

*Conceptualising the role of Information and Communication Technologies in the design of higher education teaching models used in the UK*

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## *Conceptualising the role of Information and Communication Technologies in the design of higher education teaching models used in the UK*

### **Abstract**

Despite the widespread availability of Information and Communication Technologies (ICTs) and some research into specific pedagogical practices using them, there has been little research on the role of these technologies in shaping broader pedagogical approaches in higher education (HE). Increased experimentation in using ICTs raises questions about their pedagogical role in teaching, learning and assessment provision, and in creating innovative pedagogies. An accepted approach is needed to compare the different ways ICTs and rich media are used in HE teaching models. Within the SusTEACH HE sustainability research project this was needed to support the carbon-based environmental assessment of HE courses using ICTs. Building on a review of learning design theories and models, and ICTs used for pedagogical purposes, this paper considers several approaches to conceptualising the role of ICTs in HE courses, leading to the development of the Teaching Models Rating Tool designed to examine the role of ICTs in course provision. This tool characterises courses as using Face-to-face Teaching Models; Distance Teaching Models; ICT-enhanced blended Teaching Models; or Online Teaching Models. Whilst this Tool was designed to support research on sustainable HE teaching models in the UK, it has wider applications to support comparative assessments of pedagogical and economic impacts. Further developments will be informed by the complex and evolving role of ICTs in HE teaching models.

**Keywords:** role of Information and Communication Technologies; ICTs; innovative pedagogy; higher education teaching models; learning design; teaching and learning delivery; blended learning; online learning; pedagogical tools.

## **Practitioner Notes**

### *What is already known about this topic*

- Numerous Information and Communication Technologies (ICTs) are available for use in higher education (HE)
- Adoption of ICTs varies within and across distance and campus-based education systems
- Adoption of ICTs is increasingly pervasive in HE
- Little is known about the role of ICTs in defining broad pedagogical approaches despite work on how ICTs shape learning design practice
- Tools are needed to help classify and evaluate different HE Teaching Models using ICTs

### *What this paper adds*

- Builds on learning design theory and models to offer a classification of ICTs and their media richness based on their pedagogic purpose to provide teaching, learning and assessment
- Considers issues associated with identifying the role of ICTs in online, and blended HE teaching models
- Presents the Teaching Models Rating Tool which was designed to help identify pedagogical design and teaching models adopted for planning course provision
- Indicates how this Tool was used to classify HE courses and support environmental assessments within the SusTEACH sustainability project

### *Implications for practice and/or policy*

- HE senior management and practitioners should find the examination of ICTs in HE Teaching Models helpful for informing decisions regarding these technologies.
- The Teaching Models Rating Tool helps address the scarcity of instruments to investigate the role of existing, new and emerging ICTs in innovative, pedagogical approaches.
- HE executives and practitioners should find this Tool a useful aid in the pedagogical design of courses, and for enabling comparative evaluations of pedagogical designs and practices.
- Whilst the tool was devised to support research on the environmental impacts of higher education courses in the UK, it could also support assessments of pedagogical and economic impacts.



## Introduction

Widespread deployment of ICT-based infrastructure in higher education (HE), such as Local Area Networks, wireless networks and cloud computing services and Virtual Learning Environments (VLEs), has enabled experimentation in the use of Information and Communication Technologies (ICTs) to support the provision of teaching, learning and assessment, and to create innovative pedagogies. This infrastructure includes server equipment and networks that support the VLE platforms housing educational content, tools and applications within learning systems, and also hosted separately on ICT devices. Increased experimentation has raised many questions about how ICTs are adopted and deployed in higher education (see Johnson, Adams & Cummins, 2012). The specific question of how to conceptualise the pedagogical role of ICTs within HE course provision to support comparative assessments is explored in this paper.

In the UK, e-learning provision has strategic importance for the HE sector in terms of bringing potential benefits of cost- and time-based efficiencies associated with the commodification of teaching and learning made accessible to students on a large scale (HEFCE, 2009). In addition, the wide range of available ICTs and electronic media with multiple pedagogical applications support technological enhancement and/or transformation of HE teaching and learning provision and outcomes (Ibid, 2009). This allows institutions to offer e-learning experiences - a term often used synonymously with online learning - that are personalised, and interactive, affording opportunities for collective and collaborative learning. Pedagogical use of ICTs enables more flexible learning by reducing the effect of temporal and location differences between students with other students and their teachers, thereby opening opportunities for students to learn at their own pace, using their preferred ICT device whenever and wherever they wish, in a variety of institutional, networked and work-based contexts. Such pedagogical innovations are regularly reviewed in US and UK reports, including the annual New Medium Consortium (NMC) Horizon reports (Johnson et al, 2012); the National Science Foundation Task Force on Cyberlearning (NSF, 2008); the Ipsos MORI study (Ipsos MORI, 2008); Inquiry into HE (Anon, 2009); and The Open University (OU) reports on Innovating Pedagogy (Sharples et al, 2012; 2013).

