The Digital Learning Revolution in Ireland

The Digital Learning Revolution in Ireland: Case Studies from the National Learning Resources Service

Edited by

Ann Marcus-Quinn, Catherine Bruen,
Miriam Allen, Aisling Dundon
and Yvonne Diggins

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PREFACE

This book comprises 16 chapters. Chapter one discusses how the use of digital resources in higher education has risen significantly over the last ten years and will continue to do so for the foreseeable future. The challenge for educational instructors is in determining how to utilise digital resources effectively; the basis for this should not be their availability alone, but rather their ability to enhance the student learning experience and achieve desired learning outcomes. This chapter describes the successful widespread integration of digital resources in the undergraduate teaching of civil engineering at the National University of Ireland, Galway. Various types of digital resources, including animations, videos, design software and case studies, are utilised. The aim of this chapter is to reveal how digital resources have been used successfully by academic staff in the teaching of civil engineering subjects to help achieve professional accreditation criteria whilst also providing a more engaging student learning experience.

Chapter two reports on the use of the Video Ideas for Teaching and Learning Languages (VITALL) videos in the professional development of language teachers. This chapter discusses the opportunities presented by the project to see inside the classrooms of peers and to hear them talk about their practice. This project, within a supportive environment, can act as a stimulus to reflect on and discuss with peers the viewer's own practice as well as the practice of others.

Chapter three considers the value of feedback for both students and teachers. This chapter is the result of a collaborative design team working closely together: the systems librarian, the subject lecturer and the instructional designer. The result of this collaboration was that the learning environment was improved because the real-time feedback allowed for student needs to be incorporated into the construction of content and its delivery, a quick troubleshooting response and the creation of a multi-skilled support team. The project became an attempt to meaningfully include e-students in the creation of their online environment.

Chapter four reviews the forces pushing Higher Education further towards a more instrumental role in meeting the needs of business and government. This chapter looks at Community Based Research (CBR) and how it could be a rich vehicle for civic engagement in Higher

Education. The use of existing on-line technologies to support CBR activities can be an important element of their success. This chapter outlines how we use existing digital resources in HEIs to support our work, in recruiting and supporting students, academic supervisors and community partners, and in disseminating the research results among all the stakeholders. As ever, it is not the technology itself, but the context in which it is used and supported, that will determine the effectiveness of the outcomes.

Chapter five examines the need for technical standards for the design of resources for teaching and learning. Usability is promoted as a goal for software systems; there is a need to promote reusability in learning materials, and this requires standards, conventions and norms which permit easy modification and recombination. Technical standards are needed that will allow materials to be recombined and modified. The choice of a suitable standard format will go a long way towards making it a simple matter to repurpose digital learning materials to fit new contexts.

Chapter six reports on the use of the EmpowerTheUser Talent Development Platform (ETU). The ETU simulated medical interviews made available to students provided them with a large number of decision points on which to be assessed and also provided feedback. Students found themselves able to suspend disbelief to the extent that they experienced similar anxiety levels to those experienced during real patient interviews. The majority of students felt that ETU's Talent Development Platform helped prepare them for real world patient interviews. Feedback was highly positive regarding the ability to provide individualised feedback to students and their desire for the development of further interactive patient interviews. This supports the research which shows that if the interactive teaching has real-world applicability and the feedback is useful students will welcome it.

Chapter seven discusses the value of incorporating legal writing explicitly into the curriculum. This chapter reports that in establishing the teaching of this important aspect of the curriculum as a painless and time effective practice both students and teachers benefit. From the perspective of students, the "non-explicit rules of the game" are made explicit and are easily understood in a format which is familiar to them (Barnett and Coate 2004, 33).The use of technology for this purpose is in its early stages, and despite some growing pains, shows considerable potential.

Chapter eight presents the impact on higher education of a number of healthcare related digital resources from a nursing student's perspective, as well as presenting a national and international perspective on the resources. The chapter opens with the background to the development of

the digital resources, followed by a detailed description of the resources. The literature review explores constructivism as an educational theory and supports the introduction of digital resources using a blended learning approach to teaching and learning.

Chapter nine discusses the use of YouTube as a viable teaching resource to supplement traditional methods. This study could provide the foundation for future research in which the educational use of YouTube could be examined in a larger mixed population of students.

Chapter ten details the usefulness and usability of digital resources such as digital video and social media in an interdisciplinary learning environment and examines the opportunities for further impact on module outcomes and student engagement. The Innovation Academy is the educational centrepiece of the TCD-UCD Innovation Alliance and is a collaborative educational venture between the universities and industry. The Academy is establishing innovation and entrepreneurship alongside research and education as an integral element of the doctoral education experience. Since 2010, the Academy has engaged over 200 doctoral students through active learning with digital resources. In this chapter, we examine the impact of using digital resources for course design, delivery and assessment within the context of a graduate certificate in Innovation and Entrepreneurship.

