-term, but there are varying opinions as to the extent of that drop. The current *'unprecedented level of house building at 20 units per 1,000 of the population compared with an average of only 5.5 in Western Europe'* (DKM, 2006) is widely recognised as being unsustainable. As residential construction in 2006 represented approximately 60% of the total construction output the consequences of any significant drop in this sub-sector for the overall sector and the economy in general are serious.

2.3 HIGHER EDUCATION

The overall growth in the numbers of students in Irish Higher Education institutions is outlined in Table 2 below. The rapid development of the Institutes of Technology (13 of 14 created since 1970) has been a key element in this growth. However the five established universities (TCD, UCD, UCC, NUIG, NUIM) and the two relatively new universities (UL, DCU) have also substantially increased their student populations in that period.

Higher Education	1965/66	1975/76	1985/86	1995/96	2003/04
Full-time students	19	32	53	95	134

Table 2: Past enrolments of full-time students in Irish Higher Education institutions (thousands- adapted from HEA, 2006).

In their review of Higher Education in Ireland, the OECD (2004) referred to a range of issues including participation rates and funding. They also pointed out the relative lack of students at postgraduate level. *'These numbers do not match national aspirations and in particular PhD numbers are far too low to service the growing commitment to publicly funded research to provide an adequate pool to replace existing staff or to work in R&D in the private sector.'* They proposed that PhD numbers need to be doubled *'as a matter of urgency'*. This proposal has subsequently been endorsed by a number of bodies including the government funded Expert Group on Future Skills Needs (EGFSN). Not only has the EGFSN stated (2007) that *'Ireland should aim to build capability at fourth level and double its PhD output by 2013'* it has also set other targets for the Higher Education sector. These include increasing the overall progression rate to third level 70% over the period to 2020 with specifically '*48% of the labour force should have qualifications at National Framework of Qualifications Levels 6 to 10'*.

The 'Strategy for Science Technology and Innovation – 2006:2013' (DoET&E, 2006) is regarded as Ireland's first *'national research investment plan'*. When referring to this plan, the Chief Executive of the Irish Higher Education Authority (Boland, 2006) stressed the importance of collaboration between Universities and Institutes of Technology in order to achieve world-class education and research. An impressive €8.2 billion has been subsequently allocated in the recently published National Development Plan (NDP2) to education and research in Ireland over the next seven years (Government of Ireland, 2007). An interesting feature of the NDP2 is the stated policy of promoting collaboration between Higher Education institutions for funding and also the specific encouragement of collaboration with counterparts in Northern Ireland, particularly Dundalk, Sligo and Letterkenny Institutes of Technology who are all adjacent to the border.

3.0 NATIONAL AND EUROPEAN FRAMEWORK OF QUALIFICATIONS

The National Qualifications Authority of Ireland (NQAI) was established in February 2001. One of the key outputs from the NQAI has been the creation of the National Frame National Framework of Qualifications (NFQ) which is defined as follows (NQAI, 2003): *'The Framework comprises ten levels, with each level based on specified standards of knowledge, skill and competence. These standards define the outcomes to be achieved by learners seeking to gain awards at each level. A key aspect of the awards at different levels is that they are made on the basis of 'learning outcomes'*. The Institutes of Technology in Ireland are engaged in NFQ Levels 6,7,8,9 and 10 while the Universities focus exclusively on NFQ Levels 8,9 and 10. It should be noted that there is an on-going debate as to the current and future roles and relationships of the Universities and Institutes of Technologies, particularly in relation to NFQ Levels 9 and 10. These Levels are increasingly referred to collectively as '4th level'.