Experimentation in using ICTs has led to: technology-enhanced teaching and learning provision (see [www.jisc.ac.uk](http://www.jisc.ac.uk)); wholly online or e-learning courses; the development of digital education resources, both 'closed' fully copyrighted and 'open' openly-licensed online open educational resources (OER); and Massive Open Online Courses (MOOCs) that transform student access, widen participation and support global online learning communities (eg. the Futurelearn platform [www.futurelearn.com/](http://www.futurelearn.com/); Coursera <https://www.coursera.org/>; Edx <https://www.edx.org/about> and Udacity <https://www.udacity.com/>). Pedagogical use of ICTs has led to innovative methods, sometimes replacing traditional face-to-face and distance teaching methods with radical online learning designs, or more incremental changes that blend online with traditional face-to face or print-based distance teaching approaches.

Different HE institutions and programmes in the UK have adopted ICTs to a varying extent. Distance education institutions, such as The Open University, have been early adopters of ICTs to provide online learning, recognising the potential to enhance or substitute traditional print-based distance methods, and to offer more student-centred learning experiences, previously available only in the classroom or day/residential schools. Campus-based institutions also provide technology-enhanced education and digital educational resources, and some level of use is ubiquitous with most UK universities having a VLE (Brown, Jenkins & Walker, 2006), although some evidence suggests there

are often only limited moves away from teaching still occurring predominantly in the classrooms, lecture halls or laboratories (Schneckenberg, 2009; Conole, 2013). Face-to-face teaching remains popular -as supported by a major UK survey that showed student satisfaction with university course quality is associated with face-to-face contact time with academic staff in lectures and seminars (Which?/HEPI, 2013). Whilst blended, distributed, or hybrid teaching and learning models are common and predicted to become the dominant scenario in HE (see Johnson et al, 2012), online learning models are unlikely to wholly replace other delivery methods. Outside the UK, other countries may be further advanced in the large-scale use of ICTs for educational provision in campus-based programmes, although there is a lack of international data available to compare adoption patterns within and across HE institutions.

The availability of numerous ICTs with multiple pedagogical applications leads to diverse, complex models of delivering HE courses. Currently there are no accepted methodological approaches to conceptualise the role of ICTs in HE teaching models, which is important for making comparisons of courses within and across HE institutions. This conceptualisation was required for the Joint Information Systems Committee (Jisc)-funded SusTEACH UK higher education sustainability project, which examined the transformative impact of ICTs on HE Teaching Models and conducted an assessment of the carbon impacts of UK higher education courses in campus-based and distance education systems. (<http://www.open.ac.uk/blogs/susteach/>). We needed to develop methods to compare different teaching models, addressing the planned teaching, learning and assessment provision and the likely impacts associated with pedagogical practices using ICTs. Whilst the conceptualisation of teaching models described here emerged from an investigation of the sustainability of various forms of HE teaching and learning delivery, the approach has wider applications to support comparative assessments of pedagogical and economic impacts.

This paper discusses two broad approaches to conceptualising the role of ICTs in HE, namely quantitative and qualitative approaches, although there are several elements within these approaches. This work builds on two key linked educational initiatives at the Open University (OU). The Curriculum Business Models initiative aims to provide a common framework for standardising efficient, innovative and resource-effective module planning and design (see [http://www.open.ac.uk/blogs/OULDI/?page\\_id=833](http://www.open.ac.uk/blogs/OULDI/?page_id=833)). The Learning Design Initiative develops a learning design methodology that integrates good pedagogic practice and effective use of new technologies (see [www.open.ac.uk/blogs/OULDI/](http://www.open.ac.uk/blogs/OULDI/)).

Although the approach taken could be adapted to qualification level, the main focus is on the course or module. These are terms alternately used in HE to refer to the set of modular, standardised, independent, or interrelated teaching units that construct a degree qualification programme. The ideas presented here were discussed with senior academic and management staff in four UK campus-based and distance education universities, via workshops, focus groups and communications, leading to the conceptualisation of the role of ICTs within a teaching models framework. This work supported the development of new tools, including the Teaching Models Rating Tool. Some findings from the SusTEACH study are discussed to demonstrate the usefulness of this Tool for classifying courses using various traditional face-to-face and print-based distance teaching models, and new online and ICT-enhanced blended models for the course provision, and identifying their environmental impacts.

