Open courseware as an example for user-centric innovation in higher education – towards a new social role of the university

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Abstract
The use of information and communication technology (ICT) in education has been touted as the solution to many of the challenges faced by higher education. ICTs were expected to revolutionise the way we teach and learn, increase access to higher education for all, and improve quality – while greatly reducing cost. As a result public and private institutions have been under pressure to integrate ICTs in their activities, and new virtual institutions were created to offer online teaching and degrees.

Since these early days of technology-supported teaching and learning, numerous failed projects have shown that the expectations and hopes, especially with regard to increasing access and quality of higher education in developing countries, were unrealistic. Technology dissidents have felt their predictions confirmed and returned to the comfortable conviction that the traditional ways of teaching and conducting research remain the most effective way for universities to provide social welfare.

This paper argues that the reason for failure can be traced not to fundamental
problems inherent in the technology, but rather institutional resistance to change (including technological change) and an inability to innovate the university's social role in a networked world. It posits a user/student-centric open innovation model enabled by ICTs as a possible solution to transform higher education.

The slow pace of innovative responses to global technological, legal, and social developments is endangering the traditional role of higher education institutions, and threatens the justification of public support. Considering the experience of industries that have recently undergone significant changes as a result of similar pressures, such as the software and entertainment industries, we identify areas of friction, and describe the possible consequences of resisting change and adaptation.

We explore the university's process of knowledge creation and diffusion through the lens of basic Economic models of innovation, and draw on practical experience from case-studies of student-driven open education projects. This allows us to reaffirm ICT's potential to drive deep changes in all areas of higher education. Whereas the traditional model of innovation positions the user on the receiving end of a linear trajectory (GODIN, 2006), the recent literature on technological change has identified the “user” as an important and central source of innovation (von Hippel, 2005). For example, the mountain bike was created by amateurs who were frustrated by the industry's failure to develop bicycles that were suitable for the mountain paths of California. These cyclists simply combined parts from existing bicycle models with stronger parts from motorcycles to create a new hybrid product. The mountain bike has since become the most successful recent innovation in the bicycle industry and now accounts for the majority of bicycles sold by corporate manufacturers.

Enabled by computer networks, similar innovative users have begun forming open collaborative projects in other areas (Benkler, 2002). In some industries these communities of practice (Lave & Wenger, 1991) successfully compete with traditional firms. For example, free and open source software (FOSS) projects have created the most popular web server (Apache), a widely used web-browser (Firefox), and most of the basic infrastructure that makes up the Internet itself. Beyond software, the online Wikipedia has become the largest encyclopaedia in the world and despite its self-regulated community-based quality control the accuracy of its entries was found to be comparable to that of the Encyclopaedia Brittanica (NATURE, 2005).
In higher education, the current approach to knowledge creation and diffusion (mainly through teaching and publication) mirrors the traditional linear model of innovation. However, social networking technologies, in combination with less restrictive approaches to intellectual property protection, and an affirmation of the digital commons, have enabled large-scale and distributed collaborative innovation processes that are challenging many aspects of such a traditional university: the institutional unity of research and teaching; the bundling of teaching, assessment, and accreditation services; the top-down hierarchical approach to knowledge creation and diffusion; and the strict differentiation between student and teacher roles that limit students' ability to participate in innovation of the educational experience.

Applying more recent open collaborative innovation models to higher education suggests a new social role for universities. Lessons from practical experience allow us to identify how universities can leverage the potential of open collaborative networks in order to drive innovation in teaching and learning. The empirical data used stems mainly from two case-studies of Open Courseware projects (at the United Nations University and the University of the Western Cape in South Africa), in addition to anecdotal impressions from other open education projects around the world. Most open courseware projects focus on the lecturer as the source of knowledge and are modelled after the original MIT Open Courseware Project. However, this model has proven problematic for many smaller universities, especially in developing countries, and efforts to move towards a student-focused publishing model are showing first positive results.