Chapter eleven discusses the use of a Virtual Learning Environment (VLE) to manage the diverse needs and abilities of students of Medicine, Pharmacy, Dentistry and Natural Science in Trinity College, comprising ~18% of the annual undergraduate cohort. The chapter reports on how the VLE has been a particularly effective means to communicate with and address the needs of individual students in real time, with the desired outcome of enhancing their motivation and confidence. In conclusion, the introduction of a VLE to undergraduate practical teaching has served to maximize the effectiveness of the laboratory time, deepen student engagement and promote a broadened and enriched learning experience.

Chapter twelve reports on a study focusing on a group of forty first year students enrolled in an Electrical and Electronic Systems Engineering (EESE) course at Dundalk Institute of Technology (DkIT).The key aim of this research was to investigate whether the use of digital resources, presented in parallel with a traditional tutorial approach, aided in the identification of problematic knowledge and enhanced the learning experience of first year electronic engineering students.

Chapter thirteen presents an evaluation of the experience of attempting to engage distance learners in a blended learning programme. This chapter describes the attitudes, participation rates and the experience of a cohort of

students with regard to innovative e-learning practice. Through an analysis of user experience and observations, recommendations are outlined to develop and inform future teaching and learning provision. . This chapter will provide evidence for suggested amendments to future practice.

Chapter fourteen describes two digitisation projects which have been carried out on the Magazine of Magazines. These two digitisation projects have brought the experience of the eighteenth-century Limerick reader to life, by transforming these rare materials from the microfilm format stored at the British Library and the National Library of Ireland into online and openly accessible research, teaching and learning resources. By creating these Open Educational Resources (OERs) the Magazine has been brought online to lecturers, students and researchers enabling them to research eighteenth-century text and the national and international events of the time.

Chapter fifteen discusses the role that Mobile phones play in our lives: we text, speak, take photos, make videos and check the internet on these devices at an increasing rate. The cohort of students who are now accessing third level education is part of what is acknowledged as the "digital natives" generation. Even though their digital skills vary widely, there is a seamless integration of digital spaces in their everyday life. This chapter reports on how the mobile phone can be used as a positive language learning tool.

Chapter sixteen reports on a collaborative project with world experts in mathematics learning support (Loughborough University and Swinburne University of Technology) to use tablet technology to enhance the support facilities provided by the MLC at UL. The project, entitled 'MathsCasts', involves the design and evaluation of mathematics screencasts to facilitate the mathematics education of all students pursuing mathematics intensive degree programmes. This chapter discusses the uptake of this facility by UL students and evaluates the impact of the MathsCasts on UL students' mathematics education. Issues relating to the management of such a project and future directions are also discussed.

The majority of these chapters are drawn from experiences of those involved and who participated in two events. Firstly, a contribution of teaching and learning resources to the NDLR repository, and secondly, a one-day peer-supported writers' retreat held in Limerick in June 2012 (supported through NDLR Funding). These events, organised by the NDLR core team, were centred on the theme of "Technology Enhanced Learning". They were concerned with all aspects of digital resources to enhance teaching, learning and scholarship.

The NDLR team would like to thank the following for their help in producing this book:

Professor Eamonn McQuade (Chair of the NDLR)
Dr Bob Strunz (Technical Architect of the NDLR)
Alexandra Anderson (Academic Secretary (Acting), Trinity College Dublin)
Members of the NDLR Oversight Committee
NDLR Coordinators at all participating institutions
Dr Ciara O'Farrell (Senior Academic Developer, Trinity College Dublin)
Higher Education Authority (Ireland)
HEAnet (Ireland)

INTRODUCTION

PROFESSOR EAMONN MCQUADE
(CHAIR OF THE NDLR OVERSIGHT COMMITTEE)

This book is timely; given that OERs are being strongly promoted at all levels of education. It presents a select number of case studies from contributors to the Irish National Digital Learning Resources (NDLR) service. The reflection and discussions about issues of use and integration into classroom practice are thus particularly useful

While the degree to which Open Educational Resources (OERs) will impact on education is yet unknown, the development of and Information and Communication Technologies and Open Repositories is having a profound impact on teaching and learning. In a relatively short period of time the rapid development of ICT has radically changed our methods of accessing and using educational resources.

The NDLR service was launched as a pilot project in 2005 and in the last 7 years has grown significantly. Its mission is to "promote and support Higher Education sector staff in the collaboration, development and sharing of learning resources and associated teaching practices for the advancement of academic scholarship in Ireland". The NDLR is a unique inter-institutional community, fostering the sharing and exchange of teaching and learning experiences, practices and resources and collaborative research and development initiatives across the Irish Higher Education sector in Ireland. The Service promotes and supports the sharing and creation of OERs amongst the academic community in Ireland.