## **Approaches to conceptualising the role of ICTs in HE courses/modules**

### *Quantitative assessment*

A first approach considers quantitative measures available to assess the ICT-intensiveness of the course provision. The standard UK Credit Accumulation and Transfer Scheme (CATS) system of HE institutional arrangements for measuring student progression towards defined learning outcomes and qualifications, may be taken as a starting point for measuring the 'size' of any course being investigated (see [www.qaa.ac.uk](http://www.qaa.ac.uk)). This identifies 1 CATS credit as equivalent to 10 hours total study and calculates that 360 CATS credits are required for an undergraduate degree and 180 credits for a Master's degree, and partly matches the European Credit Transfer Scheme (ECTS) within the European HE Area where 1 ECTS=2 CATS (ECTS, 2009). This offers the basis for a time-based measure of ICT-intensiveness in terms of how much time ICTs are used in teaching, learning and assessment provision.

A crude, quick measure of ICT intensiveness would ask lecturers to estimate the percentage of study hours they had planned to use ICTs to support the provision, and apportion the planned use of ICTs against course study hours (or CATS credits). Whilst this gives a snapshot view of ICT use, measurable against course study hours, in practice it is difficult to time pedagogical practices and students' actual learning hours. A major survey by Which?/HEPI (2013) showed that on average students at English universities study for less than three quarters of the time expected for a degree programme, and therefore the equation of time spent learning with CATS study hours requires recalibration. There are also difficulties in planning the time that students spend learning using ICTs, as this depends on a number of intrinsic and extrinsic factors (eg. digital literacy skills and familiarity with new software tools) and the same activity may take longer or shorter time online than in a classroom (Mayes, 2004).

Pedagogical use of ICTs is unlikely to be measureable on a linear time-based continuum, in view of the range and functionality of the various ICTs used in course provision. Time-based measures are also not easily applicable to the examination of blended approaches, where for example ICTs and multimedia are used in the classroom, or used at specific phases of a course provision. Additional measures are required to address the qualitative characteristics of ICT-based pedagogical applications.

### *Qualitative assessment of pedagogical use of ICTs*

A second broad approach to conceptualising the pedagogical role of ICTs to allow comparisons between HE courses, considers some qualitative aspects of the ICTs used to design online learning activities. The design of online learning provision is influenced by the way VLE platforms house content and tools and provides access to other available software tools and applications, for learning via ICT devices. VLEs use implicit learning systems or facilitating technologies to embed a range of tools and content to support pedagogic design practice and provide a platform for learning activities (eg. [www.moodle.org](http://www.moodle.org), [www.blackboard.com](http://www.blackboard.com)); while an increasing number of software applications offer specific learning spaces or media platforms (eg. [www.compendiumld.open.ac.uk](http://www.compendiumld.open.ac.uk), [www.freemind.net](http://www.freemind.net), [www.elluminate.com](http://www.elluminate.com), <http://cloudworks.ac.uk>). So how may the wide range of ICTs that are available for pedagogical purposes be conceptualised in terms of HE teaching models?

A key contribution to understanding the pedagogical role of ICTs comes from research on learning design and e-learning models. Learning design refers to the application of learning and instruction theories to the design of effective learning experiences in educational contexts, using a variety of media (MacLean and Scott, 2011). This integrates learning theories such as constructivism,

cognitivism, and behaviourism with learning activities and outcomes, although there is a shift away from behaviourist approaches to constructivist and dialogic approaches, viewed as being more appropriate to preparing learners for the speed and change of the information age (Conole, 2013). As our interest is in the conceptualisation of pedagogical approaches using ICTs and media to enable course comparisons rather than to evaluate online learning, wider sociological and psychological aspects of ICTs' role in teaching and learning provision are not considered here.

Learning design practices develop technical standards which describe the way a 'unit of learning' and its component parts are designed (Conole and Fill, 2005). Such practices specify the types of tasks or activities; techniques, and tools; learning sequences; technical resources; human resources and roles; and communications and interactions between staff and students that are needed to support student learning (Conole and Fill, 2005). The learning context is also important including: the subject/discipline, noting the educational standard level, and the planned learning outcomes; the temporal context based on the designated number of study hours within a qualification programme; and the location-based context, including ICT-based infrastructure, buildings and facilities. This offers a means of classifying the use of ICTs for providing learning in context.