In parallel with the development of the NFQ in Ireland has been the development of the European Qualifications Framework (EQF) for lifelong learning. The Commission of the European Communities (2006) adopted in September 2006 a proposal for a Recommendation of the European Parliament and of the Council on the establishment of the EQF. The adoption of the proposal follows almost two years of consultation across Europe. Ján Figel, European Commissioner for Education, Training, Culture and Multilingualism stated (2006) *'the EQF will make different national qualifications more understandable across Europe, and so promote access to education and training. Once adopted, it will increase mobility for learning or working. We believe the EQF is a key initiative in creating more jobs*

and growth, helping people in Europe to face the challenges of a globalising, knowledge-based world economy'. The core element of the EQF is a set of eight reference levels describing what a learner knows, understands and is able to do, i.e. their 'learning outcomes'. The draft recommendation foresees that Member States relate their national qualifications systems to the EQF by 2009. Table 2 below summarizes the relationship of the current Irish higher education awards, their NFQ Level and their European Credit Transfer System (ECTS) to the relevant Bologna Cycle and EQF Level.

NFQ Level	NFQ Award Title	ECTS Credits	Bologna	EQF Level
6	Higher Certificate	120	First Cycle	5
7	Ordinary Bachelor Degree	180	First Cycle	5
8	Honours Bachelor Degree	180-240	First Cycle	6
9	Masters Degree Post-Graduate Diploma	60-120	Second Cycle	7
10	Doctoral Degree	180	Third Cycle	8

Table 3: Summary of Awards and Levels in Irish Higher Education

4.0 IT AND AEC EDUCATION

Menzel (2006) identified the potential role that IT can play in assisting professionals address the challenges and changes of the current and future AEC industry. *'Information and Communication Technologies can contribute to mastering this change by delivering holistic, integrated and personalized teaching-learning environments'.* Frose (2006) referred to the three main eras in construction IT namely: (i) developing stand alone tools; (ii) computer-supported communications; (iii) uniting all processes and applications through full integration and interoperability into a *'cohesive overall system'.* Thomas (2004) stated that *'if the AEC industry is to make faster progress towards harnessing the true potential of IT, the education of the different professionals at all levels should be carried out in a more pro-active and integrated manner.'*

The question as to the precise nature and extent of IT education that is required for the modern AEC professional has also been questioned by a number of authors in recent years. Of all of the AEC disciplines it would appear that the associated debate in relation to civil engineering is greatest. Rebolj and Tibaut (2006) reflected on this debate, including the different views purported by Heitmann et. al. (2003) and Abuydayyeh (2004), and concluded that *'the question is still open on what body of knowledge in computer science and IT a civil engineer should master'.* Much of the difficulties in coming to a definitive answer in relation to the education of AEC professionals is that each discipline and, to a lesser extent, each higher education programme is different. Add to that the on-going developments in IT for the AEC industry, the impossibility of the task becomes obvious. Rebolj and Tibaut do however believe that there is a 'stable part' or core fundamentals in relation to three basic aspects: (i) information representation; (ii) information processing; and (iii) communication.

In addition to learning about IT, the use of IT in the learning process is also an important concern for AEC programmes. Grubl et. al. (2006) point out that the developments in the use of IT in education are '*characterized by terms such as distance education, blended learning, tele teaching, elearning, web-based learning, flexible learning and the two new ones rapid learning and mobile learning. Clear definitions and above all precise demarcations between the terms are difficult.'* In addition Wall et al (2006) point out that *'e-learning is not only an application of technology to teaching, but it is a new business model for higher education'.* Of all of the range and levels of AEC programmes, the use of IT to facilitate postgraduate and particularly CPD learning, is perhaps of most benefit. '*It is widely*

recognised by leading construction companies that organisations that possess higher skills can make more money, have more satisfied clients and complete more projects on time' (Ellis and Thorpe, 2004). Furthermore Wall and Ahmed (2007) argue that '*for busy professionals who wish to access CPD, traditional classroom instruction is often not flexible enough*'. In relation to variety of Learning Management Systems (LMS) currently available, all of them aim to deliver four main features; (i) delivery of learning content, (ii) tracking of participant performance, (iii) management of online learning and (iv) provision of tools for participant collaboration (Watson and Ahmed, 2004). Whatever about the LMS and how it accessed and used, the recognition that all learners are not the same is also essential. According to Zemsky and Massy (2004) the adoption of e-learning follows the classic S-curve for technology adoption. This adoption rate is influenced by a number of factors, particularly the role of lecturers/tutors and students, and a number of these factors were referred to in the survey described below.