The combination of user-centric innovation models with affordable means of production and communication in the form of computers and the Internet provides tremendous opportunities to innovate the ways we teach and learn at the university level. In a (truly) open university participants create and share knowledge regardless of their institutional affiliation, age, degree, or demographic characteristics. We use open courseware and open educational resources project to exemplify this point. Yet, the higher education environment seems hesitant to embrace the opportunities of “opening up” and creating space for their students to drive academic innovation. Innovative open courseware projects illustrate the potential for transforming traditional approaches to teaching and learning in universities.
The effects of globalisation and privatisation of public services in market economies have challenged the historical role of the university. Two pathways that can be defined by their different approaches to governance of knowledge, offer to lead towards the university's new social role. A push towards commercialisation requires the appropriation of public knowledge goods as tradable commodities. Open systems based on user-innovation and affordable information and communication technology are based on the concept of shared and open knowledge. Both argue that they will enable sustained innovation and economic growth. Considering three core areas of the university's activities—scholarly communication; teaching and learning; and testing and assessment—through the lens of an open innovation framework, this paper describes how open innovation practices create opportunities for radial innovation of the university.

Setting The Scene – The University Under Pressure to Innovate

The role of universities in today's knowledge society has become the focus of lively debate. Traditionally, universities have served an important nation-building function. However, recent political and economic trends to globalisation have started changing the role and importance of nation states. Products, services, capital and knowledge now move more easily between nations. As a result, in this increasingly networked world, the relevance of nation states and the need for a nation-building institution (at least in developed countries) is less immediate. At the same time, the university has moved into the centre of the economy, as a source of human capacity and knowledge within the innovation system (Mowery & Sampat, 2005: 212). Through rapid diffusion of information and communication technology (ICT) knowledge, a key driver of economic growth has become easier to codify and exchange (David & Foray, 2001; Drucker 2004). Finally, a growing belief that the market is an efficient mechanism to organise and meet the aggregate demand of individuals, has caused a shift towards privatisation of traditionally public services (health care, museums, etc.). The need for knowledge, a belief in the market, and the loss of the nation-building roll, have together created an environment in which the university finds its services in high demand, with tempting opportunities to commercialise them (Bok, 2003). And finally, in the face of enormous ecological, political and social challenges,
new scientific discoveries, and global citizens who are able to implement them to the benefit of humanity, are urgently needed.

In this challenging environment efforts to truly reinvent the university are needed. First attempts have been problematic. One one side, higher education has come under pressure to increase output and reduce cost, by establishing "universities of excellence" (Readings, 1996), which are run like global corporations, trading in commodities of knowledge creation and dissemination, minimising cost and maximising excellent output. Outputs are forced into measurable indicators (numbers of graduates, patents issues to university researchers, etc.) and production is adjusted to correspond to these indicators. Promoters of such universities subscribe to the belief that the market will ensure we get the graduates and discoveries we need (we are likely to end up with the ones we deserve instead). This push to the market has shown little regard for the core values of a unique institution dedicated to the fantastic pursuit of truth (Cowan, 2005).

Another group calls for a return to the pure academic endeavour, disconnected from market pressures or business demands, but fails to argue how globalisation and technological changes that affect all other spheres of society could leave the university untouched. Their proposals ask governments to affirm their commitment to higher education (for example Tilak, 2005), and are described by Lundvall (2002) – an Economist -- somewhat harshly as “a rather hopeless nostalgic defence for 'paradise lost'”.

What is needed is a fundamental innovation of the way the university relates to a world that has changed. Despite the university’s strong sense of tradition, there are examples of similar radical changes and innovations in its past. In 1807, Humboldt implemented a truly original vision for the University of Berlin that was distinctly appropriate for the post-revolutionary period in Europe, and a radical departure from the past. A few decades later, during the 1870s, the establishment of a new (U.S.) American University was a fundamental innovation of an existing outdated system, and eventually led to the United States’ leading position in research and scholarship. (Drucker, 1985: 21)
From here, this paper will briefly cover failed attempts to innovate through the use of ICTs, and then develop an open innovation framework for three of the university's core activities: scholarly communication; teaching and learning; and testing and assessment. Examples from projects around the world will be used to highlight the potential for open innovation in higher education. The final section contains a brief discussion of implications for the university today.