Different approaches may be taken to articulate learning design principles and represent the effective pedagogical design patterns that describe the relationship between learning problems, the context, the design solution and the teaching and learning delivery method (Laurillard, 2012). Classification of learning designs on the basis of key learning activities offers a useful approach to conceptualising the role of ICTs in teaching and learning. Based on empirical research by Conole and Fill (2005), the Learning Activity Taxonomy identifies broad types of tasks that learners typically undertake including: assimilative (eg. attending to and understanding content); productive (eg. construction of an artefact); information handling (eg. gathering and classifying resources or manipulating data); experiential (eg. practising skills in context or undertaking an investigation); communicative (eg. dialogic discussion activities); and adaptive (eg. use of modelling or simulation software). This Taxonomy broadly corresponds with Laurillard's classification of principal media forms available to support learning activities including: 'narrative media' providing online content; 'productive media' supporting work by the individual learner; 'interactive media' which respond to student instruction; 'communicative media' which permit asynchronous or synchronous communication and collaboration; and 'adaptive media' which enable the learner to effect change in a learning environment (Laurillard, 2002, p90).

Such classifications are helpful for identifying the role of ICTs in more online designs, although in practice learning design may be more creative and iterative (Conole, 2013). For the less ICT-intensive designs used widely in HE, student learning activities may not be mapped out in this way. A simpler approach reflecting our interest in the balance of different types of teaching, learning, and assessment practices in context that shape the overall student experience was therefore considered, building on the Curriculum Business Models initiative at the OU which maps out courses using the following classification of course provision including:

- Teaching provision of guidance, learning support, content and information;
- Learning provision to support student activities, and thinking, reflection, learning and work on assignments;
- Assessment to support both formative and summative assessments, and student demonstration of learning; and
- Provision for communication and collaboration between staff and students to mediate teaching, learning and assessment.

This approach offers a simple classification for identifying the use of a range of ICTs on HE courses and comparing different pedagogical designs (Table 1). A further consideration is the media richness of the ICTs used in teaching models, as media-rich ICTs have the potential to offer: more online, interactive, personalised and specially-designed learning experiences; with integrated resources; options for synchronous and asynchronous communication; options for individual and collaborative learning; and formative and summative online assessments. Such affordances are in addition to their potential applications to support offline and individual learning. Richer media provide greater scope for offering students the type of interactive, collaborative, synchronous and personalised online learning experiences that were only previously available in the classroom and for substituting traditional face-to-face or print-based distance teaching methods for some or all of the course provision.