5.0 SURVEY METHODOLOGY

Given the wide variety of disciplines and participants in the AEC industry, defining what constitutes an 'AEC programme' is not a straightforward process. Although there are significant numbers of students who are undergoing construction craft apprenticeships in the Institutes of Technology, these were not included in this study. Nor were the Universities and Colleges in Northern Ireland. The study was limited to the NFQ Level 6,7,8,9 and 10 programmes that are exist or were about to commence in the Universities and Institutes of Technology based in the Republic of Ireland in June 2006. An initial review of all higher education websites was carried out to identify the names of the relevant Departments and the general range of AEC programmes. This process identified 5 of the 7 Universities and 11 of the 14 Institutes of Technology (see Figure 1 below).

Universities

1 University College Cork (UCC)
2 University College Dublin (UCD)
3 National University of Ireland Galway (NUIG)
4 The University of Dublin (TCD)
5 The University of Limerick (UL)

Institutes of Technology

6 Dublin Institute of Technology (DIT)
7 Athlone Institute of Technology (AIT)
8 Cork Institute of Technology (CIT)
9 Dundalk Institute of Technology (DKIT)
10 Galway Mayo Institute of Technology (GMIT)
11 Institute of Technology Carlow (ITC)
12 Institute of Technology Sligo (ITS)
13 Institute of Technology Tralee (ITT)
14 Limerick Institute of Technology (LIT)
15 Letterkenny Institute of Technology (LYIT)
16 Waterford Institute of Technology (WIT)

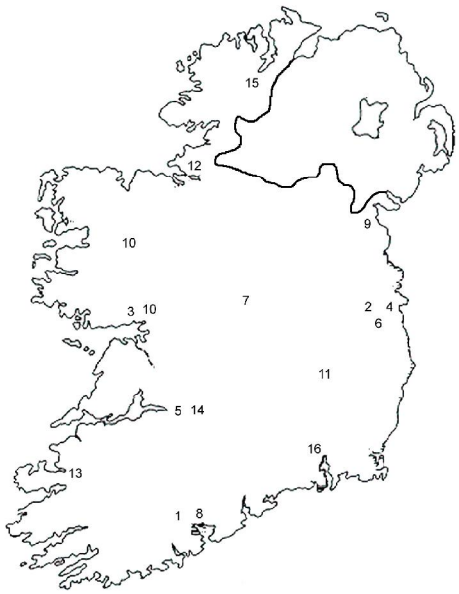

Figure 1: Universities and Institutes of Technology in Ireland engaged in AEC programmes (NFQ Levels 6-10), June 2006

A questionnaire was prepared, piloted and modified before being sent to the Head of each identified Department. In five of the identified organisations, more than one Head of Department was contacted.

Prior to the sending of the questionnaire each of the Heads of Departments were contacted by phone or email to inform them of the research and to ask for their participation. Of the twenty seven people identified and contacted, forms were completed and returned by twenty four (i.e. 89% response rate). For the purposes of this study the system was used as outlined in Table 4 below to classify such programmes under the five broad headings of Engineering, Architecture, Economics, Management and 'Other'. It is recognised however that there are difficulties in establishing clear boundaries between these categories and a number of the programmes are listed in one category but include significant elements/content from other categories (e.g. Structural Engineering with Architecture).

Engineering	Civil Engineering, Civil & Water Engineering, Civil & Environmental Engineering, Environmental Engineering, Structural Engineering, Structural Engineering with Architecture, Building Services Engineering, Sustainable Energy Engineering, Civil Construction Works, Highway Traffic Engineering
Architecture	Architecture, Architectural Science, Architectural Technology, Interior Architecture, Urban Design, Conservation, Urban & Building Conservation
Economics	Quantity Surveying, Construction Economics, Construction Economics & Management, Property Economics, Property Studies, Real Estate
Management	Construction Management, Construction Management & Engineering, Building Management, Site Management, Construction Technology & Management, Building & Services Management, Facilities Management, Construction Project Management, International Construction Management, Project Management, Construction Law & Contract Administration
Other	Construction, Building, Construction Technology, Building Surveying, Construction Health & Safety, Applied Building Repair & Conservation, Fire Safety for Engineers

Table 4: Classification of AEC programmes in Irish Higher Education.