Failed Attempts to Innovate through ICT
The use of information and communication technology (ICT) has been suggested as one possibly way to innovate higher education. ICTs were expected to revolutionise the way we teach and learn, increase access to higher education for all, and improve quality, while greatly reducing cost. As a result public and private institutions came under pressure to integrate ICTs in their activities, and new virtual institutions were created to offer online teaching and degrees.

We know today, that the introduction of ICTs has not had the benefits that many expected. Numerous failed projects have shown that the expectations and hopes, especially with regard to increasing access and quality of higher education in developing countries, were unrealistic (see Keegan et al, 2007, for a review of failed e-learning projects in developed countries). Technology dissidents have felt their predictions confirmed and returned to the comfortable conviction that the traditional ways of teaching and conducting research remain the most effective way for universities to provide value to society.

However, this first wave of ICT in education was not a true effort to redefine the universities role in society, but rather an attempt to increase efficiency and commercialise teaching. In the following section we will introduce the concept of open innovation as an alternative approach in which technology is not the means to an end, but creates opportunities to innovate the university's role and practices.

Open Innovation
Whereas the traditional model of innovation positions the user as a client on the receiving end of a linear trajectory that runs from research lab to the the market (Godin, 2006), recent literature has identified the user as an important and central
source of innovation in at least some areas (von Hippel, 1988 and 2005). In one example von Hippel describes how the mountain bike was created by amateurs who were frustrated by the industry's failure to develop bicycles that were suitable for the mountain paths of California. These industry “outsiders” simply combined parts from existing bicycle models with stronger elements from motorcycles to create a new hybrid product. The mountain bike went on to become the most successful recent innovation in the bicycle industry and now accounts for the majority of bicycles sold by corporate manufacturers.

Enabled by computer networks, similar innovative users have begun forming open collaborative projects in knowledge-intensive sectors (Benkler, 2002). In some industries, such as software and academic publications, these collaborative projects of volunteers successfully compete with traditional firms.

**Open vs Closed**

In the open innovation model, the process of knowledge creation is public and transparent and there is an underlying principle of sharing knowledge rather than restricting access to it. Participants display a strong sense of community (Schroer & Hertel, 2007). The barriers to entry and participation are lower, because the means of production are readily available and affordable (Benkler, 2002).

Open innovation creates high social value, because barriers to participation (and learning) are low, and both the innovation process and its final result are publicly available for others to improve or turn into products and services. Contrary to knowledge development in closed processes, free-riding is not a problem, as there are important benefits from direct participation in the production and membership in the community (these benefits are not available to non-participants). In fact, an increase in free-riding users can have positive externalities such as additional feedback about the quality of the product, and the network effects enjoyed by de facto standards.

There is a concern that “quality” will suffer if innovation processes are open and anyone (meaning, those without qualifications and expertise) can participate.
However, there are reasons why the opposite might be the case, and open processes will produce equal or higher quality than closed ones, including:

- User-innovators are best able to identify and address their own needs and have strong incentives to innovate (von Hippel, 1998 and 2005).
- Collaborators form communities of practice, which offer effective learning and innovation opportunities (Lave & Wenger, 1991).
- Reduced barriers to participation, enable a more diverse population of contributors/innovators; and diversity in opinions and backgrounds can improve a group's ability to identify solutions to problems (Page, 2007).
- Critical evaluation (Popper, 1973) in an open forum serves as the key mechanism that guides community-based knowledge creation. As a result an ongoing process of review and iterative improvement is a fundamental component of the development model (Lee and Cole, 2003).
- United by a common practice of sharing, open innovation communities often display high levels of social capital, which in turn positively influence knowledge production (Nahapiet and Ghoshal, 1998).

There is at least one empirical study on the quality of content production in open models vs. closed models. In 2006, Nature found that the accuracy of articles in Wikipedia, a vast online encyclopaedia that anyone can edit, is on par with the eminent Encyclopaedia Britannica (Nature, 2006).