**Table 1: Classification of ICT tools and applications in teaching, learning and assessment**

ICTs for teaching, learning and assessment	Read only	Read & write	Support Individual learning	Supports collabor-ation
<b>Provision of guidance, support, teaching content and information</b>				
Offline software provided by HE provider (eg. DVD, CD)	X		X	
Structured online content provided using schema for ‘structured authoring’ (eg. eXtensible Mark-up Language (XML)).		X	X	
Podcast audio/video files via online streaming	X		X	
Electronic books read via an eBook reader or application (eg. <a href="http://www.kindle.com">www.kindle.com</a> , <a href="http://www.apple.com">www.apple.com</a> ).	X	X	X	
Digital library resources integrated online (eg. <a href="http://www.refworks.com">www.refworks.com</a> ).	X		X	
VLE study tools eg. interactive online planner for students		X	X	
Interactive multimedia (e.g. Flash animation) allows interaction between learners and media (e.g. <a href="http://www.adobe.com">www.adobe.com</a> ).		X	X	
Mobile applications (Apps) providing access to downloadable educational resources (eg. <a href="http://www.apple.com/uk-iphone-apps">www.apple.com/uk-iphone-apps</a> )		X	X	X
Smart objects communicate 3D information online about the workings and interactions of objects.		X	X	
<b>Provision for student-directed thinking, reflection, learning and work on assignments</b>				
Electronic portfolios provide personal, online spaces for sharing and creating resources (eg. <a href="http://www.eportaro.com">www.eportaro.com</a> , <a href="http://www.google.com">www.google.com</a> , <a href="http://www.dropbox.com">www.dropbox.com</a> ).		X	X	X
Social bookmarking provide links for sharing online resources (eg. <a href="http://www.delicious.com">www.delicious.com</a> , <a href="http://www.diigo.com">www.diigo.com</a> ).		X	X	X
Digital presentation sharing websites (eg. <a href="http://www.slideshare.net">www.slideshare.net</a> , <a href="http://www.prezi.com">www.prezi.com</a> ), photos (eg. <a href="http://www.flickr.com">www.flickr.com</a> <a href="http://www.picasa.google.co.uk">www.picasa.google.co.uk</a> ) and videos (eg. <a href="http://www.youtube.com">www.youtube.com</a> ).		X	X	X
Virtual reality worlds are computer simulations of worlds navigated via avatars (eg. <a href="http://www.secondlife.com">www.secondlife.com</a> ).		X	X	X
Game-based learning on video game technology (eg. <a href="http://www.3dgamefab.org.shivtr.com">www.3dgamefab.org.shivtr.com</a> ).		X	X	X
Gesture-based computing using physical movements/ gestures		X	X	X
Online laboratory work in 3D immersive environments using virtual control instrumentation (eg. <a href="http://www.open.ac.uk/about/teaching-and-learning/esteem/">http://www.open.ac.uk/about/teaching-and-learning/esteem/</a> ).		X	X	X
Wikis for collective authoring. (eg. <a href="http://www.wikispaces.org">www.wikispaces.org</a> )		X	X	X
Synchronous videoconferencing in real time (eg. <a href="http://www.skype.com">www.skype.com</a> )		X	X	X
Online tutorials with options for audio-visual communication and sharing materials (eg. <a href="http://www.illuminate.com">www.illuminate.com</a> )		X		X
Mobile learning (m-learning) with digital content, tools and applications hosted on mobile technologies	X	X	X	X
<b>Provision for communication and collaboration</b>				
VLE Feedback tools, eg. voting tools	X		X	
Asynchronous text communication (eg. <a href="http://www.msn.com">www.msn.com</a> ) and conferencing (eg. VLE forums)		X	X	X
Blogs and Microblogs allow online publishing of views and news (eg. <a href="http://www.twitter.com">www.twitter.com</a> , <a href="http://www.plurk.com">www.plurk.com</a> ).		X	X	X
Synchronous communication/ instant messaging (eg. <a href="http://www.skype.com">www.skype.com</a> ).		X	X	X
Social networking (eg. <a href="http://www.facebook.com">www.facebook.com</a> , <a href="http://www.ning.com">www.ning.com</a> , <a href="http://www.myspace.com">www.myspace.com</a> ).		X	X	X
<b>Provision for assessment of evidence and demonstration of learning</b>				
Plagiarism detection tools (eg. <a href="http://www.turnitin.com">www.turnitin.com</a> ).		X	X	
VLE tools for formative assessment eg. quiz, questionnaires and uploading digital content	X		X	
Computer-marked assessment/e-assessment (eg. <a href="http://www.open.ac.uk/openmarkexamples">www.open.ac.uk/openmarkexamples</a> )		X	X	
Certification of learning outcomes towards qualifications (eg. <a href="http://www.questionmark.com/uk/">www.questionmark.com/uk/</a> )	X		X	
Learning Analytics to provide real-time individual feedback (eg. <a href="http://www.learningcatalytics.com">www.learningcatalytics.com</a> )		X	X	X

Building on the Learning Design Initiative at the OU to devise qualitative measures of the teaching and learning provision across the university curriculum (The OU, 2010), ICTs may be classified in terms of their media ‘richness’ (Table 1). Richer media use dynamic, multi-media formats with more

visualisation and communication options to allow students to read, write (ie. produce as well as use) and record their learning online; and to engage in collaborative as well as individual learning activities; whereas static media offer read-only narrative media for individual learning, for example providing online links to downloadable resources. Offline media-rich applications also may support individual learning. Table 1 offers an effective tool for identifying and classifying the main pedagogical applications of a range of ICTs for the provision of teaching, learning, assessment on courses, and identifying their media richness, although it may be too detailed for most purposes of comparison at this stage in the adoption and use of ICTs in HE.

## **Developing qualitative assessments within a Teaching Models Framework**

The pedagogical role of ICTs is in part, indicated by the type, number, richness of media used and their pedagogical purpose. It is also indicated by the primary way teaching is delivered, which is the teaching model. Much of the work on learning design is focused on online learning provision; therefore to ensure applicability to all HE educational institutions and teaching models, there is a need to widen considerations to include the main teaching methods adopted, and their blended forms, including:

- Face-to-face teaching, which relies strongly on buildings dedicated to providing campus and residential accommodation and facilities for learning;
- Distance-teaching, which mostly uses specially-developed print-based materials mailed to students and correspondence tuition;
- ICT-enhanced teaching using digital tools and rich media to provide a blended (with face-to-face or distance teaching) or wholly online learning provision.