6.0 SURVEY RESULTS

Not all of the questions and associated answers that were included in the survey are shown below. The majority however are, and these have been grouped under the following three sub-headings:

- AEC Programmes and Student Numbers
- IT Education and Training
- Learning Management Systems (LMS)

6.1 AEC PROGRAMMES AND STUDENT NUMBERS

There are two questions included in this section, A1 and A2.

Q.A1 Please list all of the undergraduate and postgraduate AEC education programmes currently being delivered in your Department.

The numbers of students on AEC programmes at NFQ Levels 6,7,8,9,10 in each of the Universities and Institutes of Technology are summarised in Table 5 below. For the three of the twenty seven Departments that did not reply, the official return figures from the Higher Education Authority for the previous academic year were used (HEA, 2006). Although not specifically identified in Table 5, the extent of students attending Institutes of Technology (8045/81%) compared to the Universities (1927/19%) is interesting. This reflects the substantial growth of Institutes of Technologies, both in terms of the range of AEC programme disciplines and NFQ Levels. While the largest cohort of students are currently on Level 8 programmes (4534/45.5%) there are also significant numbers of students on Levels 6 (1869/18.7%) and 7 (3046/30.6%). The figures at Levels 9 (439/4.4%) are relatively small and the majority of these students are on taught post-graduate diploma or taught MSc

programmes. The numbers at Level 10 (84/0.8%) is not surprisingly the lowest, but the overall number reflects the relative lack of AEC doctoral research in Ireland.

NFQ Level	6	7	8	9	10	TOTAL
Engineering	1034	1151	1713	188	78	4164
Architecture	0	808	648	49	6	1511
Economics	0	553	1199	33	0	1785
Management	0	223	784	119	0	1126
Other	835	311	190	50	0	1386
TOTAL	1869	3046	4534	439	84	9972

Table 5: Summary of Student Numbers on AEC Programmes NFQ Levels 6-10

Q.A2 Please list any new/additional AEC education programmes that your Department is planning to run in 2006/7.

One of the Universities and nine of the Institutes of Technology indicated that they were planning to run a total of thirteen new AEC programmes in 2006/7 in addition to their current portfolio. Five of these programmes were classified under Engineering; two each under Architecture, Economics and Management; and two 'Other'. Six of the programmes were to be at NFQ Level 7, five at Level 8 and two at Level 9. Of particular interest to this survey was the Level 9 'MEngSc IT in AEC' that UCC planned to run in conjunction with the ITC-Euromaster programme.

6.2 IT EDUCATION AND TRAINING

There are six questions included in this section, B1-B6.

Q.B1 Is basic IT training on your undergraduate programmes? **Yes: 92%**

The two Departments that said they do not include such training indicate that they expect their students to have this training prior to attending their University programme. This expectation is also been common in many universities in the US in recent years and it is likely to increase as students obtain the basic IT skills at a younger age through a combination of study and personal/home usage.

Q.B2 Is 'understanding how computers work' among the learning outcomes of your programmes? **Yes: 71%**

It is perhaps surprising that almost one third of the respondents indicated that they did not include understanding how computers work on their programmes. Having at least a basic 'understanding of how computers work' could be regarded as a fundamental requirement for all disciplines.

Q.B3 Is 'understanding and writing computer programmes' among the learning outcomes of your programmes? **Yes: 42%**

The respondents that replied positively to this question were all in the 'Engineering' category. The need to be able to understand and compile software would not appear to be regarded by the other discipline categories as essential or important.

Q.B4 Is the move to more integrated IT systems and Building Information Modeling (BIM) in the AEC industry included in the syllabi of your programmes? **Yes: 54%**

This result was both surprising and encouraging from the author's perspective. As the industry progresses into the 'third era of construction IT' (Frose, 2006) it is vital that each discipline understands the need for greater integration as well as the theory and practice associated with BIM.