The NDLR currently hosts over 27,000 OERs across many subject areas from images, podcasts, videos, presentations, and documents to more complex learning objects and content packages. The types of resources include such things as exam questions, exercises, course notes and interactive tutorials. All OERs are free to use and repurpose under the Creative Commons licences. The NDLR also provides a medium through which to interact and collaborate nationally in a community involved in the teaching of your subject area. The NDLR actively supports the dissemination of your research and teaching discipline through the

repository nationally and internationally, and through its training and events programmes.

Since 2009, the NDLR service, through the support of the Higher Education Authority (www.hea.ie), has supported a 3 Stage Evolutionary Pathway for Supporting Irish Users (McAvinia & Maguire, 2011).[1]. The NDLR, through the local Institutional representative, provides support and encourages the development and sharing of reusable teaching and learning resources to members of academia through the coordination of a number of local initiatives and local supports (Local Innovation Projects (LIPs)) across all 21 Irish Higher Education Institutes.

Learning Innovation Community Support Projects (LInCS) are supported nationally, across institutions, sectors and subject disciplines. The teaching and learning activities (around the development and utilisation of these learning resources) encourage the emergence of academic groupings around particular subject disciplines (i.e. SMARTCoPs). The NDLR service identifies synergies, promoting and extending collaborations building towards sustainable SMARTCoPs.

These national collaborative projects are modelled on European projects, with a 'lead' institution coordinating the project in partnership with others. The NDLR service attempts to identify prioritised subject areas, as part of an annual funding call, and projects situate themselves in the internationally recognised ISCED subject listing. Successful projects are measured in terms of the numbers of learning resources delivered and the impact that these resources will have in terms of use in student programmes and re-usage for other academic staff.

SMART CoPs (Sustainable, Manageable, Active, Relevant and Reflective, Targeted Communities of Practice) are cross-institutional subject discipline related communities associated with locally funded institutional learning innovation projects (LIPS) and cross-institutional collaborative projects funded (LINCs). They are nurtured and sustained from support given to individual academics and groupings at both local and national levels. SMART CoPs are focused on targeted funded OER development through projects, and evolve from successful collaborations through LINC projects.

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[1] McAvinia, C. & Maguire, T. (2011) Evaluating the National Digital Learning Repository (NDLR): new models of Communities of Practice. *AISHE-J* Special Issue: papers from EdTech 2009.

‘YOU’RE NOT JUST WRITING A CHAPTER - YOU’RE CONTRIBUTING TO A BOOK’: FACILITATING REVIEW AND SUPPORTING WRITING.

DR. CIARA O’FARRELL

Moore and Barrett (2011) note that a collaborative review process can give a book a sense of coherence that is difficult to achieve in a more traditional editing process. For this publication the editors requested that I facilitate a writing day that would involve all authors and encompass a peer review. Before completion of the final draft, authors were thus invited to meet each other and work together over the course of two days to finalise their drafts and undertake a peer review of each chapter. In this short introduction, I will explain the process that we undertook and share the authors’ experiences of it as expressed in their reflections of the event which were written and collected upon its completion.

The writing/review event

Ten different institutions were represented in this writing event, with the majority of authors close to their final drafts, although a small number considered their chapters to already be a final draft and an equally small number considered their chapters to be an early draft. Most of the authors (with the exception of co-authors) were meeting each other for the first time and were new to this form of writing/review event. They therefore didn’t know what to expect from the process and were encouraged to share their expectations upon meeting with the facilitator and other writing participants in order to help dispel any concerns:

> *“This is my first publication and I was worried about being critiqued by peers. But I was hopeful that I would learn about other papers, develop networks and get some fresh perspectives on my own work.”*

“I didn’t know what to expect. I felt coming to the event that I was the ‘newbie’ and that it was all going to be really academic, but this was not the case. It was a very friendly group.”

“I was concerned I hadn’t enough written.”

“People came with no agenda other than to help and be helped.”

In order to ensure that the writing process was not stalled by self-doubt or procrastination the editors were eager to establish a relaxed and collegiate atmosphere among the authors right from the beginning; they thus decided to begin the event with an informal introduction and dinner to kick start the process and set the tone. Authors thus met for an introductory session and dinner on the eve of the review day.

Session One: Pre-event dinner

During this introductory session, the editors and I introduced and discussed with participants the writing and review process before each author introduced themselves and their chapter. Further informal discussions about chapters took place over dinner, where initial links were established between content and themes.

“It was great to meet on the first evening – chatting to people really helped us feel part of a team; I think the book will benefit from this.”