Building on the approach taken by the OU Learning Design Initiative to the assessment of types of online learning provision; the classification of ICT uses and media richness (Table 1); and the importance of recognising online and blended approaches to using ICTs and other teaching delivery methods, the Teaching Models Rating Tool (Table 2) was developed to incorporate a number of elements discussed here, including:

- The design of teaching, learning and assessment provision on a course;
- Qualitative measures of different teaching delivery methods used, including face-to-face teaching; print-based educational materials; and the use of ICTs and rich media to enhance or substitute traditional face-to-face and distance teaching methods [Here enhancement refers to technology use rather than improving teaching and learning outcomes]; and
- The integration of ICTs in teaching and learning provision, together with the richness of the electronic media used for the provision.

This Tool was designed to help lecturers and academic designers identify their planned teaching delivery model for course provision, recognising that different delivery methods may be adopted and blended for the course provision. Based on lecturers' ratings, the approach outlined in Table 2 helps identify variations in course design, and to classify a HE course by its primary teaching model as follows:

- The Face-To-Face Teaching Model using little or no ICT-enhancement for teaching and learning.
- The ICT–Enhanced Face-to-face Teaching Model enhanced by some use of ICTs for teaching and learning.
- The Distance Teaching Model with little or no ICT-enhancement for teaching and learning.
- The ICT–Enhanced Distance Teaching Model enhanced by some use of ICTs for teaching and learning.
- The Online Teaching Model provides mainly online teaching, learning and assessment, with content, tools and applications available on the course Virtual Learning Environment.

The main application for this Rating Tool is to support the identification of the main delivery techniques used for course provision and classification of HE courses for comparative purposes.

In the case of the SusTEACH project, the Tool has been useful for comparing a range of HE courses and their environmental impacts, some with traditional face-to-face teaching; others using blended techniques; and others with an online provision. Whilst this Tool was devised principally to identify broad pedagogical approaches to course provision and to support environmental assessment of HE teaching and learning, the work may also support assessments of some pedagogical and economic impacts. To explore ICT-enhanced and online courses further, Table 1 offers a useful classification of ICTs in relation to pedagogical purpose, in addition to the learning design models and practices already discussed.

Table 2: The Teaching Models Rating Tool

For each statement below, **select 1-3 responses** which express the main ways you propose to deliver your teaching, learning and assessment on a course.

**1. How do you plan to provide Guidance and Support for students?**

Guidance is provided:

- face-to-face (eg. during a lecture) (a)
- using printed text (eg. a Welcome pack, Introductory Study Guide/Planner) (b)
- using off-line software (eg. DVDs, CDs) (c)
- as text for download using web-links (d)
- online using web-link (e.g. to access a Study Planner) (e)
- using online, interactive guidance for study planning (f)

**2. - How do you plan to provide Teaching Content and Information?**

Teaching content is provided

- during regular or occasional face-to-face teaching that requires students to travel to campus buildings to attend lectures, seminars, tutorials, workshops, day schools, residential schools or field trips (a)
- using printed text and educational materials (eg. printed set books and recommended publications) (b)
- using off-line software and audio-visual resources (eg. DVDs, CDs) (c)
- via web-links to access textual content available for download (d)
- using online audio-visual resources (e)
- using online interactive content (eg. enhanced eBooks) (f)

**3. How do you plan to provide Library Resources?**

- Students are not expected to access library resources during the taught module/course (0)
- Students are recommended to travel to library facilities to access library resources (a)
- Library resources are provided as printed text (b)
- Library resources are provided using offline software or audio-visual resources (c)
- Students are recommended to use online web-links to access library resources for download (d)
- Students have some remote online access to library resources (e)
- Library resources are provided as an integrated online library resource (f)

**4. How do you plan to provide the learning activities and experiences for students?**

Student learning activities are provided:

- during face-to-face teaching eg. at seminars, tutorials, workshops, field trips, day or residential schools (a)
- using specially-developed printed teaching materials (b)
- using offline software, ICT equipment and/or campus facilities (c)
- using online links to access website materials (d)
- with online tutorials, eg. Elluminate (e)
- using specially-designed, interactive and collaborative activities hosted online or on ICT devices (f)

**5. How do you plan to provide opportunities for student reflection and learning?**

Student reflection and learning is:

- encouraged during face-to-face teaching, (eg. seminars, tutorials, workshops, field trips, work environments, day schools or residential schools) (a)
- provided using specially-developed printed distance-teaching materials (b)
- provided using off-line software and audio-visual resources (eg. DVDs, CDs) (c)
- provided with reference to online quizzes and assessments (d)
- provided with online opportunities to write and record learning activities (e)
- provided with opportunities for students to collaborate during online learning activities (f)