Whether those Departments that are currently including BIM in their syllabi are doing so on a theoretical rather than a practical basis (i.e. actually using BIM technologies) is unclear and warrants further investigation.

Q.B5 Which specific software is currently used on your programmes?

The main software identified and the associated percentage is listed below under five broad headings:

- General: MS Office (100%)
- CAD: AutoCAD (91%), ArchiCAD (29%)
- Services Engineering: Hevacomp (24%), Cymap (19%)
- Economics: Buildsoft (43%), Masterbill (10%)
- Management: MS Project (62%), Primavera (29 %)

It should be noted that 67% of the respondents indicated that had a range of other additional software within the Department, many of which were specialised tools for specific tasks. 29% of the respondents also went on to give details of additional software that they intended to purchase in the next year.

Q.B6 Have you experienced problems in using software in your University/Institute? **Yes: 63%**

Although this figure is high, it is perhaps surprising that it was not 100%. Among the problems identified by the various respondents who answered 'Yes' were as follows:

- Costs of licenses and available funding
- Rapid changes/updating of software versions
- Matching versions and updates of software with existing hardware
- Networking of software
- Lack of dedicated technical support within the University/Institute of Technology
- Poor customer care/technical support from software supplier

6.3 LEARNING MANAGEMENT SYSTEMS (LMS)

There are six questions included in this section, C1-C6.

Q.C1 Does your Department use an LMS? Yes: 83%

The four Departments that were not using such a system at the time of the survey indicated that while their University or Institute of Technology had purchased an LMS, they had yet to start using it on their AEC programmes.

Q.C2 Which Learning Management System (LMS) is used in your Department?

WebCT	60%	Blackboard	15%	Moodle	20%	Saki	5%

The merger of WebCT and Blackboard means that 75% of the respondents have effectively the same LMS provider. The general trend towards open source software may lead to a number of Universities and Institutes of Technology changing their LMS in the future.

Q.C3 Are the lecturers/tutors in our Department actively encouraged to use the LMS? Yes: 90%

A number of those that answered 'Yes' to this question indicated how this 'active encouragement' occurred and these included the following:

- Direct promotion/encouragement to staff from the dedicated centre (e.g. Centre for Excellence in Teaching and Learning)
- Assignment of an individual in the Department to promote and encourage the use of the LMS
- Provision of training via structured Staff Development programmes
- Integration of LMS with module management software
- 'Forcing' people to use the system by putting the Departmental notice board on the LMS

Q.C4 How are your lecturers/tutors trained to use the LMS?

No Training	0%	Training provided by Department	10%	Specific Training provided centrally	90%	Other	5%

One of the respondents indicated that training is provided both centrally and also by their Department. Of the 90% of respondents that replied 'Specific Training is provided centrally' this was achieved typically via the Library or a dedicated Teaching and Learning Centre.

Q.C5 How are your students trained to use the LMS?

No Training	25%	Training provided as part of programme	35%	Training provided centrally	30%	Other	10%

It is interesting to contrast the approach to training of lecturers/tutors against that for students on the AEC programmes. Whereas all respondents that currently use an LMS provide training for their staff, one quarter do not provide such training to their students. It would appear that in many cases individual lecturers/tutors give some guidance to their own class groups on how to use the LMS. Those 10% of respondents that were classified as 'Other' indicated their students were introduced to the LMS as part of their initial induction/orientation.

Q.C6 To what extent is this LMS currently used on your courses?

Basic	75%	Substantial	25%	Comprehensive	0%	Other	0%

The definitions used for each of the categories were as follows:

- Basic: 'some lecture notes/presentations'
- Substantial: 'most lecture notes/presentations, some discussion boards'
- Comprehensive: 'all lecture notes/presentations, all email, discussion boards and tests'

It is interesting to note that none of the respondents claimed that they were using their LMS to a 'Comprehensive' extent and the vast majority were in the early stages of adoption (i.e. 'Basic' level).