**Open Innovation in Higher Education**

The university is currently caught in the middle between two possible pathways. Caused by the pressures of globalisation and increased opportunities for commercialisation, one direction argues for increased private appropriation of knowledge; I refer to this here as the closed approach. At the same time, in the open approach, collaborative innovation models enabled by more accessible technology, are beginning to appear, driven by pioneering lecturers and researchers, and in some cases the students themselves.
In the following section I am comparing closed and open innovation in the context of three of the university's core activities: (i) scholarly communication, (ii) teaching and learning materials, (iii) teaching and learning practices, and (iv) testing and accreditation.

Examples from projects across the world are included to support the theoretical arguments put forward, show how open innovation is changing the way universities operate, and highlight that a shift towards open innovation in higher education has already started. In absence of a rich body of research on open innovation in higher education, these examples describe possibilities; more rigorous analysis will be needed to substantiate their promise.

**Open Scholarly Communication (Open Access)**

The original meaning and intention of scholarly publication was to create a public record of original contributions to the body of knowledge and clarify attribution in order avoid disputes over who had made a discovery first. Publication in the Philosophical Transactions, the journal of the Royal Society allowed natural philosophers to stake their claims in the swiftly growing landscape of scientific discovery. The peer-review process to assess these claims expressed a social and political system of participatory meritocracy, in which hierarchy was based naturally on intellectual capacity.

As more publications were created new tools were needed to navigate the quickly growing body of codified scientific knowledge. Citations provided a useful roadmap, showing connections between points A and B, and in aggregate form of citation indices, differentiating intellectual highways from dirt roads.

Keeping up with the state of knowledge in one's field requires access to the publications at the top of the hierarchy. At the same time, one's own rank in this hierarchy influences compensation and recognition. As a result, core journals became indispensable resources and goods in an inelastic market, and the citation index became a “career management tool” (Guedon, 2001).

Commercial publishers stepped in to support researchers' struggles with profitability of their publications, seemingly a welcome symbiosis that allowed researcher to focus on reviewing and evaluating the work of their peers, and
publishers to handle the mundane aspects of ensuring the publication would generate sufficient income to remain sustainable. However, this calculation leaves out the negative effect of price increases on knowledge dissemination (and follow-on research and innovation). One can speculate that while the scientific community believed in the power of the “market” to ensure affordable pricing, publishers realised that this particular market offered tremendous opportunities for rent seeking. As a result, access to the body of scientific knowledge is today far from public or common. This places a severe limit on its value to society, since increased access to research results can positively affect economic growth (for example Houghton and Sheehan, 2006; but going back to Nelson, 1959).

Besides limiting access to the findings, the current hierarchical model of journal publication, also favours certain kinds of knowledge. For example, as a result of structural characteristics, research from developing countries is under-represented (Guedon, 2001; Gibbs, 2006). Participation in the global scientific conversation is not open to all.

Open innovation models can increase diffusion and access to scholarly work. Open access publishing, where authors can either self-archive papers in public online repositories, or the entire journal is available online, has emerged as an alternative with demonstrable benefits. These include: higher survival rates of journals; more citations (and hereby diffusion of knowledge); and increased opportunities for a more diverse participation by global researchers. “Of the scholarly journals started from 2000 - 2006 recorded in Ulrich's, the open access journals were ten times more likely to be still active, strongly suggesting an open access survival advantage for new journals.” (Morrison, 2007). A study of earlier open access journals also shows high survival rates (Crawford, 2006). In addition, although evidence is not conclusive across disciplines, Eysenbach (2006) finds strong evidence that in Biology open access publishing has citation advantages, that “articles are more immediately recognized and cited by peers” and that open access “is likely to benefit science by accelerating dissemination and uptake of research findings.” Finally, there is a strong theoretical argument that some of the structural barriers encountered by African scientists as reported by Gibbs (1995) would not exist in open access journals.
Other open innovation models create alternatives to the journal system of research dissemination. In the case of the United Nations University's Open Courseware Initiative, students have been able to publish short research papers they prepared for their PhD courses online. As a result two students have been asked by an Indian publisher for permission to include their papers in an upcoming book. In a closed model, the students would not have been able to get this level of exposure for their work, the publisher would not have known about the research, and potential readers of the book would not have had access to it.