“A good start to the event was the social aspect. I think this helped everyone relax.”

“The pre dinner works really well as people have a chance to break the ice.”

“I was really nervous as I am relatively new to academic writing. It was great to talk with people the first night and it helped put my mind at ease about handing over my writing for review.”

Session Two: Engaging the reader

The first formal writing session took place the following morning over four hours in a conference-style room where authors set up their laptops. We had covered the walls of the room with large A3 blank sheets of poster paper and authors took two sheets each. The theme of this session was on ‘engaging the reader’ and the facilitation concentrated on pulling back or

distancing the authors from their writing before allowing them to 'zoom in' again with a renewed focus. Writing prompts and exercises I chose thus concentrated on defining the intended audiences for the individual chapters, identifying the key benefits of each chapter for the reader, and eliciting just how each chapter could be used in an educational context. Authors wrote prompts, often to a restricted number of words, to define key aspects of their work before writing up (on the posters) their answers to the prompts and reading them out to the larger group. As each author listened to their fellow writers, they were encouraged to write down on their posters possible links with other chapters, which they would follow up on between sessions. Key words were then elicited and circled, and active verbs educed in an attempt to focus on the practical application of the theories and the processes discussed in the chapters. Finally, prompts were used to examine and improve existing titles to engage and inform the reader as much as possible (Sword, 2012).

> *"The prompts made me reflect and focus clearly on what I wanted to achieve with my chapter"*

> *"It was very useful to capture what the chapter was about. And there was really useful advice about the writing process."*

> *"I thought the prompts were very useful for generating ideas and getting in a 'writerly' frame of mind."*

> *"The prompts will be transferable to other writing situations."*

Session Three: Peer review

Colleagues benefit in becoming better observers of writing in themselves and in others (Boice, 1990). The third session comprised the peer review session, integral to the writing event. By now authors had identified commonalities between chapters so they were encouraged to self select groups, each group comprising three authors. Each author both gave and received feedback. A strong emphasis was placed on the collaborative and developmental aspects of feedback, and this was discussed before the groups dispersed. Authors were all given forms to fill in for their readers which delineated key aspects of the paper and highlighted particular areas of feedback they were interested in receiving. The readers were also given a form on which they had to write comments when reading through the papers, loosely based on Barbara Grant's peer review sheet (University of Auckland). Questions included what they liked best about the paper they

were reading, what specifically could be improved and how they would suggest improving it. The groups of three then dispersed and each group had over two hours to read and discuss the chapters, with one person volunteering from each group to be a timekeeper so that each author received an equal amount of time for feedback on their chapter.

> *“I was concerned the review process would be a bit soft but actually it worked [...] with an excellent mix within the group.”*

> *“The peer review process was a very positive experience and one that I would recommend to others”*

> *“It was great to get feedback from people in other academic disciplines”*

> *“The ideas from the peer review will help me develop and improve my paper.”*

> *“The peer review allowed feedback from established practitioners within the area.”*

> *“People were fair and encouraging.”*

Session Four: Wrapping up and moving forward

The final session concentrated on integrating feedback from the peer review. Using springboard prompts to frame this session, authors spent time in intense, individual writing to progress or complete their chapters. A final prompt looked to what authors wanted to do when they returned to their papers after the writing event so that they could plan their writing and editing over the following days and weeks.

The benefits of the writing/peer review day:

The use of writing prompts and writing interventions is well documented in the literature (Boice, 1990; Elbow: 2012; Murray, 2001; Moore and Murray, 2006). Sharing our writing experiences undoubtedly help us master the sense of privacy and mysteriousness which can impede writing (Boice, 1990). Our authors concurred that the practicality of the sessions, prompts and exercises were useful:

"The information I learnt during the writing and review process was transferable – I will certainly use the prompts again and would love to take part in a similar process again. It was very valuable."

"It was a real boost in progressing my work."

"My chapter will definitely be better because of this process."

Talking about our writing and sharing it pre-publication was deemed by participants to have other benefits. For example, authors got to read and hear about other chapters in the publication, which informed or influenced their chapters and helped to establish a sense of coherence between the chapters.

"It was really interesting to hear and see other author's work –I really didn't anticipate that knowing about their work would influence my own work, and yet it did."

"It was really useful to read the other chapters – and it validates your own work."

The authors' reflections on the writing process focused strongly on the sense of collegiality that occurs when authors come together with a common goal:

"The sense of collegiality, all working together for a common goal, was powerful"

"Brilliant sense of collegiality – we all took this process seriously and accepted feedback willingly."

"It's so refreshing to work together on a publication."

Authors also noted that they benefitted from working with people from other disciplines, and hoped future collaborations may arise:

"One of the really enjoyable things about the NDLR projects is their practicality and interdisciplinary nature."