**6. How do you plan to provide for student communication and collaboration on learning activities?**

The provision planned for student communication and collaboration on learning activities is:

- offline and face-to-face (eg. in a seminar or tutorial) (a)
- provided using offline distance methods, such as post and telephone (b)
- provided mainly offline with informal opportunities for online communication and collaboration (c)

- supported formally using mainly ONE asynchronous tool (eg. email) (d)
- supported formally using SEVERAL asynchronous tools (eg. email, VLE forums, wikis, blog) OR ONE synchronous tool (eg. Elluminate, Skype, Facebook) (e)
- supported formally using SEVERAL tools including AT LEAST ONE synchronous tool (eg. Elluminate, Skype, Facebook) AND asynchronous tools (eg. email, VLE forums wikis, blog) (f)

### **7. How do you plan to provide assessment of the evidence of student learning?**

Students are required to:

- travel to exam theatres for assessment (a)
- complete assessments from home following the receipt of printed assignments, assessments and/or exam materials by post (b)
- complete assessments offline using some ICT software or equipment(c)
- submit assignments/projects/dissertations online (d)
- complete some formative assessments online (e)
- complete summative assessments online, for example interactive computer-marked examinations (f)

### **Scoring the responses**

*Step 1:* Key teaching delivery methods may be identified by counting responses selected on (a-f) to provide measures of:

- (a) Face-to-face teaching, described as teaching students face-to-face;
- (b) Distance print-based teaching, described as teaching using specially-developed teaching materials;
- (c) ICT-resourced teaching, described as providing offline audio-visual resources to supplement teaching;
- (d) Online-focussed teaching, described as providing online links to resources to supplement teaching;
- (e) Online-learning, described as integrating ICTs to substitute online teaching for other teaching delivery methods;
- (f) Online learning provision with rich media, described as using rich media to provide interactive learning hosted online or on ICT devices.

Add scores (for each ticked response) on each measure to create high=6-8, med= 4-5, low 1-3, zero=0 scores. ICT-enhanced teaching is identified by (c) or (d) as the use of ICTs to supplement and blend with other teaching methods,

Online teaching is identified by (e) or (f) as online provision that is likely to substitute traditional teaching methods.

*Step 2:* The following classification of HE Teaching Models is identified by ‘grouping’ the ratings of a course/module’s (zero-high) scores:

The Face-To-Face Teaching Model uses mainly face-to-face teaching methods with no ICT-enhancement. This has high (a); and low or zero (b), (c), (d), (e), (f) scores.

The ICT-Enhanced Face-to-face Teaching Model uses face-to-face teaching methods enhanced by some use of ICTs, eg. to provide online links to downloadable resources. This has high or medium (a); low or zero (b); low, medium or high(c), (d); and low or zero (e), (f) scores.

The Distance Teaching Model uses mainly classic distance teaching methods, such as using printed educational materials with supported learning and has little or no ICT-enhancement. This has: high (b); and low or zero (a), (c), (d), (e), (f) scores.

The ICT-Enhanced Distance Teaching Model uses classic distance teaching methods, enhanced by some use of ICTs. This has high or medium (b); low or zero (a); low, medium or high (c), (d); and low or zero (e), (f) scores.

The Online Teaching Model provides mainly online teaching, learning and assessment, with content, tools and applications available on the course Virtual Learning Environment. The model may include minimal printed materials and face-to-face teaching eg. to attend day schools. This has: high or medium (e), (f); and low or zero (a), (b) scores.

## **Application of the Teaching Models Rating Tool**

The Teaching Models Rating Tool was developed for the SusTEACH project to allow classification of HE courses by their primary teaching model for the purposes of comparing their carbon-based environmental impacts. This supported an environmental assessment of 30 UK HE courses in campus-based systems (19) and distance education systems (11) using data collected through specially designed student and staff surveys about course activities including: travel; the purchase and use of ICTs and printed materials; residential energy consumption, and campus site operations. Results were converted into energy and CO<sub>2</sub> emissions per student, per 10 CATS credits or 100 study hours using quantitative time-based measures, and then classified by their primary teaching model (Caird, Lane & Swithenby, 2013). This approach allowed for the comparison of courses within the HE Teaching Models framework. This led to the development of freely available online web tools (<http://www9.open.ac.uk/susteach>) that provide information, feedback and interpretation to lecturers about the likely carbon-based environmental impacts of their planned teaching and learning provision, based on the SusTEACH research findings.