6.0 CONCLUSIONS

The overall conclusions to this research are:

- The population and economy in Ireland has undergone unprecedented growth over the past ten years and the Construction Industry has been central to that development. The development of broadband services in Ireland has been relatively slow however and Ireland currently ranks 14 of 15 in the ECTA Broadband League Table.
- The National Framework of Qualifications (NFQ) has been established and implemented in Ireland. The NFQ has been mapped against the proposed European Qualifications Framework (EQF) for lifelong learning that is in the process of being adopted within the EU.
- There are record numbers of students on AEC programmes (approximately 10,000) in Irish Universities and Institutes of Technology, 95% of whom are at undergraduate level (i.e. NFQ Levels 6, 7 & 8). There is a national requirement to increase the numbers of students at post graduate/4th level (i.e. NFQ Levels 9 & 10). A significant element of this increase is likely to be achieved through collaboration between the Universities and Institutes of Technology as well as Industry-Academia collaboration.
- Students on the existing AEC programmes in Ireland are learning about IT (general and discipline specific), although the majority do not gain either a detailed knowledge of software or an ability to write software through their AEC programme. Those students that do gain such knowledge or ability are on Engineering programmes.

- The move towards the integration of IT systems into a 'cohesive overall system' and BIM is reflected in the majority of the current AEC programmes in Ireland, but the precise extent and nature of this essential development (including interdisciplinary issues) requires further research.
- Learning Management Systems are being used widely on the AEC Programmes in Ireland, but generally at a Basic Level (i.e. for some lecture notes/presentations). The use of these systems will increase as the lecturers/tutors are actively encouraged and trained, and the higher education providers develop AEC programmes in a distance-learning or blended-learning format (particularly for postgraduate/CPD). However it is vital that the broadband infrastructure in Ireland develops quickly to accommodate the increased use of LMS outside the higher education campuses.

Although these conclusions refer specifically to the Irish Universities and Institutes of Technology engaged in AEC programmes, they are likely to have some relevance to other countries. The importance of integration to students on the various AEC programmes is of particular concern. As we enter the 'third era' of construction IT (Frose, 2006) the need for education and research programmes that focus on the integration of all of the AEC disciplines and associated IT has never been greater.

REFERENCES

Abudayyeh, O.Y., Cai, H., Fenves, S.J., Law, K., O'Neill, R. and Rasdorf, W.(2004). "Assessment of the Computing Component of Civil Engineering Education", J. Comp. in Civil Engrg., ASCE, New York, NY, 18 (3) 187-195.

Boland, T. (2006). Presentation at conference "Towards the Lisbon Agenda for 2010 and beyond – Implementing Change in Education and Training in a European Context", Farmleigh House, Dublin, Ireland, 22nd November 2006.

Commission of the European Communities (2006) Proposal for a Recommendation of the European Parliament and of the Council on the establishment of the European Qualifications Framework for lifelong learning, Brussels, COM(2006)/0163 (COD).

Craig, N. (2006) Presentation at conference "National Construction Conference 2006", Croke Park, Dublin, Ireland, 28th September 2006.

CSO (2006) 2006 Statistical Yearbook, Central Statistics Office, Ireland

DKM (2006) Review of the Construction Industry 2005: Outlook 2006-2008, Government Publications, Ireland.

DoE&LG (1997) Ireland: Building our future together – Strategic Review of the Construction Industry, Government Publications, Ireland.

DoET&E (2006) Strategy for Science Technology and Innovation 2006-2013, Dept. of Enterprise Trade & Employment (available at www.entemp.ie/science/technology/sciencestrategy.htm).

Government of Ireland (2007) Ireland National Development Plan 2007-2013: Transforming Ireland - A Better Quality of Life for All, Government Publications, Ireland (available at www.ndp.ie/documents/ndp2007-2013/NDP-2007-2013-English.pdf).

DoF (2006) "Budgetary and Economic Statistics – August 2006", Report from the Dept. of Finance (available at www.finance.gov.ie/documents/publications/other/bes2006update.pdf).

ECTA (2006) "Broadband Take-up Dramatically Slows Across Europe", Report by the European Competitive Telecoms. Association (available at www.ectaportal.com/en/basic650.html).