"I met some people I would be really interested in keeping in touch with for possible future collaborations."

We only had one such writing event for this publication, towards the end of the writing process, but the process could also be used at earlier stages of publication, as noted here by one participant:

> *“A short series of writing events would be useful, for example: 1)idea generation; 2) writing the chapters; 3)editing.”*

The writing event, aside from the many practical benefits expressed in terms of writing style and engagement, also (and importantly) resulted in authors taking ownership of the book, as depicted by the participant quote I have used in the title of this introduction: ‘You’re not just writing a chapter - you’re contributing to a book’. We believe that this process also helped strengthen the relationship between the chapters. In so doing this publication has become more than just a series of chapters, and has instead achieved a coherence and consistency that we hope will benefit authors and readers alike.

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THE USE OF DIGITAL RESOURCES IN CIVIL ENGINEERING EDUCATION: ENHANCING STUDENT LEARNING AND ACHIEVING ACCREDITATION CRITERIA

DR. STEPHEN NASH, DR. BRYAN MCCABE, DR. JAMIE GOGGINS AND DR. MARK HEALY

Abstract

The use of digital resources in higher education has risen significantly over the last ten years and will continue to do so for the foreseeable future. The challenge for educational instructors is in determining how to utilise digital resources effectively; the basis for this should not be their availability alone, but rather their ability to enhance the student learning experience and achieve desired learning outcomes. This paper describes the successful widespread integration of digital resources in the undergraduate teaching of civil engineering at the National University of Ireland, Galway. Various types of digital resources, including animations, videos, design software and case studies, are utilised. The recently completed Engineering building is itself a digital resource. Designed as a living laboratory, the building's structure, energy systems and internal environment are heavily instrumented and the structural, environmental and energy datasets are used as teaching tools.

The higher education teaching of Engineering differs significantly from that of other disciplines, such as the Arts or Humanities, in that engineering degrees are typically subject to a strict accreditation process by the national professional engineering body. In Ireland, this body (Engineers Ireland) prescribe six programme outcomes for Level 8 engineering degree programmes. The learning outcomes of individual course modules must therefore map onto one or more of these prescribed programme outcomes. The aim of this paper is to elucidate how digital resources have been used successfully by academic staff in the teaching of civil engineering subjects to help achieve professional accreditation criteria whilst also providing a more engaging student learning experience.

Introduction

Digital technology is an integral part of the modern world. Texting, web-browsing, video-gaming and online social-networking are all common activities in the daily lives of today's teenagers and students arrive at university with many years of exposure to digital media. As a result, it is often argued that teachers should incorporate digital resources in their teaching methods in order to properly engage these technology-savvy students, or ‘digital natives’ as they are sometimes called (Prensky, 2001). While there is not yet sufficient empirical evidence to verify the truth of this argument (Pedró, 2009), there is no doubt that digital resources have enormous potential as teaching tools. Images, videos and animations, design software, databases and scientific publications are just some examples of the digital resources available to teachers; however, not all digital resources make for useful teaching tools and even those that do can be misused, such that they may actually detract from the student learning experience.

The rapid acceleration of information available via the internet has meant that the use of digital resources in higher education has risen dramatically in recent years. In a 2008 survey of 119 institutions of higher education in the United States investigating their use of digital resources for scholarly purposes (Mc Martin et al., 2008), a majority (59%) of the respondents felt that digital resources were of "great value" to their instruction. While the internet means that digital resources are easy to source, their proliferation can present its own problems. Sometimes, teachers incorporate digital resources inappropriately simply because they are easily available, while, conversely, some teachers struggle to incorporate them at all because they are overwhelmed by the sheer volume available. Indeed, McMartin et al. (2008) also note that "the rapid acceleration of information available via the internet makes locating high-quality, accurate, and truly useful educational resources challenging for teachers".

Two important questions when considering using digital resources as educational tools are:

1) Why is the resource being utilised?

2) How will it be integrated in the course?

In answer to these questions, the authors believe that digital resources should only be used as teaching aids if, first, they enhance the student learning experience and, second, they enable the student to achieve one or more learning outcomes. In some instances, it may be the case that the former is accomplished while the latter is not, i.e. the student learning

experience is enhanced without directly enabling the student to achieve a learning outcome, but it should never be the case that the latter is accomplished in the absence of the former. Other important issues which may enable one to answer the two key questions above are the quality of the resource, its applicability to the subject area, its ease-of-use and the level of interaction/ engagement it affords the student.