A summary of the SusTEACH findings demonstrates the usefulness of the tool in helping to identify differences between HE teaching models and their carbon-based impacts (Ibid.). By comparison with other models, the Online Teaching Model achieved the lowest energy consumption and emissions of 36kg CO<sub>2</sub> per 10 CATS credits. Energy impacts associated with residential accommodation and campus operations were low. Travel impacts were low; for example students made on average less than 1 journey per 10 CATS credits, covering an average distance of 10 miles per journey. There was some compensating effects with higher student ICT-related energy consumption: for example, students used ICT devices for an average of 98 hours per 100 study hours, and were doing course activities online for 82% of the time. Students also had a high use of paper for printing, using 195 sheets per 10 CATS credit, perhaps because of a preference to read print rather than on-screen, although their use of other materials was low.

The main sources of HE course energy consumption and carbon emissions in the UK sample were travel; residential energy consumption; and campus site operations, and analysis revealed striking differences between the blended ICT-enhanced models adopted in the distance education and campus systems. The ICT-enhanced Distance Teaching Model produced 45kg CO<sub>2</sub> per 10 CATS credits, which were 82% lower than the emissions associated with the ICT-enhanced Face-to-face Teaching Model of 246kg CO<sub>2</sub> per 10 CATS credits. Within distance education systems, students are supported to learn via various combinations of print-based and online methods, with minimal face-to-face teaching whilst living at home. By contrast in campus systems, students frequently need to take additional residential accommodation, use campus facilities and travel to university sites. The use of ICTs sometimes enabled students to travel longer distances, including from abroad by non-UK domiciled students, for brief classroom-based experiences whilst studying online otherwise; such courses had different pedagogical designs for each phase, different applications of ICTs and carbon impacts. Such wider impacts of pedagogical design need to be considered in estimations of the carbon impacts of online and blended teaching models.

## **Concluding Comments**

Despite the transformative role of ICTs in higher education, there has been little work to conceptualise the complex role of ICTs in HE Teaching Models. This is partly because of the number of new and emerging digital technologies; the complexity of teaching models using ICTs for pedagogical applications and innovative pedagogies; as well as different patterns of adoption in HE

institutions. Interest in methodologies to examine and assess the role of ICTs in the design of effective online learning provision is becoming more mainstream as online and blended teaching models become more pervasive across HE. The NMC Horizon Report notes “*paradigms are shifting to include online learning, hybrid learning and collaborative models*” (Johnson et al, 2012, p.4).

Emerging innovative pedagogies create new challenges to understand the way ICTs are being used in higher education teaching models. Without a clear conceptualisation of the complex and evolving role of ICTs in HE Teaching Models, it is difficult to evaluate the benefits and limitations of using ICTs and rich media in online and blended ICT-enhanced teaching models to support student learning pathways. With the ongoing ICT-based transformation of HE together with the diversity of ICTs and pedagogical applications, it is difficult to develop teaching models using ICTs capable of addressing the changes and complexity in the way ICTs are being used. To support the SusTEACH project, several simplified approaches were examined to help classify and compare the energy consumption and carbon impacts of HE courses using ICTs and other teaching delivery models.

This paper has considered quantitative and qualitative approaches to conceptualising the role of ICTs in the design of HE teaching models. A quantitative approach considers whether the use of ICTs on a course could be timed and measured using study hours and credits awarded for HE qualifications. This was not easily applicable because of difficulties in equating study hours with specific characteristics of using ICTs in the teaching, learning and assessment provision. Qualitative approaches consider several aspects of ICTs, taking into consideration the type and number of technologies available; their pedagogic purposes in course provision; their media richness; and integration with face-to-face and distance print-based teaching methods to offer online and blended teaching models.

A Teaching Models Rating Tool was designed to examine the pedagogical role of ICTs, as well as classify and support comparisons of HE course teaching models. This represents a simplified approach to identifying broad aspects of pedagogical design for delivering teaching, learning and assessment, together with measures of different teaching delivery methods, including indicators of the media richness of ICTs being used.

The Rating tool was devised principally to support the environmental assessment of HE courses on the SusTEACH project, which found that traditional, online and ICT-enhanced blended teaching models had different energy impacts and this has implications for pedagogical design. The Tool was useful for data collection, classification and comparison of HE Teaching Models using ICTs in different education systems, including teaching models with low ICT-enhancement, and has wider applications to support pedagogical and economic assessments of HE courses. Further refinements and work to validate this Tool will reflect ongoing developments in the use of ICTs in HE teaching models and provide research and management tools for comparing courses and qualification programmes and contribute to understanding effective and innovative pedagogy.

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