EGFSN (2007) Tomorrow's Skills – Towards a National Skills Strategy. Expert Group on Future Skills Needs, Ireland (available at www.skillsireland.ie/press/reports/index.html).

Ellis, R.C.T., and Thorpe, A. (2004). "An illuminative evaluation of distributed interactive multimedia project management resources", Intl. J. of IT in AEC, Salford, UK, 2 (1) 33-45.

ESRI (2006) "The Labour Market Impacts of Immigrants in Ireland, Economic and Social Research Institute", Ireland (available at www.esri.ie/pdf/JACB2006_The%20labour%20Market.pdf).

Figel J. (2006) quoted in the press release "The European Qualifications Framework: a new way to understand qualifications across Europe", 5th September 2006 (available at http://ec.europa.eu/education/policies/educ/eqf/index_en.html).
Frose, T. M., (2006). "Information Management for Construction", 4th Int'l Workshop on ITC Education, Dresden University of Technology, Germany, 18 July, pp 7-16.
Grubl, P., Kohler, S., Schmidt, B., and Schnittker, N. (2006). "OWS-Further Education in Civil Engineering", 4th Int'l Workshop on ITC Education, Dresden University of Technology, Germany, 18 July, pp 49-55.
HEA (2006) Higher Education – 04/05 Key Facts and Figures: HEA Funded Institutions, The Higher Education Authority (available at www.hea.ie/uploads/pdf/HEA%20key%20facts%200405.pdf).
Heitmann, G., Avdelas, A., and Arne, O. (2003). "Volume C - Innovative Curricula in Engineering Education", E4 Thematic Network: Enhancing Engineering Education in Europe, Firenze University Press, Italy.
LaCapra, L.T. (2006). "Ireland looks to U.S. in Search of Skilled Workers", Wall Street Journal, New York, October 31, 2006.
Menzel K. (2006). Editorial to 4th Int'l Workshop on ITC Education, Dresden University of Technology, Germany, 18 July, p1.
NCB (2006). 2020 Vision – Ireland's Demographic Dividend. March 2006, NCB, Ireland.
NQAI (2003). National Framework of Qualifications - Policies, Actions and Procedures for Access, Transfer and Progression of Learners. The National Qualifications Authority of Ireland, Oct. 2003
OECD (2004). "Review of Higher Education in Ireland – Examiners' Report", Report by Organisation for Economic Co-operation and Development EDU/EC(2004)141.
OECD (2006).Economic Survey of Ireland 2006. Organisation for Economic Co-operation and Development, 2 March 2006.
Rebolj, D. and Tibaut, A. (2006). "Computer Science and IT in Civil Engineering curricula", 4th Int'l Workshop on ITC Education, Dresden University of Technology, Germany, 18 July, pp 35-41.
Thomas, K. (2004) "Integration, Isolation and IT Education for an improved AEC Industry", Keynote Paper to 3rd Int'l Workshop on ITC Education, Istanbul Technical University, Turkey: 7 September, ITU Press, pp 1-12.
Wall, J., and Ahmed, V., (2007). "Use of a simulation game in delivering blended lifelong learning in the construction industry – Opportunities and Challenges", article in press, J. Computers and Education, doi:10.1016/j.compedu.2006.12.012, 2007
Wall, J., Ahmed, V., and Smit, D. (2006). "Addressing the Lifelong Learning Needs of Construction Professionals Using Technology Facilitated Learning", J. of Ed. in the Built Env., 1 (2) 57–69.
Watson, J. and Ahmed, P. K. (2004). "Learning in the age of global information technology: development of a generic architecture for an advanced learning management system", Campus-Wide Information Systems, 21 (1) 4-21.
Zemsky, R. & Massy, W. F. (2004). "Thwarted Innovation: What Happened to e-learning and Why". Final Report for The Weatherstation Project of The Learning Alliance at the University of Pennsylvania in cooperation with the Thomson Corporation, (available at www.irhe.upenn.edu/Docs/Jun2004/ThwartedInnovation.pdf) .