Within a context of increased digital resources and the relatively recent availability of content on-line, engineering education has been well positioned to take advantage of these developments. Academic staff in the Discipline of Civil Engineering at the National University of Ireland, Galway (NUI Galway) have successfully integrated many different forms of digital resources in the teaching of civil engineering undergraduates. Digital resources are utilised as teaching tools across all of the fundamental areas of civil engineering including structural, geotechnical, hydraulic and environmental engineering. The teaching of Engineering in higher education institutes differs significantly from that of other disciplines, such as the Arts or Humanities, in that engineering degrees are typically subject to a rigorous accreditation process by the national professional engineering body. In Ireland, Engineers Ireland (2007) prescribes six programme outcomes for Level 8 engineering degree programmes. The learning outcomes of individual course modules must therefore map onto one or more of these prescribed programme outcomes. Digital resources, if used, must therefore not only enable students to achieve individual module learning outcomes, but also the programme outcomes specified in the accreditation criteria.

This paper describes how digital resources have been successfully deployed by academic staff in the teaching of civil engineering subjects to help achieve the professional accreditation criteria whilst also facilitating an enhanced student learning experience. The professional accreditation criteria prescribed by Engineers Ireland and the educational ethos of the Discipline are described. Examples of the integration of digital resources in the teaching of various programme modules are presented and are supplemented with some qualitative and quantitative analyses of anonymous student feedback. It is hoped this paper will provide encouragement and ideas for teachers of engineering, as well as those of other disciplines, who may be considering the use of digital resources.

Civil Engineering at NUI Galway

Civil Engineering is one of four disciplines in the College of Engineering and Informatics at NUI Galway, and it is the host discipline

for the BE (Bachelor of Engineering) in Civil Engineering. It is one of the oldest disciplines in the University and dates back to the opening of the university in 1849, from which time there has been an unbroken tradition of producing Civil Engineering graduates. Initially, the degree was three years in duration but this was increased to four in 1958. The current BE in Civil Engineering is a four-year, full-time course. NUI, Galway implements the European Credit Transfer System (ECTS) with an academic year being worth 60 credits and 240 credits being required for graduation. By the 1970s, Civil Engineering had expanded significantly and produced about 50 graduates per year. From the late 1990s, student numbers increased steadily, due in part to the enormous demand for Civil Engineers. The numbers reached a peak in 2010 with a graduating class of 130. More recently, the numbers entering the programme have dropped due to a decline in the construction industry in Ireland. While class sizes have fluctuated over the years, the intellectual and technical content of the BE Civil Engineering continues to evolve and is strong across all branches of Civil Engineering.

Educational Ethos and Programme Design

Differences in curricula between subject areas can be effectively demonstrated using the descriptive framework suggested by Barnett and Coate (2005). This framework describes different curricula using the three domains of *knowing*, *acting* and *being* which relate to content, skills acquired and student development, respectively. Programme curricula can be differentiated by the relative contributions of these three domains to the programme and the extent of interaction between domains. Barnett and Coate (2005) conclude that one of the main differences between engineering or 'professional' programmes and those from arts and humanities is the relative contributions of the *knowledge* and *action* domains. The *knowledge domain* is a substantial component of an arts or humanities programme as these curricula tend to be designed first and foremost by the knowledge content that is deemed necessary. In contrast, the *action domain* is a more substantial component of engineering programmes, as graduates must learn the practices and skills of an engineer. The civil engineering curriculum at NUI Galway (Table 1) has been designed accordingly. It is therefore imperative that teaching pedagogies allow students to practice skills as they acquire them such that they 'learn by doing'. It is shown in the next section that digital resources serve as very useful tools in this respect.

Important aspects of the educational ethos of the civil engineering programme at NUI Galway include:

- a strong emphasis on the mathematical and physical sciences in the first two years
- a fundamental grounding in computing and engineering graphics
- a clear focus on discipline-specific design
- a significant percentage of practical and laboratory work
- the use of industry-standard software in many of the modules
- the requirement for students to gain structured professional experience
- an emphasis on student development in: ethics; social responsibility; communications; lifelong learning; and individual, team and multi-disciplinary work

The educational ethos and overall learning experience for the students is also enhanced through the research-active nature of the Civil Engineering discipline. From their interaction and involvement with research-active staff and postgraduate students, the spirit of enquiry among the undergraduates is fostered. This contributes to their capacity for and interest in life-long learning.