Open Teaching and Learning Materials (Open Educational Resources)

The case of textbooks shows similarities to journal publications. In many countries, educational materials are produced in concentrated markets with a few (sometimes international) corporations controlling dominant shares, high mark-ups and rising costs (for the case of South Africa see Gray, 2001; Genesis Analytics, 2007). Open innovation models, such as collaborative development of textbooks, offer potential for financial savings for universities and governments (Beshears, 2005), increased quality through the pooling of expertise and the ability for adaptation to local environments. In 2002 the Massachusetts Institute of Technology (MIT) launched its OpenCourseWare project and subsequently published learning resources for its entire course catalogue of more than 1800 courses online, open for others to use, modify and share, and free of charge. MIT has slightly over 10,000 registered students, but it's Open Courseware collection is accessed by more than 1 million uses every month. And other universities are following suit. The Open Courseware Consortium now has more than 150 members from many parts of the world, who have published more than 4200 courses together.

While open courseware projects create important input into other open educational projects (such as informal learning communities), the development model in which most open courseware is produced has been largely institutional and not open collaborative. Most projects focus on the lecturer as the source of knowledge and are modelled after the original MIT Open Courseware Project, in which dedicated staff handles material collection, intellectual property clearance,
graphic design. Finding the resources required for similar projects, has proven problematic for many smaller universities, especially in developing countries. Alternative open innovation models are either working more closely with students or are designed and implemented by students without any involvement of the institution itself.

In Hungary, students of the Faculty of Electrical Engineering and Informatics at Budapest University of Technology and Economics, have created a vast repository of educational resources that includes lecture notes, exam texts with model answers, and summaries of articles and books. Without institutional support (and to some degree without awareness of these efforts) the students have compiled roughly 10,000 pages of content. Main benefits reported by the project co-ordinator are more flexibility in the learning process, and access to useful information to prepare for exams and support studying.

Open Teaching and Learning Practices

Compared to technological advances in other areas, there has been very little real innovation. As one example, the length of undergraduate instruction has remained constant although many characteristics of the economy and society have changed since it was set at 3-4 years. “Most commercial products are distinctly superior to what they were a quarter century ago. In contrast, most college teaching remains, with a few technological embellishments, very much as it was twenty-five years ago – or even fifty years ago, for that matter” (Bok, 2003). New theories in educational research (for example constructivism, scaffolding, active learning) have greatly improved our ability to conceptualise learning processes, but the actual classroom practices have remained largely unchanged. “This is not to say that there is no understanding about principles of good teaching. But these have been known for generations. And it is not clear that we know much more now than one hundred years ago” (Nelson, 2000). Reasons for the slow pace of innovation in teaching are varied, but one limiting factor is the absence of appropriate incentives to codify, diffuse, and absorb innovation for instructors (Foray and Hargreaves, 2002). Lecturers are evaluated (and promoted) on the basis of their research, not the quality of their teaching. Yet, there are examples of teachers as well as students, and
communities outside of the education environment, that are finding ways to innovate in open models.

Free and Open Source Software projects are open to participation, and provide opportunities to learn and gain new skills. The process through which participants in these communities develop skills is similar to an informal apprenticeship where inexperienced developers learn from their peers. Individuals invest time and effort to learn and share knowledge, but no money is exchanged, and social value in the form of a skilled work-force is produced. The practices that have evolved in FLOSS communities are innovative and effective. FLOSS developers make use of electronic communication tools, sophisticated co-ordination structures, and collaborative artefact development. An interim study found that FLOSS contributors consider the developer community a more effective learning environment than formal training not only for skills relevant to software writing, but also management and intellectual property (Ghosh & Glott, 2005).