Accreditation Criteria: Programme Outcomes

Through the *Institution of Civil Engineers of Ireland* (Charter Amendment Act 1969), Engineers Ireland is compelled to "set up and maintain proper standards of professional and general education and training for admission to membership or to any category of membership of the Institution". In fulfilment of this purpose, Engineers Ireland has formally accredited engineering degree programmes in the Republic of Ireland since 1982. Engineers Ireland (2007) specifies the following programme outcomes (PO) which apply to all honours Bachelor degree (Level 8) engineering programmes aimed at satisfying the educational standard for the title of Chartered Engineer up to 2012:

(a) The ability to derive and apply solutions from a knowledge of sciences, engineering sciences, technology and mathematics.
(b) The ability to identify, formulate, analyse and solve engineering problems.
(c) The ability to design a system, component or process to meet specified needs, to design and conduct experiments and to analyse and interpret data.
(d) An understanding of the need for high ethical standards in the practice of engineering, including the responsibilities of the engineering profession towards people and the environment.
(e) The ability to work effectively as an individual, in teams and in multidisciplinary settings together with the capacity to undertake lifelong learning.
(f) The ability to communicate effectively with the engineering community and with society at large.

Year	Course Code	Subject Name	ECTS
1st Year	MA140	Engineering Calculus	6
	MM120	Mathematical Methods For	6
	MP120	Engineers	6
	PH104	Engineering Mechanics	6
	CH111	Principles of Physics	9
	CE107	Engineering & Medical Chemistry	3
	CE118	Fundamentals of Civil Engineering	6
	CE112	Introduction to Surveying	9
	CE117	Engineering Graphics II	9 (60)
		Introduction to Computing	
2nd Year	CE219	Year's Work in Civil Engineering	18
	CE207	Engineering Materials	3
	EOS216	Geology for Engineers 1	3
	CE202	Principles of Building	6
	MA256	Engineering Calculus	3
	MA254	Engineering Algebra	3
	MA278	Engineering Statistics	3
	MP254	Engineering Applied Mathematics I	3
	MP252	Engineering Applied Mathematics II	3
	CE217	Elementary Hydraulics	6
	CE213	Strength of Materials	6
		Foreign language *or* Numerical Analysis	3 (60)

3rd Year	CE306	Year's Work in Civil Engineering	18
	CE307	Environmental Engineering	6
	CE330	Engineering Hydraulics I	6
	CE318	Construction Operations I	3
	CE312	Elementary Soil Mechanics	3
	CE313	Highway & Traffic Engineering I	3
	CE319	Construction Operations II	3
	CE320	Solids and Structures I	6
	CE322	Design of Concrete Structures	3
	CE321	Solids and Structures II	6
	CE323	Design of Steel Structures	3 (60)
4th Year	CE411	Year's Work in Civil Engineering	12
	CE412	Engineering Project and Report	6
	CE451	Engineering Hydrology I	3
	CE405	Design of Structures	6
	CE421	Structural Analysis I	3
	CE439	Coastal Engineering	3
	CE414	Geotechnical Engineering	6
		Plus	
		21 credits from 16 optional modules	21 (60)
			Total: 240

Table 1: NUI Galway civil engineering programme curriculum.

The three domains of *knowing*, *acting* and *being*, identified by Barnett and Coate (2005), are addressed by the programme outcomes. PO(a) and PO(b) address *knowledge*, PO(c) and (d) address *action*, i.e. the engineering skills, while PO(e) and PO(f) address *being*, i.e. the development of the person as an engineer and the engineer as a person.

Inputs such as entry standards, programme duration and structure, and resources, including buildings, laboratories, equipment, academic and support staff, must also be of an appropriate standard for successful accreditation. Accreditation can be awarded for up to a maximum period of five years, after which time re-accreditation must be sought. The accreditation process involves the submission of an accreditation report followed by on-site assessment by an accreditation panel. It is incumbent on staff to demonstrate, using supporting evidence, that each programme outcome is adequately addressed by the programme curriculum.

Use of Digital resources in Undergraduate Teaching

Educational digital resources range from simple teaching support tools such as photographs, images and videos, through to complete courses that are developed, managed and delivered online. For the purposes of this paper, the integration of digital resources is discussed under the following categories:

1) videos and animations
2) software and databases
3) learning technologies
4) the Engineering building

Videos and animations are generally used by staff as an aid to the explanation of particular engineering concepts or principles and are therefore grouped together. Digital images generally fall into the same category, but as their use is relatively commonplace they are not discussed here. Software and databases are grouped together as their integration in teaching is usually in a design context. Students undertake design projects in the areas of structural, geotechnical, transport, hydraulic and environmental engineering, and central to these projects is the use of digital software packages, from Microsoft Excel to advanced finite difference/element models, and digital databases. Learning technologies include online learning systems, Blackboard in the case of NUI Galway, and in-class systems, such as electronic classroom response systems, better known as 'clickers'. Both Blackboard and clickers are used by our staff to encourage student engagement in, and out of, the classroom. Finally, the new Engineering building is a digital resource that is unique to NUI Galway. The building, completed in 2011, houses all of the engineering disciplines and is the largest engineering education building in Ireland. More importantly, it was designed to be a teaching and research tool. Hundreds of gauges and sensors collect data relating to the building's structural behaviour, energy performance and internal environment and these data are logged and stored in a data repository where they can be accessed by staff and/or students.