The poor quality of secondary education for (previously) disadvantaged communities in South Africa is one reason for the low graduation rates of poor learners, and even lower enrolment in tertiary education. Non-profit organisation IkamvaYouth started offering supplementary tutoring and career guidance to help high-school students from townships in Cape Town enter university. The organisation was entirely volunteer driven and unfunded until recently (it now employs some of the learners that have come through the programme), and has been managed on the basis of open innovation community principles – anyone can participate in management meetings, but those that contribute most and show leadership are elected by the community to have higher voting power than others. All teaching materials that Ikamva Youth develops are shared freely online – and are being used by others. The results show how effective a user-driven approach can be in preparing learners for tertiary education. “Between 42 and 65% of IkamvaYouth's learners access tertiary institutions (estimates for township youth are generally around 1%)” (Ikamva Youth, 2008).
Open Testing and Assessment

Without the ability to demonstrate acquired knowledge, an investment in education can not easily be recovered by the student. Employers need ways to assess applicants abilities, and a university degree from a respected institution is one common practice of doing so.

Assessment and accreditation are strictly regulated to ensure certain quality standards of graduates. The approaches differ slightly between countries slightly, but most require universities to have some form of accreditation in order to be able to award degrees. In addition there are efforts to evaluate and accredit degrees internationally to improve cross-border acceptance. Accreditation of students takes place at three levels: (i) instruction/learning process, (ii) assessment of knowledge, (iii) awarding of certification. A number of open models, both within universities and offered by new providers are emerging at all three levels.

Open reputation models might create very different opportunities for accreditation in the future. For example, in Free and Open Source Software communities, developers enjoy reputation based on their level and quality of participation, and report that their FOSS experience has a positive effect on employability similar to that of a formal degree: “According to the respondents of the FLOSSPOLS developer survey there cannot be any doubt about the compensational capacity of FOSS experience, as 70 per cent claim that FOSS experience can compensate for the lack of formal degrees and only 16 per cent state it cannot” (FLOSSPOLS, 2005). Employers remain slightly more cautious, but over 56% of respondents report that FOSS experience is either similar or superior to a formal degree.

An example for open innovation within an educational institution is being launched at Utah State University, where a pilot project will allow anyone to register for some of the university's courses and--upon passing a final exam at the total cost of US$ 20--be awarded three official US university credits. There are no additional costs for textbooks, because the selected courses are also part of the open courseware project at USU, which means all course materials are licensed openly and available online. USU has a policy environment that was conducive to such innovation: it included a provision to allow anyone, not just students, to register for
courses (up to a certain number of course credits, after which the student has to be admitted into a degree programme); and allowed students to ask for an opportunity to demonstrate sufficient knowledge of a course by completing only a final exam. In combination with the existing open educational resources, this offers self-motivated students opportunities to obtain credits towards an undergraduate college degree at almost no cost for teaching, testing, or accreditation.

From Open Innovation Towards a New Social Role for the University

We have identified a common thread across some core activities of universities. Financial pressure and the perception that some aspects of the public education system are wasteful have increased applications of a business approach to education that promises to save costs and increase quality. In order to enable commercialisation, the university's knowledge assets need to be appropriated—for example as copyrighted textbooks or articles, or patents--and turned into private goods. Access is closed off.

Applying open innovation models to higher education suggests a new social role for universities. Defining this new role requires us to consider the influence of technological and social change and globalisation on dearly-held traditions: the institutional unity of research and teaching; the bundling of teaching, assessment, and accreditation services; the careful hierarchical approach to knowledge creation and diffusion; and the strict differentiation between student and teacher roles that limit students’ ability to participate in innovation of the educational experience. The combination of user-centric innovation models with affordable means of production and communication in the form of computers and the Internet, provides tremendous opportunities to innovate the ways we teach and learn at the university level. These new practices will not replace the richness of personal face-to-face interaction in campus-based programmes, but they offer possibilities for those without access, and enhance the experience of others already enrolled on campus. In a (truly) open higher education environment participants create and share knowledge regardless of their institutional affiliation, age, degree, or demographic characteristics.
Innovative projects in many areas, and across the world, already illustrate the potential for transforming traditional approaches in higher education. Yet, many universities seem hesitant to embrace the opportunities of “opening up” and creating the space for their researchers and students to drive academic innovation from within the institution. This creates opportunities for outsiders and while such new sources of innovation hold tremendous potential, they might not be grounded in commitment to scholarship, advancement of knowledge, and service to society, as the university has traditionally been. Embracing open innovation models is the first step towards developing a new social role of the university in the global knowledge economy.
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