The following sections provide examples of how these four categories of digital resources are used by staff to enhance the student learning experience and to help achieve programme outcomes.

1) Videos and Animations

In the Soil Mechanics and Geotechnical Engineering modules, videos are used as learning support for many of the concepts covered in lectures. One of the most popular videos is a 21-minute documentary of the Rissa Landslide produced by the Norwegian Geotechnical Institute (NGI), recently made available on YouTube (http://www.youtube.com/watch?v=3q-qfNlEP4A). In the process of constructing a foundation for a small barn in April 1978, 700m^3 of excavated material was stockpiled on a lake shore and triggered a landslide with a final volume of 6,000,000 m^3. The documentary includes some live amateur footage of the retrogressive sliding activity. The footage is dramatic and the documentary successfully frames the slide in the context of the underpinning soil mechanics principles, including water content/Atterberg limits, shear strength and geochemistry. The two former topics are fundamental topics in introductory soil mechanics modules and therefore help achieve PO(a) of the accreditation criteria. In addition, an exposure to geochemistry stimulates a curiosity about how soils were formed and shows that processes other than mechanical ones can have an influence upon likely behaviour today.

Kentledge is the term used in geotechnics to describe a stacked arrangement of concrete blocks used to load test piles. Another powerful YouTube video shows a dramatic Kentledge collapse at a construction site at Gilstead Road, Singapore in January 2011 (http://www.youtube.com/watch?v=14JM2-Yj2bY&feature=related). Some of the concrete blocks tumbled over the site boundary and caused damage to the gas pipeline under the road. This accident could potentially have led to a loss of life. In addition to providing a clear illustration of how pile load tests are performed in practice, this video has an important secondary learning outcome, highlighting the importance of responsibility, ethics and health and safety matters in construction PO(d) in the accreditation criteria).

Online videos and animations are also utilised in the teaching of Elementary Hydraulics. For example, a java applet of Newton's Cradle (Figure 1a) is used to demonstrate the laws of conservation of momentum and energy, thereby helping to achieve PO(a) of the accreditation criteria. If a single ball from the left side of the Cradle is pulled outward and released (Figure 1b), it swings and strikes the second ball. On impact, the momentum of the first ball is transferred through the series of balls, causing the last ball on the right to swing outward while the other balls remain motionless (Figure 1c). When this ball swings back, its collision again results in momentum transfer and the first ball swings outward to

repeat the process. Pulling away several balls results in the same number of balls moving away at the other end. The animation provides a very visual demonstration of the conservation laws. Students find it quite intriguing and are motivated to use the applet themselves to vary the number of balls that are pulled away and observe the result.

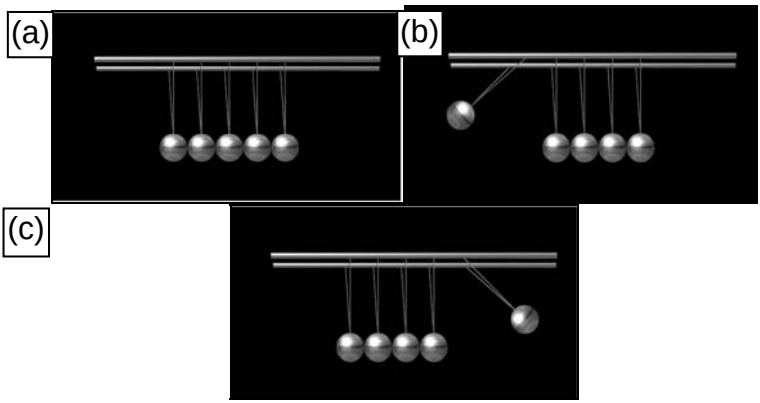

Figure 1: Screenshots of Newton's Cradle animation
(courtesy of: http://www.school-for-champions.com/science/newtons_cradle.htm).

In the area of environmental engineering, recent investment into wastewater treatment processes means it is now possible to use ‘before and after’ digital data to illustrate and discuss with students the impacts of engineering activities on the environment and society. Using videos and images, the theory of operation of these systems is explored and fundamental questions relating to the inter-relationship between engineering and society are discussed. Questions are posed such as: Would the students, as future consulting engineers, recommend such systems for the treatment of wastewater? What are the environmental/social consequences of installing these systems? Are there health or safety concerns associated with these systems? Working with ‘real world’ examples, digitally projected in the lecture hall, concepts of design versus practicability versus public health and safety are explored. This type of critical thinking forms part of the training of an engineer and addresses a number of Engineers Ireland programme outcomes, particularly PO(c) and PO(d).